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New Perspectives in Information Systems and Technologies, Volume 1

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Preface

This book contains a selection of papers accepted for presentation and discussion at The 2014 World Conference on Information Systems and Technologies (WorldCIST'14). This Conference had the cooperative support of AISTI (Iberian Association for Information Systems and Technologies/Associação Ibérica de Sistemas e Tecnologias de Informação) and IEEE Portugal Section. It took place between the 15th and 18th of April in Funchal, Madeira, Portugal.

The World Conference on Information Systems and Technologies (WorldCIST) is a global forum for researchers and practitioners to present and discuss recent results and innovations, current trends, professional experiences and challenges of modern Information Systems and Technologies research, technological development and applications. One of its main aims is to strengthen the drive towards a holistic symbiosis between academy, society and industry. WorldCIST'14 built on the success of WorldCIST'13, held last year in Olhão, Algarve, Portugal.

The Program Committee of WorldCIST'14 was composed of a multidisciplinary group of experts and those who are intimately concerned with Information Systems and Technologies. They have had the responsibility for evaluating, in a 'blind review' process, the papers received for each of the main themes proposed for the Conference: A) Information and Knowledge Management (IKM); B) Organizational Models and Information Systems (OMIS); C) Intelligent and Decision Support Systems (IDSS); D) Software Systems, Architectures, Applications and Tools (SSAAT); E) Computer Networks, Mobility and Pervasive Systems (CNMPS); F) Human-Computer Interaction (HCI); G) Health Informatics (HIS); H) Information Technologies in Education (ITE).

WorldCIST'14 received contributions from 42 countries around the world. The papers accepted for presentation and discussion at the Conference are published by Springer (this book) and by AISTI (another e-book) and will be submitted to be indexed by ISI, EI, SCOPUS, DBLP and/or EBSCO, among others. Extended versions of best selected papers will be published in relevant journals, including SCI/SSCI and Scopus indexed journals, and in a SCI series book.

We acknowledge all those who contributed to the staging of WorldCIST'14 (authors, committees and sponsors); their involvement and support is very much appreciated.

Madeira, April 2014

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Abstract. Information on insolvency proceedings is among the most important indicators as to the quality of the entrepreneurial environment in individual states. It is likewise important for entrepreneurial subjects, as without knowledge of the fact that a business partner or cooperating firm is in insolvency they cannot participate in insolvency procedures and thereby enforce their receivables. Despite this, there is as yet no European system of insolvency registers, and in numerous European Union states it is difficult to check whether commercial partners are in insolvency or not. This state of affairs leads to an increase in creditors' costs or to a situation where legitimate creditors do not even claim their receivables. Yet given rigorous utilisation of the possibilities of information technologies, it would be relatively easy to provide the public with substantially better information as regards insolvency proceedings. Using examples from the Czech Republic and other states, this work shows the possibilities that would arise even with relatively simple usage of modern information methods.

Keywords: bankruptcy, information technology, insolvency, reorganisation, state department, statistics.

1 The Significance of Information on Insolvency Processes

Information on insolvency proceedings has a relatively high testimonial potential for economic subjects. Firstly, it gives a signal as to the quality of the entrepreneurial environment in the country; secondly, it defines the extent of risk by which the default of a commercial partner is burdened and thirdly, it refers to the quality level of court proceedings. Here, however, we are speaking of an optimal case when information on the course and outcome of insolvency proceedings is in fact available. In reality, however, our knowledge of the manner in which these proceedings run their course is very sparse.

It likewise applies that information available simply and without high expenses as to a debtor's state of insolvency entails lower transactional costs for creditors. If the actual ascertaining of a debtor's insolvency is difficult and gaining such information

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requires spending considerable time and perhaps also incurs further costs, an entrepreneurial subject is consequently faced with the risks connected with these difficulties being implemented into prices – then, if this risk is in principle the same for the majority of entrepreneurial subjects in a given field, potential transactional costs become part of the price level.

Entrepreneurial subjects therefore need certain items of elementary information to make correct decisions. The first level includes easy and effortless availability of news of a debtor's state of insolvency, which entails availability in an electronic register of insolvent subjects, where entry is direct and free of charge.

Here it is necessary to confront the logical objection that ascertaining a debtor's state of insolvency is important for the creditor and the creditor therefore cannot demand from state bodies a simplification of its position, especially not at the expense of outlays from the public budget – not even in the event that it would be useful to a large number of creditors simultaneously. This objection would be founded if the state did not force creditors to behave according to a specific model. However, in all developed countries it applies in reality that the possibility for creditors to enforce their receivables individually ends once an insolvency proposal is filed against a debtor, and the only other possibility is to participate in collective enforcement, i.e. in insolvency proceedings (On this problem, see [1] or [2]. A polemic with this approach is held in [3], for instance.). Because non-participation in insolvency proceedings leads to unenforceability of receivables, a clear responsibility arises on the part of the state authority to make insolvency proceedings accessible to all existing creditors. This especially concerns the availability of information on the actual commencement of insolvency proceedings.

On the next level, it is necessary for entrepreneurial subjects to have at their disposal information about the customary course of insolvency proceedings and their usual outcome. This primarily concerns references on the standard duration of insolvency proceedings, on the average costs of such proceedings and also on the standard satisfaction gained by creditors (secured, but mainly non-secured). Even here, the same argument against the state authority applies as in the previous case: Given that the state imposes a certain approach on creditors under certain conditions, it is logically obliged also to create adequate information systems that will provide commercial subjects with information as to the efficiency of the forced approach.

And finally, at the highest level, which is now connected with the general legal certainties of economic subjects, it is essential that these subjects have access to information on the course of insolvency proceedings without the necessity of incurring further costs to ascertain such information. There is yet again the requirement for availability of information through electronic networks without further fees. This level arises directly from the principle of collective enforcement of a receivable, created by the situation of the common pool.

As far as the prisoner's dilemma or common pool is concerned, both of these games deftly describe insolvency proceedings, even if they are too simple. There is only one round in insolvency proceedings, albeit divided into several, to some extent different, partial games. The example of the common pool is based on the fact that the pool has the same parameters for all fishermen and they have the same possibilities and technologies – although none of this applies in insolvency practice.

But a relatively fundamental question should be discussed here as to why the state authority enters into the area of enforcing variables from debtors and imposes on creditors participation in collective enforcement that is regulated and to a certain extent also directed by the state. It is regulated in the sense that the state adjusts this area with a special act that in effect terminates the possibility of individual enforcement. It is directed by means of insolvency courts, i.e. institutions created especially so as to supervise the due regulation of insolvency processes. States generally tend to enter the common pool situation – in that sense, their behaviour is predictable – as for goals that regulations are meant to achieve, the most common argument voiced is the need to find a "just" solution and prevent insolvency proceedings from becoming the place for unauthorized redistribution of assets. If "justice", however, is the goal, then the state authority is obliged to create at its own expense an environment to ensure that justice can be attained.

If we take the Czech Republic as an example, where Act 182/2006 Coll. on bankruptcy and ways towards its settlement has been in effect since 2008, we can see that the insolvency system has in many of the above-mentioned aspects reached the peak, even in comparison with the most developed states. On the other hand, it is surprising that despite the large amount of work done in this direction (which has led to broader legal certainty on the parts of creditors) this progress has stopped at a certain level of utilisation of information technologies. Similarly, one might be surprised that despite significant progress in the quality of insolvency proceedings and their societal control was made after January 2008, the impact evidently met expectations to a significantly smaller degree in terms of real results.

In the following passages we will attempt to analyse the influence of the extent of usage of information technology on qualitative parameters using primarily the example of the Czech Republic and comparing it with other states (especially with countries of the European Union).

2 The State of Usage of Information Technology in the CR and Other Countries

2.1 The Availability and Existence of Insolvency Registers

In the period prior to the coming into force of the above-mentioned Insolvency Act, information on the course of proceedings for interested parties was practically unavailable; it was often available to participants of proceedings only with relative difficulty. This applied both for individual proceedings and from the perspective of aggregated data describing the quality of proceedings using average values or other statistical methods. The emergence of the insolvency register was an enormous step forward in this sense.

The insolvency register in the CR [4] is accessible on-line without registration, contains practically all actions that were taken during proceedings, and the corresponding documents are entered into the register practically immediately, as soon the court does so or as soon as the court receives information about them. Even information on the actual filing of an insolvency proposal is made public without delay, practically within a matter of hours.

Although the European Union has on several occasions recommended to member states that they liberalize the area of sharing of information on insolvency proceedings and enable electronic circulation of this information, the situation in many member states remains far from comforting. In the European Union Commission's official statement on this problem it states, among others, that "Insolvency registers are a very important source of information of a legal nature for facilitating the daily tasks of citizens, legal professionals, state authorities, companies and other interested parties. They facilitate access to official and trusted insolvency-related information to banks, creditors, business partners and consumers. This information enhances transparency and legal certainty in European Union markets." [5]

If we examine the situation in individual states more precisely, we find unusual differences, which we will now describe by dividing these states into several groups.

The first group consists of states where the insolvency register is available without fees and registration and to all subjects regardless of whether they are parties that are interested or uninterested in a particular insolvency case and regardless of whether these are professionally interested parties or not. At the same time, it applies that information on the course of proceedings and individual court rulings is also available. Here we can include the Czech Republic, Germany, Austria, Spain, Latvia, the Netherlands (with certain minor reservations), Poland (although here we have only partial and not complete information available on the course of proceedings), Portugal (with the same reservation as in the case of Poland), Romania and Slovenia.

In the second group, we include countries where the insolvency register is accessible, but only under certain further specified conditions – this could either be registration of the user, or the information is available for a fee; nevertheless, under certain conditions, it is possible to gain complete information on insolvency proceedings. At the same time, however, information as to the commencement of insolvency proceedings with a particular company (or natural person) is free or available without further complications. At present, Finland and Sweden belong here.

In the third group, we include countries where insolvency registers do not exist, but information on changes in the state of a business and mostly also on certain further steps connected with proceedings is available electronically in other sources, especially in the business register or list of companies. At the same time, one must add that this information tends to be limited and does not provide an absolutely complete image of the course of proceedings. Nevertheless, news that a debtor's company is in insolvency is available directly and free of charge and, most importantly, in electronic form. Belgium, Estonia, Ireland, Latvia, Luxembourg, Hungary (besides information on the state of a company, one can relatively easily also find court orders in individual bankruptcy proceedings, although the information is not legally binding, and its completeness is not guaranteed) and Slovakia (the insolvency register is in a pilot phase and searching is limited; after its completion, Slovakia will move to the first group) are part of this group.

The fourth category includes states that for various reasons do not have a cohesive electronically accessible insolvency register – Bulgaria (information from individual judicial proceedings is not connected, but is relatively available at individual courts, if often incomplete, i.e. it is not possible to reconstruct a general image as to the course of proceedings) and lastly Cyprus (an electronic register is kept, but searching for information is extremely difficult).

States which do not keep an insolvency register are in the fifth group: Denmark, Greece, France, Italy (a system is being launched) and also Malta. In certain cases of these states, information on the commencement of proceedings is available in commercial registers, although the information is not legally binding and is available with some delay. In other cases, information is made public only in printed outputs (bulletins).

The situation in the United Kingdom is special as there is a different system in England and Wales, in Northern Ireland and in Scotland. As regards England and Wales, a complete register of natural persons is kept and it is also possible to gain (in a slightly limited degree) information on the state of the entrepreneurial sphere. In Northern Ireland, there is a complete register falling mostly into the first group, and in Scotland there is also a register, although it charges quite high fees, i.e. falling into the second group. Britain thus cannot be unambiguously classed into any of the above-mentioned groups, although mostly features of group number 1 predominate.

As we can see, despite the European Commission's endeavour to ensure that creditors are informed so as not to disqualify foreign investors as opposed to domestic creditors and so that incorrect conditions do not arise for creditors in general, it is still very difficult to gain this information at present. This is heightened by the fact that the majority of registers are operated strictly in the languages of the individual countries (including the actual notification of a company's insolvency), so there is a relatively significant language barrier for foreign investors.

2.2 Further Problems with Insolvency Registers

The issue of availability of information via internet connection in real time and without further limitations is, however, only one of those that appear in this area in connection with utilisation of information technology. From the perspective of users of information systems, information on individual cases is one level of the problem. This level is of interest especially to investors and persons interested in these particular cases, i.e. especially creditors. The second level, then, is the problem of complete information on the performance of insolvency systems, their efficiency, on the usual length of proceedings and also creditors' expenses in enforcing receivables. This view, as we have already described, is of considerable importance as an indicator of the general quality of the economic environment.

As regards these items of information, it is almost surprising how few thereof we have at our disposal and, moreover, the extent to which they are mutually incomparable. In the Czech Republic, for instance, information is available on commenced insolvency proceedings, on the number of declared bankruptcies, the manner in which these bankruptcies are settled, to a certain extent on the duration of insolvency proceedings (albeit in this case with considerable reservations as to the relevance of these data). The sum of available data practically ends here; the Ministry of Justice CR receives a statistical questionnaire on all completed proceedings, although the quality with which these questionnaires are completed and processed is clearly thoroughly inadequate. The information gained has not been made public; it was utilised when the amendment of the Insolvency Act was being prepared. It is surprising, then, that we encounter similar limitations quite regularly in other countries which also do not provide the market with relevant information on the course of insolvency proceedings.

A further oddity from the perspective of information technology is the ongoing dependence of court systems and insolvency proceedings on paper information carriers. The Czech insolvency register contains absolutely all events that take place during proceedings (with a small few precisely defined exceptions, although some information could be entered into the register subsequently). This means that numerous documents which record these events emerge in a fully electronic environment. Despite this, the information is entered into the system in pdf or jpg documents generated by scanning from paper forms. But no system of electronically verified documents (in which practically all legal persons are involved) exists in the country.

The situation in other countries of the European Union is for the most part not much different. Here also, court cases and insolvency proceedings are based primarily on paper documents, even in cases where these documents were originally in electronic form. Despite this, they are usually printed initially for the needs of the insolvency registers and then scanned and saved so as to be available and so that they can be searched.

This, however, leads to numerous limitations when searching in insolvency registers. To return to the Czech case once again, a long list of limitations exists here. Firstly, it is not possible, for instance, to select from a total number of identified cases those, for instance, where reorganization was chosen as a method of settlement after a declaration of bankruptcy. After searching for a concrete case, the interested party can open all documents that the court has stored in the insolvency register, meaning not only documents created directly by the court, but also those submitted to the court by participants of the proceedings or other relevant persons. Where more complex cases are concerned, this leads to an interesting effect – it is almost impossible to find what is relevant in the flood of information. For instance, on the 9 November 2013 the insolvency register contained a total of 4783 documents in the case of the proceedings with the Sazka lottery company, whereas 3405 of these were applications by creditors and steps concerning these applications. The difficulty lies in the fact that these documents are generally divided only into those concerning the proceedings before declaration of bankruptcy, proceedings after declaration of bankruptcy, documentation of incidental lawsuits, a division of "other" and finally "receivables". Within these individual sections the system offers no further search possibilities. Searching for them is possible only by using the regular Ctrl+F function in the search engine. But owing to the fact that document titles placed in the insolvency register are often standardised, searching by terms is problematic. Individual steps within the scope of proceedings have their own code labels (this is the ID events column in the extended display mode). But in order to use these, the interested party would have to have at its disposal a list of these codes and their specification; moreover, it is possible even then to search only by using the Ctrl+F function.

In the actual document titles, however, the name of the participant (who filed the document and whom the document concerns) of the proceedings is not stated. The name of the creditor is only exceptionally stated in the column of valid creditors, but this is so only in a minimum from the entire number of entries in the insolvency register. It is not possible to identify creditors from code identifications. In the case of Sazka, this then means that it is unusually difficult to find a specific application for a receivable and the correspondence around this application (for example, its partial or complete withdrawal).

As we can see, the register which was established according to the Act from 2006 and which has been working since 2008 (and which gives the impression of being very thorough) does not in fact enable, or at least does not facilitate detailed investigation of individual cases and their analysis. The register in this form is thus an unusually useful tool for participants of insolvency proceedings, but it is not suitable for more comprehensive analytic activity or investigation of the entire insolvency system from the perspective of its performance and the quality of its course.

2.3 Possibilities for Rectification

While we do not have any ambition here to offer a complete solution to the problem described above, elementary steps moving in the direction of rectification can be expressed fairly simply.

- the system would be significantly improved by strengthening search possibilities especially in a way that would easily enable search of entire groups of proceedings or types of individual actions, such as identical steps undertaken within a certain period in all proceedings underway at the time, or in a part of ongoing proceedings (such as focusing on a specific insolvency trial),
- it is crucial to strengthen search capacities so as to be able to search through a long time period, which is basically not possible at present,
- in the case of individual proceedings, it should be possible to select from the entire set of documented steps and acts of individual actions of the same type (for example, information on the course of proceedings compiled by the insolvency administrator), documents concerning individual receivables should be marked with codes allocated to assigned applications in such a way as to make it possible to select documents concerning specific receivables.

None of these steps should entail a fundamental technical problem, and this should not be an unreasonable measure from the perspective of costs. It is to a certain extent an irony of fate that clearly the most complex action would be the marking of documents (with the aid of code markings) of individual applications for receivables or of individual creditors. This would entail a certain burdening of the courts and some (albeit rather exceptional) cases would in fact require relatively sophisticated professional solutions.

3 The Relationship between Access to Information and Results of Proceedings

As has already been mentioned, we have no relevant statistical information on the course of insolvency proceedings in countries of the European Union or in other states. There is, however, one very interesting initiative by The World Bank (WB) and International Finance Corporation (IFC).

3.1 *Doing Business* and Interesting Aspects of Data in This Publication

WB and IFC's regularly issued mutual publication, titled *Doing Business* [6], contains a very interesting survey conducted among experts in individual countries. The editorial team addresses distinguished lawyers and other respondents who are directly concerned with insolvency proceedings and applications of insolvency law. The same question is consistently posed to them or, to put it more precisely, the same model case from an insolvency proceeding. [6] The respondents' task is then to answer a series of questions. They are asked for their estimate as to the duration of this particular model case in the given country, what satisfaction individual creditors would gain and what expenses would need to be outlaid for the insolvency proceeding. The data gained from individual experts are then aggregated and a professional estimate for individual national economies is gained thereby.

As one can see, it is pointless to consider this model to be anything that could compete with statistical data. This is primarily an opinion poll – albeit aimed at the professional public. Furthermore, the defined case of the company in bankruptcy is relatively atypical (at least from the perspective of experience in the Czech Republic). The debtor has relatively significant property, but its assets have not been expended in the endeavour to save the business, nor have they been removed in an attempt to transport the assets out of the creditors' reach. In the real world, however, debtors of this type usually appear sporadically or at least are not as common as debtors whose assets are few and suffice to repay creditors only partially or not at all. The case presented to professionals by WB and IFC may be a model, but it is not a usual one. In reality, creditors' yields are significantly lower than those in this study.

The data from the survey in *Doing Business* can, however, serve well for comparing the performance of insolvency systems in individual countries. Of course, there is the question of how great a role is played by individual approaches in the way particular respondents reply – we can assume that some of them "improve" their country's results, i.e. they give more optimistic replies. But it is just as easily possible that other respondents will be stricter with their countries and their replies will therefore be more pessimistic. Let us say, however, that the quality of replies (especially in the group of "developed countries") should be essentially similar, so these surveys can serve the purposes of international comparison.

3.2 The Basic Results of *Doing Business*

It will be interesting to compare the data from *Doing Business* by separating individual countries of the European Union into groups according to how easy or, on the contrary, how difficult it is to gain information on insolvency proceedings that have commenced or are in progress.

Table 1. The relationship between availability of information on insolvencies and results of proceedings (Time in years, Cost in % of estate, Recovery rate as cents on the dollar)

Country	Year	Rank	Time	Cost	Recovery rate	Group
Netherlands	DB2004	..	1.1	4	87.4	
Netherlands	**DB2013**	**6**	**1.1**	**4**	**88.8**	**1**
United Kingdom	DB2004	..	1.0	6	85.6	
United Kingdom	**DB2013**	**8**	**1.0**	**6**	**88.6**	**1**
Austria	DB2004	..	1.1	18	73.1	
Austria	**DB2013**	**12**	**1.1**	**10**	**83.3**	**1**
Germany	DB2004	..	1.2	1	83.2	
Germany	**DB2013**	**19**	**1.2**	**8**	**78.1**	**1**
Spain	DB2004	..	1.5	15	73.5	
Spain	**DB2013**	**20**	**1.5**	**11**	**76.5**	**1**
Portugal	DB2004	..	2.0	9	73.2	
Portugal	**DB2013**	**23**	**2.0**	**9**	**74.6**	**1**
Latvia	DB2004	..	3.0	13	35.7	
Latvia	**DB2013**	**33**	**3.0**	**13**	**59.8**	**1**
Czech Republic	DB2004	..	9.2	18	15.4	
Czech Republic	**DB2013**	**34**	**3.2**	**17**	**56.3**	**1**
Poland	DB2004	..	3.0	15	31.4	
Poland	**DB2013**	**37**	**3.0**	**15**	**54.5**	**1**
Slovakia	DB2004	..	2.0	8	41.6	
Slovakia	**DB2013**	**42**	**2.0**	**4**	**49.8**	**1**
Romania	DB2004	..	4.6	9	6.9	
Romania	**DB2013**	**102**	**3.3**	**11**	**29.2**	**1**
Finland	DB2004	..	0.9	4	88.3	
Finland	**DB2013**	**5**	**0.9**	**4**	**89.7**	**2**
Sweden	DB2004	..	2.0	9	81.0	
Sweden	**DB2013**	**22**	**2.0**	**9**	**74.7**	**2**
Belgium	DB2004		0,9	4	86,0	
Belgium	**DB2013**	**7**	**0,9**	**4**	**88,7**	**3**
Ireland	DB2004	..	0.4	9	87.7	
Ireland	**DB2013**	**9**	**0.4**	**9**	**87.5**	**3**
Slovak Republic	DB2004	..	4.8	18	39.8	
Slovak Republic	**DB2013**	**38**	**4.0**	**18**	**53.6**	**3**
Lithuania	DB2004	..	2.0	22	34.3	
Lithuania	**DB2013**	**40**	**1.5**	**7**	**51.0**	**3**
Luxembourg	DB2004	..	..	..	..	
Luxembourg	**DB2013**	**52**	**2.0**	**15**	**43.5**	**3**
Hungary	DB2004	..	2.0	15	38.8	

Table 1. (*continued*)

Hungary	**DB2013**	**70**	**2.0**	**15**	**38.8**	**3**
Estonia	DB2004	..	3.0	9	36.6	
Estonia	**DB2013**	**72**	**3.0**	**9**	**38.5**	**3**
Cyprus	DB2004	..	..	..	..	
Cyprus	**DB2013**	**25**	**1.5**	**15**	**70.7**	**4**
Bulgaria	DB2004	..	3.3	9	33.8	
Bulgaria	**DB2013**	**93**	**3.3**	**9**	**31.7**	**4**
Denmark	DB2004	..	3.3	4	63.1	
Denmark	**DB2013**	**10**	**1.0**	**4**	**87.1**	**5**
Italy	DB2004	..	1.8	22	34.9	
Italy	**DB2013**	**31**	**1.8**	**22**	**63.4**	**5**
France	DB2004	..	1.9	9	45.7	
France	**DB2013**	**43**	**1.9**	**9**	**48.4**	**5**
Greece	DB2004	..	2.0	9	44.5	
Greece	**DB2013**	**50**	**2.0**	**9**	**44.5**	**5**
Malta	DB2004	..	..	..	..	
Malta	**DB2013**	**67**	**3.0**	**10**	**39.2**	**5**
Croatia	DB2004	..	3.1	15	28.8	
Croatia	**DB2013**	**97**	**3.1**	**15**	**30.1**	**X**

3.3 Comparison of Countries According to Freedom of Information and Efficiency of the System

As we see from the preceding table, our categorisation into groups according to type of information openness in the area of insolvency proceedings does not at first glance influence the efficiency of insolvency processes. However, if we look at the problem more precisely, we find several strong arguments that tend rather to confirm the relationship between these parameters. In the Czech Republic, for instance, the estimates of professional respondents to the survey have significantly improved following the coming into force of the Insolvency Act as of January 2008, whereas the generally accessible insolvency register is in fact one of the building blocks of the system. We can prove a similarly drastic improvement of the situation in other states also – in Rumania, Slovakia, Poland and Latvia. Furthermore, it applies that although the second group is specific insofar as insolvency register services are not free of charge or are subject to registration, this is in both cases a formal difficulty, and once it is overcome, interested parties can monitor any insolvency proceeding in detail. Yet both Finland and Sweden have one the best-rated insolvency systems in the world (shown by the "Rank" column, which states the order of the country in comparison to insolvency systems in more than 170 countries).

If we consider the third group (information freely available on the internet, but to a limited degree) as open in terms of information, then in the first to third group one can find the vast majority of economies that are evaluated positively on the parts of experts in insolvency proceedings. Here we can find five out of ten countries which are best evaluated worldwide in the area of insolvency proceedings. Denmark, Italy, Finland and Greece are special cases – insolvency proceedings in these countries tend to be successful and are evaluated positively (to the fiftieth place in global comparison); nevertheless, the possibility to gain information on insolvency proceedings is limited. But especially in the cases of Denmark and France, these are traditional economies and stable state systems where court authority functions relatively quickly and predictably – it is for this reason that their insolvency systems are effective despite the reservations mentioned.

4 Closing Thesis

It therefore seems to be possible to prove a certain dependency between two researched aspects. The first aspect is the emphasis with which the state authority utilises information technology so that insolvency proceedings can be monitored by the public and information on individual cases can be available either without any limitations whatsoever or with only minimal limitations. The second aspect, then, is evaluation of quality of insolvency processes and the estimate of their efficiency on the parts of the professional public. It seems that at least within the bounds of the European Union, we can track a certain dependency between the extent to which information technology is used and the quality of insolvency proceedings. To return to the example of the Czech Republic, insolvency proceedings in the country have, according to expert evaluation, shortened to a third of the original time following the introduction of the new Act and, connected with this, with the utilisation of the possibilities of information technology; costs for proceedings have decreased slightly and creditors' yields have increased fourfold.

On the basis analyses of the search possibilities of the insolvency register built in the Czech Republic, we have nevertheless come to the conclusion that, given better utilisation of information technology and especially given better utilisation of the possibilities of searching in existing databases, the possibilities of utilising information that is now available would be fundamentally increased at relatively low cost and through what would in substance be relatively small technical changes. While the awareness of specific cases is practically absolute (as the vast majority of documents are made public within a very short term), the possibility of analysing a larger number of cases is practically nil. This is one of the reasons why economic subjects do not receive truthful information on the efficiency of the insolvency system as a whole.

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The Intention to Share and Re-Shared among the Young Adults towards a Posting at Social Networking Sites

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Abstract. The activity of sharing information among the young adults over the Internet has led to various types of damages in the community. This study explores the damages leading from posting of young adults' overs the social network. The damages in this context refer to the damages in the form of business reputation, psychologist damages, cyber bullying and etc. In order to provide a neutralizing platform to these damages, the intention on the sharing and re-sharing between the postings among the young adults is studied. This paper summarizes the result of the intention to share and re-shared mechanism of the young adults on a posting at social networking sites.

Keywords: Social Tie, Social Influence, Social Network Analysis, Share and Re-Share.

1 Introduction

Online Social Network (OSN) has becoming indispensable activities for young adults. Romero et al, (2011) [1] pinned that people rely on other people to spread their information in order to strive for attention flowing through social media. Social networking have become a popular medium for users to interact with each other's in which it has become a more well-liked online activity compared to email. It is a fundamental part of the global online experience nowadays (Wilson et al, 2009) [2]. Kramer (2012) [3] showed that a person's emotion can be easily influenced by someone with its statement posted at social media. He conducted a three days analysis where the selected participants posting are studied for the next consecutive days. Significantly, the result shown that, when the information is shared, a large group of people might be influenced. It happens to both the positive and negative effects. This shows that social media can eventually influence people.

Social network had also become a tool to explore approaches to behavioral change, for instance health panelist broadcasting personal health goals on Facebook to influence health challenges [4]. Social networking or information technology these days are not the only issues that influences the community, the way of people use or

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shapes that enables strengthen ties with colleagues has its influences [5]. Thus, what are the ways that people use to strengthen the ties? What are the main reasons the user share or re-share a posting? If the intention of sharing is positive, is the action of re-sharing of a same posting affected by the social tie? What are the main reasons user share and re-share a posting? Thus, this study not only explores how people use the social network, but also investigates the intention to share and re-sharing a posting.

2 Related Work

Ellison (2007) [6] recorded that the first social networking site (SNS) was created in year 1997. Friendster was well known for a period of time until overtaken by Facebook in year 2005. Twitter and LinkedIn have later stands a very good status in the consumer perspective. Figure 1 shows that Facebook and Twitter were the top leading social networking site in 2012 with the highest numbers of visitors based on U.S. statistics.

Fig. 1. SNS top users list 2012 from [7] comScore

Online Social Network (OSN) has become a very important interactive medium nowadays. Several studies have proven the interaction within the social media and its effectiveness in supporting different types of implementations. OSN not only allows friends to interact with each other [8], it also promotes health and wellness behavior spread [4]. It strengthens social ties and increases trust of the co-workers [9], as well as determining a competitive relations between companies to success [10]. It also promotes marketing activities [11] and was utilized to increase the decision support in social capital and job hunting process [12]. Researcher studied the usage point on social networking sites [13]. Most of the studies render around the benefits, the effectiveness of the social networking sites, the implementation and its influences to others.

However, social networking has its own share of dark side. Although social networks are increasingly used for business branding, they also have negative effects among the young adults. Therefore, business are actively searching for effective marketing strategies, tapping online to build better products, and strengthening the branding at social networking practices [14]. Summers (2011) [15] verified that teenage nowadays cannot go longer without checking their Facebook message or updates. Verbal communication among them has been reduced in their real life activities. As a result, some of the youths today not only unable to construct a proper sentence, but also make grammatical and spelling errors while writing and applying for a job [15]. Although there are some studies on utilizing the social network in job hunting and requiting process, the effectiveness in this is still under investigation.

Identity theft and cyber bullying has also become frequent illegal activities in social networking sites [16]. It has been warned that one should not share contents with others if they do not trust each other [17, 18]. However, most of the users may not aware that their information has been sneaked for other purposes. Trust has been one of the key issues in social media. Privacies and security are also the issues concerned [5, 19]. Study by Romero (2011) [1] has determined the influence and passivity of information forwarding activities of the social platform. The damages were caused by misusing of social networking information especially in harvesting the email addresses of others and creating spam for their benefits [20]. Privacy issues and identity theft on a social network has also been linked to cyber bullying [16].

How much does the Social Media damage the business branding? This has to do with how the damaging had occurred. Social media had intensively spread the "news", no matter it is true or untrue of that particular period of time. And the action of sharing and re-sharing are the main reason of this spreading mechanism. So, what is the intention of these actions by the user? And does the strength of ties in the community affecting it? Let's study this case, Figure 2 shows a conversation and complaints about a café that a blogger has visited. In respect to the dissatisfaction of this café's customer service, the reputation of this restaurant is affected by the blogger in a very short period of time. There are approximately 3,300 of shares and 2 over thousands of likes of responses to this issue in 11 hours. Users from distinct location have also commented and it has strongly damaged the branding of the particular cake shop. The power of worth-of-mouth has indispensably effected the reputation of the business in this case. This is caused by the action-reaction mechanism of the social tie among the respondents towards the posting.

Fig. 2. Screenshot of customer complaint on Facebook with the number of "3342" of share at the "11' hours after it was shared at this posting

What are the intentions of sharing the posting among them? How the sharing of posting does affects the young adults? Figure 3 depicts a scenario in which two Social Networking Sites' users who are able to communicate in social media but unable to communicate effectively in real life. Most of the young adults agreed that this kind of situation is common in their real lives. Young adults are feeling more comfortable talking with their superiors or friends through the OSN as compare to real life. This has again supported the study of Summers (2011) [15] as discussed.

Fig. 3. A case study on the comments of young adults agreed to the problem in reality

3 Methodology

In our preliminary study, the exploration of action-reaction of the respondents are investigated from the social media posting. This exploration is conducted by distributing the questionnaires to those who are actively involved in OSN. Posting that had been shared online between the OSN which causing damages in reputation that occurred in year 2013 in Malaysia has been sampled in this study.

Firstly, two Facebook accounts that have high number of network connection are selected as the platform of the study. The number of users connected to these two Facebook accounts is about more than 1500 peoples in total, including friends, relatives, young adults, professional links and etc. The whole study was lasted for about six months to one year period of time. All the cases that are actively discussed at that period of time were noted. Among all the topics, four are selected.

Figure 4 categorized the top 4 most popular cases into different samples: Case 1) Reputation damage; Case 2) Business damage; both Case 3) and 4) on the Country's reputation damage and public concerns. To investigate the action-reaction of the bloggers and respondents and their intention to share online, friends and users from the network that has clicked "like" and comments on these four cases were distributed with the questionnaire to enquire on the intention of their actions. At their personal message in Facebook, a HTTP address which is linked to online questionnaire in survey money was shared to them. Normally those selected respondents are the young adults who are active in Facebook; as well as the friends from their common networks.

Case A: Shariffah's 'Listen, Listen, Listen'

Case B: Impolite workers from a cake shop

Case C: Child thrown by maid.

Case D: Stop Lynas, Save Malaysia

Fig. 4. Sample of Cases used in the study

4 Data Representation on the Action-Reaction Mechanism

In total, 101 online questionnaires responses were received from young adults in our preliminary study. The respondents are mainly University students that have connected to social media and are those actively comments and clicks "like" at Facebook.

Table 1. Top 5 preferable Social Networking Sites accessed by the young adults

Social Networking Platform	*Valid Percentage (%)*
Facebook	98.02
YouTube	67.33
Blogs	20.79
Twitter	36.63
LinkedIn	17.82
MySpace	6.93
Others	3.96

Table 1 shows the preferable Online Social Networking Sites accessed by the universities' student. Facebook is the top Social Networking Sites that responders preferred. Obviously, Facebook is the most popular sites compared to other platforms. YouTube scored the second comparing to other social networking sites.

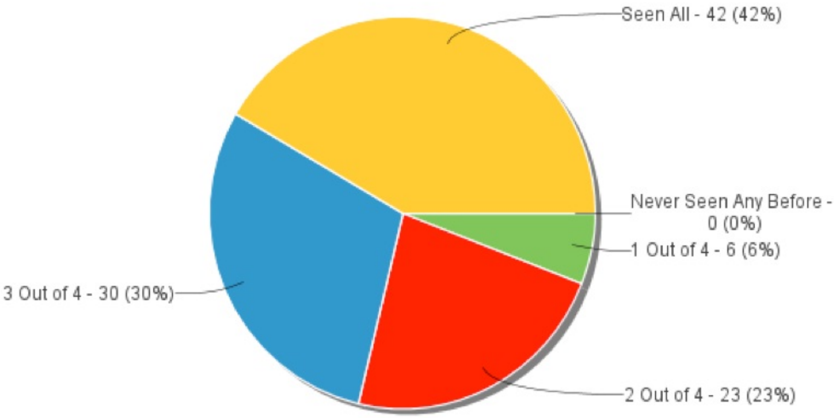

Fig. 5. Numbers of Cases has seen among the Sampled Case Studies

From Figure 5 we can observe that all the respondents have seen at least one of the sampled case studies. Forty-two percent out of the respondents seen all the four cases, this has validate that they are active user. Other than these, 30% seen at least three of the sampled case studies, 23% has seen at least two of the case studies and only 6% seen one of the case studies.

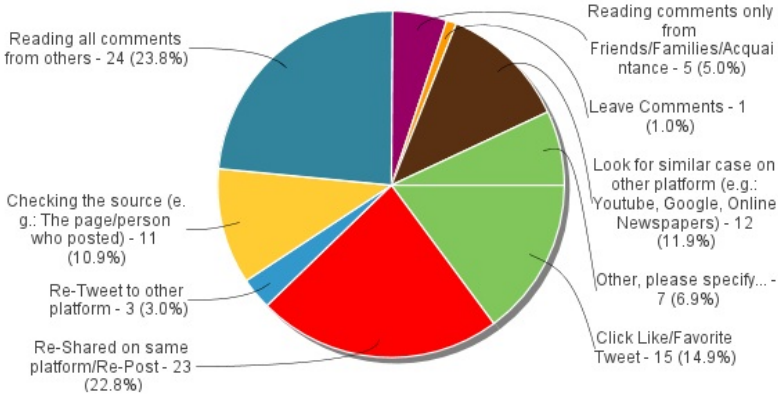

Fig. 6. Reactions upon Reading the Cases Sampled (Cases Studied)

Figure 6 shows the responses of those who click "like" or commented at any of the four cases sampled in the questionnaire. It is to specifically verify the responder's reaction after reading the cases. This question was posted together with the four samples of cases studied (in picture format) in the online questionnaire survey. The respondents were contacted from the personal message from the list where they had commented or click "like" on those four cases. Figure 6 shows that the three highest responses of young adults are 1) Read the comments by others; 2) Re-share and Re-post; 3) Click "like" or "favorite" to tweet in order to support the posting. Leaving a comment and giving personal opinion are not as popular as reading others comments.

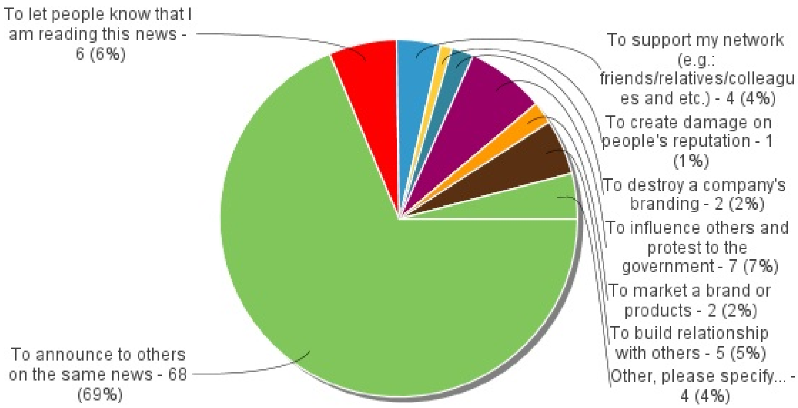

Fig. 7. Reasons and Intention of Sharing a Posting

Figure 7 describes the reason of the intention on sharing a posting. The highest reason is merely just to announce to others the same news (as a reporter), which is 69% of all the responses followed by the intention to influence others and protest to the government (7%). Six percent would want to show that they had read the news, and 5% admitted their intention to build relationship by sharing the friend's posting.

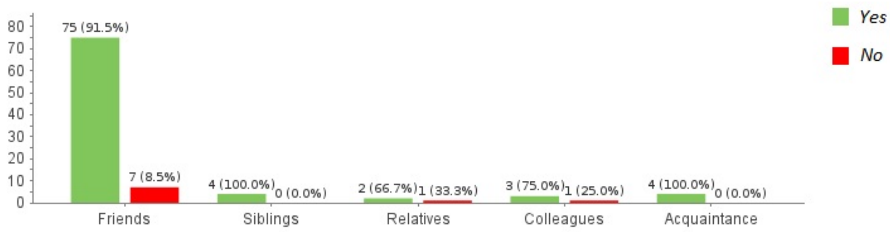

Fig. 8. Repeat the discussion after re-share at Social Media

After the share and re-share action at social media, respondents were asked if they will further discuss on the similar topic during their visits to other social networks. Ninety-one percent agree that they will discuss with their friends, followed by 4%

with sibling and acquaintance, 3% with colleagues and 2% with relatives. For those having discussion with friends, most of them admitted that the topic may likely to keep them in touch or to initiate a new conversation with most of their friends. The results also show that there is a higher preference on the discussion of the similar topic with siblings and acquaintance instead of colleagues and relatives. As concluded, once would discuss a posting after they have re-shared a posting at social networking sites.

5 Summary and Future Works

Results show that young adults always have the intention to share and re-share a posting after they have read others comment. They also prefer to share the posting with their own friends and with those who usually influenced each and others, rather than their own relatives or siblings. They would likely discuss again on the same topic when they socialize with their friends after the online sharing. Most of them also agreed that it helps keeping them up-to-date to the latest news. It also encourages them to start a new topic for their conversation during their social activities in real world.

With the above results, the strength of the social tie between the sharing of posting is predicted to have strong influence. And yet, the action-reaction mechanism carry towards the sharing has yet to be proven. Future works will investigate the underlying reasons to push a person to have the intention to share and re-share a posting. It may finally be implemented onto the products advertisement, utilized as one of the marketing strategies.

Social networking sites have experienced the unprecedented growth in recent years and incorporated various kinds of smart technologies and value-added services. The new generations of implementation vitally depends on the social influence in the near future regardless of the functions and nature of the participants involved and various social networking sites. From our experiment, we find that social influence highly depends on the action-reaction mechanism. Thus, this future study may look into the relationship and constructs that cause the action-reaction mechanism.

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Using Text Summarizing to Support Planning of Research and Development

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Abstract. Some governmental organizations process a large number of research and development (R&D) projects simultaneously in their R&D program. For the planning of such a R&D program, decision makers can be supported by providing an overview that contains summaries of all currently running projects because they normally are not experts in all concerned R&D areas. A manual creation of such an overview is time consuming because the description of each project has been summarized in a homogeneous form. Further, each project summary has to be updated very often to consider changes within the project. Based on results of comprehensibility research, we identify a specific structure for the project summaries to ensure comprehensibility for a decision maker and usefulness for the R&D program planning. We introduce a new approach that enables a semi-automatic summarization of descriptions from R&D projects. It creates a summary in accordance to the proposed structure. A case study shows that the time taken by using the introduced approach is less than by creating a summary manually. As a result, the proposed methodology supports decision makers by planning an R&D program.

Keywords: Text Mining, Text Summarizing, Decision Support, Knowledge Discovery, R&D Planning.

1 Introduction

The planning of a research program that contains many research and development (R&D) projects is demanding in cases where a lot of projects run simultaneously [1]. Here, R&D planners have to consider all different projects to enable a decision making [2]. Examples for decisions are adding a new project to the research program, removing or modifying an existing project, identifying duplication of work between two simultaneously running projects, identifying suitable collaboration partners for several projects etc. [3].

Especially in areas with a wide technological scope, it is necessary to provide an overview on all currently processed projects because the R&D planner is not familiar

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with each technology [4]. Examples are governmental organizations e.g. the German Ministry of Defense (GE MoD) where about 800 current R&D projects are processed covered by about 100 different technologies. No research planner is able to keep this large amount of different technological topics and aims in mind. Creating such an overview can be done in two steps. The first step is to create a summary for each R&D project and the second step is to compose the summaries in a report.

It is time consuming to create a summary that briefly describes the main technological topics and aims of each R&D project. This effect is enhanced by the fact that a summary often has to be updated because many changes occur during the processing of a R&D project. For a research planner it is necessary to be aware of these changes at the point of time where a decision has to be made. While this point of time is often unforeseen, an updated summary should be created ad-hoc in short time for each project.

Each summary has to be created in a way that it is comprehensible specifically for R&D decision maker purposes. This is in contrast to related work where studies about automatic text summarization (used techniques range from natural language processing, machine learning, to text mining) focus on general purposes.

We consider results from comprehensibility research. Current research in that field is based on cognitive effects occurred by the writing and by the receipting of texts [5, 6]. Four dimensions of comprehensibility can be identified, the simplicity, the structure-organization, the brevity-shortness and the interest-liveliness. We consider the detailed explanations of these dimensions that can be found in the two predominant models, the 'Hamburger Verständlichkeitsmodell' [5] and the 'Groebener Modell' [6].

To create a summary on a large number of R&D projects as decision support, the simplicity is very important. This is because a decision maker is normally not an expert in all technological areas covered by the projects. Thus, the frequently used abbreviations in a research project have to be mentioned in short form as well as in long form. Further, very important technical terms have to be explained.

The structure-organization is also important for creating such a summary. It is important to use the same structure for every summary based on the needs of the decision maker. Important information for a decision maker is the examination task (modifying, developing, or examining an object, coupling several objects, etc.), the examination object (semi-conductor laser, terahertz camera, infrared sensor, seeker head, etc.), the aim of the project (e.g. creating an advanced knowledge, creating a prototype, etc.), and the potential application fields (sensor, robots, unmanned aerial vehicles etc.).

Further, the brevity-shortness is also very important to present information to decision makers in brief. Thus, we limit the summary of each project to one sentence structured by the four points as described above.

In this paper, we provide a methodology that enables a semi-automated creation of summaries based on the description of the R&D projects and based on the results of comprehensibility research. Relevant terms are identified by text mining approaches e.g. part-of-speech tagging and by comparing the textual information to taxonomies. The approach provides automatic created summaries for each project. They are of low quality and cannot be used by a decision maker. Human experts have to modify these summaries to improve quality. Thus, this approach should be used semi-automatically.

In a case study, we use this approach to create project summaries of 800 current R&D projects from GE MoD. The approach is evaluated by comparing time efforts for a manual creation of 800 summaries without using this approach to the time efforts for a semi-automated creation.

2 Methodology

The methodology is depicted in Fig. 1.

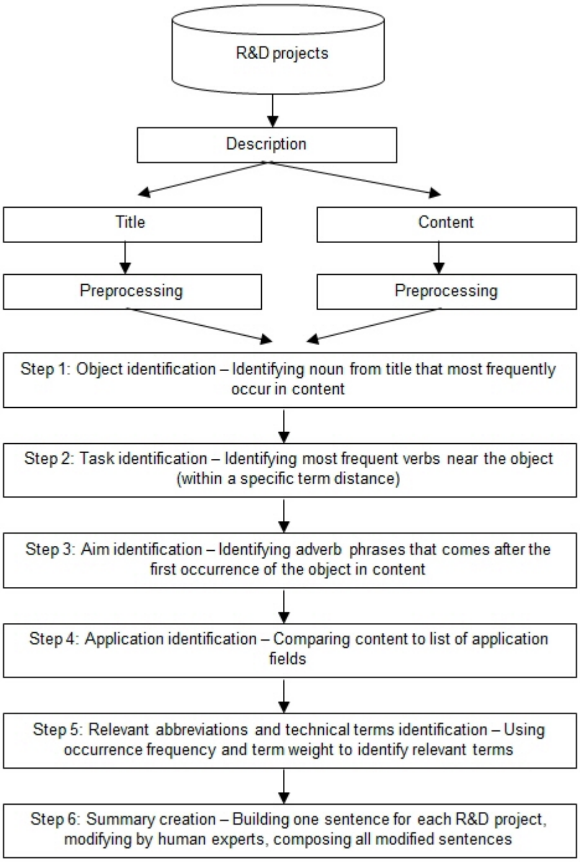

Fig. 1. Processing of the approach

A description of each R&D project in an R&D program is used. The description contains a title and content. Both are available as textual information and pre-processed to identify terms. Non-informative terms are identified by stop-word filtering and term frequencies are calculated based on the stemmed form of the words [7].

We also use part-of-speech tagging to identify the linguistic structure of the terms for both, the title and content. The subject form is not relevant because subjects normally represent the researchers that process the R&D project. A term weighting scheme is applied to identify terms that occur frequently in the description of one R&D project but that seldom occur in the collection of all project descriptions [8]. For this, we use the well-known term weighting scheme as proposed by [9].

$$w_{i,j} = \frac{tf_{i,j} \cdot \log(n/df_i)}{\sqrt{\sum_{p=1}^{m} tf_{i,j_p}{}^2 \cdot (\log(n/df_{i_p}))^2}} \tag{1}$$

The weight $w_{i,j}$ for term i and for a document j is calculated by the product of term frequency ($tf_{i,j}$) and inverse document frequency as represented by $\log(n/df_i)$ where n is the number of projects and m is the number of terms in stemmed form [10]. The result is divided by a length normalization factor that considers different lengths of project descriptions.

The first step is to identify the examination object. This object is normally mentioned in the title and it normally occurs often in the context because all R&D activities in the project are related to this object. We identify single terms (Nanotechnology) or group of terms (Gallium Nitride Radar technology) in the tile that are assigned as object by part-of-speech tagging. If several objects occur in the title then we select these terms that occur more frequently in the content.

The second step is to identify the examination task by identifying verbs near the object and by transforming them to a verbal noun, e.g., 'Examining radar technology'. The third step is to identify the aim of the project, by searching for an adverb phrases that comes after the first occurrence of the object in content. This can be identified based on the results of part-of-speech tagging.

The fourth step is to identify the application field where the R&D results probably can be applied. For this, a list of application fields is used. These application fields should be relevant from the point of view of the decision makers. Items on the list are transformed in stemmed form and compared to the stemmed terms in content.

The fifth step identifies frequently used abbreviations in the content with a frequency and a term weight above a specific threshold. Further, their corresponding long form is identified in the content. Additionally, very important technical terms have to be mentioned if not identified before. Thus, terms that are not in title but occur more frequently then the object in the content and that have a term weight above a specific threshold have to be considered.

In the sixth step, a sentence is build for each R&D project. It starts with the title of the R&D project, followed by a ':', and followed by the description. It consists of the four components: task, object, aim, and application. Task, object, and aim are concatenated, followed by a ' in ', and followed by a list of all application fields from this project. After this, the important terms and abbreviations are listened. While this sentence is created automatically, it is necessary to evaluate its quality by human experts. They check the four components and the sentence structure for correctness and change the sentence if necessary. A document that consists of all sentences in a specific order as recommended from the decision maker fulfils the requirements on the summary and can be used to support the decision makers. A possible order could be the technology structure of the R&D program.

After creating the summary for the first time as described above, the summary has to be updated. For updating, steps 1 to 4 are done and a sentence for each R&D project is built. The sentence is compared to the corresponding sentence from the last update. Changes are presented to human experts for manual evaluation.

3 Case Study

In a case study, we use the proposed approach to create a summary on 800 projects funded by GE MoD between 2006 and 2008. For each project a description is available with a size of about half a page to three pages written by researchers and developers working in the project. The descriptions contain the object, task, and aim of the project as well as the corresponding application fields. They are updated annually to add current milestones and events. This might also change object, task, aim, or application fields of the project. Each year, about 20% of all projects are running out and they are replaced by new projects normally with a new object, task, aim, or application field. The data characteristics are displayed in Table 1.

Table 1. Characteristics of the data

Number of projects in 2006, 2007, and 2008	
2006	794 projects from 2006 and before = 794 projects
2007	646 projects from 2006 and 158 projects from 2007 = 804 projects
2008	544 projects (2006), 137 projects (2007), and 132 (2008) = 813 projects

The proposed methodology is applied on the data and a first-time overview is created for 2006. Further, two updated overviews are created for 2007 and for 2008. A human expert modifies the automatically created summaries to ensure a specific quality. For evaluation purposes, a human expert also creates the three overviews manually without considering the proposed approach. It is important, that the quality is equal for both ways.

The average time that a human expert needs for the first-time creation of a summarized sentence for a project is measured for both, for using the proposed approach and for not using it. In total, 1084 projects are considered (all projects from 2006 and all new projects in 2007 and 2008) and the average time for the first-time creation without using this approach is about 5 minutes per project. In this time, the human expert reads the project description, identifies object, task, aim, and application fields, and creates a summarized sentence. In contrast to this, human expert get help by improving the automatically created summaries. This leads to a better performance because the average time decreases to 4 minutes per project.

For updating, 1327 projects are considered as calculated by the sum of all projects from 2006 in 2007 and all projects from 2006 and 2007 in 2008. The average time for updating a summarized sentence is 2 minutes per project without using the proposed approach. In this time, the human expert checks that object, task, aim, and application fields still remains equal. Otherwise, the existing summarized sentence has to be changed. Using the proposed approach does not lead to a significant increase in performance in these cases where the summarized sentence has to be changed. However, the time for updating the summarized sentence is 0.5 minutes per project in those cases where no changes are necessary.

The process of updating a summarized sentence by the proposed approach can be evaluated by well-known precision and recall measures [11]. For each of the 1327 projects, the result from updating is compared to the result from its last update or if not exist from its first-time summary creation. Each project is assign to the class ‘change’ if results differ and to the class ‘no change’ if results equal. The ground truth is determined by a human expert and the chance baseline is used (50 % precision at 50 % recall). The number of projects that are correctly assigned to ‘no change’ is the true positive (TP), the number of projects that are incorrectly assigned to ‘change’ is the false negative (FN), and the number of projects that are incorrectly assigned to ‘no change’ is the false positive (FP). Precision as calculated by TP / (TP + FP) equals 88% and recall as calculated by TP / (TP + FN) equals 68%. This outperforms the baseline.

4 Conclusion and Outlook

Overall, the proposed methodology enables to support decision makers by creating project summaries. The time effort for creating a project summary is lower by using the proposed methodology than by not using it. Further, the overall time effort for creating summary updates is also lower by using the proposed methodology. This helps decision makers to save time. Future work should be focussed on considering semantic aspects e.g. by applying latent semantic indexing [12] or by including relationships between projects by applying cross impact analysis [13,14]. A further avenue of future research is to increase the quality of the automatically created sentences. Up to now, the quality does not match the requirements of decision makers. Thus, a post-processing by human experts is necessary. This is also time consuming and could be improved by considering results from artificial intelligence research.

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The Impact of Educational Background on Working Relationships in Offshoring Projects

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Abstract. Offshore outsourcing provides opportunities for great gains but is also characterized by numerous unsuccessful ventures. As personal relationships within the team structure have been located as source of success we ask the question whether the same educational background is an enabler for successful collaboration in offshoring. In other words: "Do engineers work better with engineers or does the educational background not matter?".

An exploratory study has been conducted based on a questionnaire with 89 offshoring professionals. Results substantiate the crucial importance of the educational background for the success of offshoring projects and as such request sufficient management attention.

It is shown that for team members with similar educational background relationship quality is of much higher importance then relationship management to successfully work together in offshoring projects.

Keywords: Offshore Outsourcing, Individual's Relationship Management, Project Management, Educational Background, Exploratory Study.

1 Introduction

Offshore outsourcing -when a company outsources parts of its business to one or more vendors located outside its immediate reach [1] is a trend which tremendously gained importance over the last years [2] and established itself as viable option of strategic management. Reasons for offshoring is predominantly the cost pressure modern corporations face in stiff competition, as well as a lack of skilled labor in their home countries [3]. The number of outsourced IT projects in the form of offshore outsourcing continues to rise [4]. However, the success rate is alarmingly low: an estimated one in two offshore outsourcing projects fail [5]: budget and time schedule are often overrun or the result is not satisfactory [6].

It becomes obvious that offshoring inherits a lot of challenges and dangers which must be managed [3, 7-9]. To a large extent the quality and thus the success of offshored projects depends on the communication of the offshoring project partners. Therefore it seems reasonable to investigate the relationship of the people involved in offshoring projects in order to better understand drivers for positive communication. Similar-attraction theory already confirmed the assumption that similarities in relationships have a positive effect on work outcomes [10, 11]. A study by Sha and

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Chang [12] came to the result that any kind of intra-personal identification amongst team members has a positive impact on their collaborative behavior. Kumar and Bjorn-Andersen [13] showed that team member's intrinsic values -including their educational background- affects team performance. Also Crosby et al. [14] state, that similarities in working relationships leads to individual's putting more effort, time and energy into managing the joint projects. These types of relationships are also more open and forthright. It can be assumed that people with a similar educational background have a common understanding, not only in terms of expertise. They see each other as "the same kind of people" through their career choice and they share similar areas of interest and related conditions such as skills and talents.

It can therefore be assumed that individuals sharing the same background develop a better working relationship leading to a higher success rate in collaboration. As one of the most important issues in offshore outsourcing projects are misunderstandings and cultural differences it seems worth investigating whether presumed similarities can diminish the cultural differences and minimize the number of misunderstandings. This leads to this paper's research question, whether *the educational background of project team members has an impact on their successful collaboration in an offshoring environment.*

The literature review indicates that the question whether similar educational background of offshored co-workers has an impact on collaboration has not yet gained wide attention in academia. Therefore this research has been constructed as a first step towards tackling this question and needs to be positioned as explorative. The main goal was to investigate whether evidence supporting the research question becomes obvious justifying deeper investigation of the issue. As such this paper needs to be regarded as a first step towards a larger research effort.

The paper begins with a review of the applicable literature followed by the development of the research model. It continues with a description of the research method and its execution and a discussion of the results. It closes with stating its limitations, an outlook to further research and the conclusion.

2 Review of the Literature

This chapter examines literature related to educational background and team collaboration in the context of offshore outsourcing.

Carver et al. [15] define **educational background** as "the field in which a subject's most advanced degree was awarded" (p. 802). This approach assumes that this field required the most time and effort to achieve the award. Consequently, it can be assumed that this characterizes the person and she/he can be seen "at home" in this field. Therefore, we assume that a person's educational background consists of the highest degree and the field it was awarded.

The concept of **collaboration** has been subject to several scientific investigations. Smith [16] researched the impact of similarity in buyer-seller relationships on relationship quality and relationship management. They developed a model based on the similarity-attraction theory and conducted a self-report survey was mailed to randomly selected employees (185 male and 181 female) of the Purchasing Management Association of Canada. These participants were asked to answer questions regarding their working relationship with the last supplier. The study reinforced the importance of relationship management. Facets of similarity did not have a direct effect on relationship quality, but had an indirect effect through relationship management [16]. This result is consistent with Crosby et al. [14] who found that similarity in relationships lead to more time, effort and energy to be put in the managing of those. Furthermore, those relationships are more open and forthright [16].

A similar topic was taken up by York [2] who studied demographic similarities in offshore outsourcing dyads. His aim was to provide guidance for decision making in relation to offshore outsourcing teams. The model was planned to be tested by a survey amongst matching pairs of existing offshoring projects. Unfortunately, the study was never conducted in practice. However, the research model provided an extension to Robinsons and Davis' study [17] which was the basis for his work.

Similarity and familiarity in distributed teams, especially knowledge sharing in this context, have been examined by Cha and Shang [12]. Their work focused on knowledge sharing and its connection to project member relationships and technology support in distributed teams. They analyzed social network data from teams of a global IT organization. The study found that all forms of identification are significantly related to knowledge sharing. It can be concluded that the similarities are an important factor in those relationships.

The literature review indicates that a lot of emphasis has been put on team collaboration and the personal background that enables successful collaboration. However, no study has been identified that investigates the influence of an individual's personal educational background when collaborating with others.

3 Model Development

The model of Smith [16] was selected as basis for this research due to the fundamental similarity of the research question. Smith examined the effects of similarities in relationship management behavior and relationship quality on buyer-seller relationships based on the similarity-attraction theory [10, 11]. His study was conducted by questionnaire and respondents were asked to report information about the last relationship to a supplier, one time with a person of the same gender and another time with a person of the opposite gender.

Smith found that similarities do not have a direct impact on relationship quality, but indirectly through a significant influence on relationship management behavior. Also the results confirmed the great importance of relationship management in this business. His findings are consistent with the findings of Carver et al. [14] showing that similarities in relationships have a positive effect. This manifests itself in terms of effort, time and energy which are put in the care and management of these relationships leading to a positive effect on the quality of the relationship.

Smith links similarities in life-stage, sex, cultural background, work attitude and personality with the management and quality of relationships between buyers and sellers.

Smith hypothesizes that greater similarity will positively affect relational management as well as relationship quality. Furthermore he assumes a direct effect of relationship management on relationship quality.

Relationship management is the extent to which the partners actively cultivates and maintains close relationships [14]. It consists of relationship investment, open communication and relationalism. **Relationship investment** are all efforts and attentions devoted to that relationship, which do not have outside value [18]. **Open communication** is the extent to which the parties communicate sincerely, openly and substantively [19, 20]. **Relationalism** is the degree to which the partners actively and purposefully manage their relationship and promote behavior for maintaining and improving it [21].

Relationship quality is described as a variety of positive outcomes that reflect the strength of a relationship and the extent to which this meets the expectations and needs of the partners [16]. It consists of trust, satisfaction and commitment. **Trust** is defined as confidence in the integrity and reliability of the partner, also the willingness to rely on this confidence [22, 23]. **Satisfaction** is an emotional state that occurs in response to an evaluation of interaction experiences in relation to alternatives [24]. **Commitment** is understood as the enduring desire to maintain a valued working relationship [25].

Similarity may also be affected by differences in the duration of a relationship and the experience and expertise of the person [26]. Therefore Smith included it as mediating factor in his model, linked to relational management and relationship quality.

The work of York [2] was also built on Smith's model. York's goal was to examine the influence of demographic similarities on project success in offshoring relationships. Basis was the assumption that relationship management and relationship quality positively affect the project success. He wanted to provide findings of the composition of project teams. He removed life stage, personality and work attitude from the model, as he found this impossible to measure. They were replaced by age, sex and marital status. Since the impact should be measured in terms of project success he added this variable to the model.

The designated research approach was a survey of pairs, whose answers can be directly matched. However, he noted that if this proves as too difficult, it can be carried out by adjustments in the model to make it also one-sided. Unfortunately, this model was not tested using real data.

Based on Smith's model and York's additional insights the following research model was developed. Since the effect of educational background on collaboration should be examined, the variable team performance [27-29] was added to the model.

As the model (see figure 1) depicts the hypotheses are that relationship management has a direct effect on relationship quality, team performance is composed of effectiveness and efficiency [30] and relationship management and relationship quality both directly affect the team performance.

In accordance with the underlying research model of Smith we therefore propose the three following major hypotheses:

H1 Relationship management positively affects relationship quality.
H2 Relationship management positively affects team performance.
H3 Relationship quality positively affects team performance.

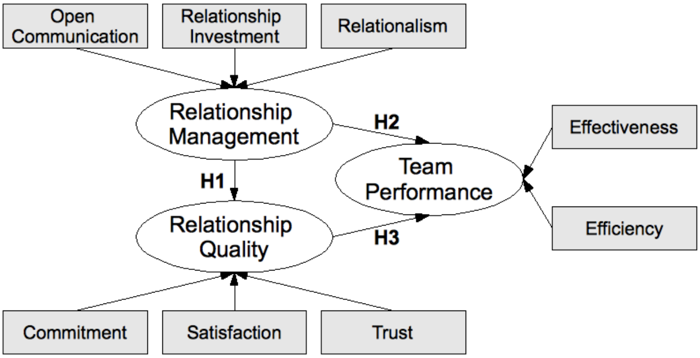

Fig. 1. Research Model with Hypotheses

Table 1. Construct Definitions of the Research Model

Construct Definitions	Source
Relationship Management Extent to which parties have the orientation or behavioural tendency to actively cultivate and maintain close working relationships	[14]
Relationship Investment Effort and attention devoted to a relationship that do not have outside value	[18]
Open Communication Extent to which partners communicate openly, sincerely and substantively	[19, 20]
Relationalism Extent to which parties actively and purposefully manage their relationship and promote behavior to maintain or improve the relationship.	[21]
Relationship Quality Variety of positive relationship outcomes that reflect the overall strength of a relationship and the extent to which it meets the needs and expectations of the parties	[16]
Trust Having confidence in the reliability and integrity of the partner and the willingness to rely on this confidence	[22, 23]
Satisfaction Emotional stat that occurs in response to an evaluation on interaction experiences in relation to alternatives, serves to strengthen bonds of trust	[24]
Commitment Enduring desire to maintain a valued relationship	[25]
Team Performance Extend to which a team is able to meet established quality, cost and time objectives	[27-29]
Effectiveness Degree to which the team meets expectations regarding the quality of the outcome	[30]
Efficiency Assessment in terms of adherence to schedules and budget	[30]

The measurement of the influence of educational background is done via case distinction. Thus, different groups were defined in accordance with Tambe's [31] listing of functions in offshoring projects the categories 'computer', 'business', and 'engineering' have been used. The educational background in regards of degree has also been categorized following Tambe who segregates 'high school degree', 'vocational degree', 'bachelor', 'master' and 'doctorate'.

4 Empirical Study

4.1 Methodology

As already stated by York [2] the ideal setting to answer the research question would be an analysis of paired employees working on the same offshoring project. Several attempts were undertaken but we were not able to confirm a sufficient number of interview partners. Therefore we chose a different approach to first evaluate whether the stated hypotheses can be confirmed. If the outcome is positive we will then use these indicative exploratory results to convince potential partners from practices to conduct a larger research project.

Instead of pair-wise interviews a self-report online survey was issued. Since the survey is one-sided only one party of the offshore relationship has been questioned to evaluate both sides of the project. Respondents were asked to evaluate their relationship with their business partner and give information on this. The reference here was the last completed project and the person with whom they worked most closely on this project.

To segregate the effect of similar educational backgrounds, three groups had to be segregated: (1) Both partners share the same educational background; (2) partners have a different background and (3) the background is not known (see Appandix A).

The data of each group was calculated and compared with each other. As mentioned above educational background is defined through a person's highest degree and their education field.

4.2 Research Execution

The survey was deployed online using the tool 'LimeSurvey'. We selected participants with practical experience in offshore outsourcing projects in software development. They needed to be able to evaluate the relationship to their offshore partner and answer questions about it. The survey consisted of 37 questions, was anonymous and had an average processing time of 10 minutes.

500 people were contacted and asked for participation. This was done by E-Mail based on research in search engines (about 50% of the registered contacts), by messages to members of offshoring thematic groups in the leading German career portal 'Xing' (40%) as well as open invitations in professional forums (10%). A total of 154 persons participated in the survey. This represents a responsive rate of 30.8%. 65 survey results were incomplete and sorted out. The remaining 89 questionnaires were complete and form the basis for the study.

4.3 Data Analysis

The answers were provided on Likert scales ranging from 1 ("strongly disagree”) to 5 ("strongly agree”). To evaluate impact of educational background on team performance the resulting data sets were grouped according to the educational degree and field of the respective outsourcing partners.

The tested research model was represented as a linear system of equations and the path coefficients numerically obtained by a multivariate linear regression fit with the PLS-method using the 'SmartPLS' software. The method was chosen to ensure correct estimations on the anticipated low number of participants.

The model fits were calculated separately for the three groups with similar or different educational degree or field, respectively. To test the statistical significance of the results obtained for the coefficients this way, the respective T- and P-values were calculated using bootstrapping with the 'construct level changes' option and 30 samples. The P-values were obtained from the T-values by means of a one-tailed Student's T-distribution. The one-tailed distribution was chosen to reflect the exploratory nature of this research.

5 Results

Similar vs. Different Educational Degree

Due to the strong variance of the answers in combination with the small number of responses, no non-trivial statistically significant results could be obtained for the groups with similar or different educational degrees. Further research is needed to collect more data and finally analyze the role of educational degree on the team performance.

Similar vs. Different Educational Field

For the groups with similar or different educational field, meaningful and statistically significant results were provided by the model analysis.

The evaluation of the outer weights of the model shows that commitment has a major effect on relationship quality and relationship investment proved to have an important influence on relationship management in both cases. In case of different educational fields effectiveness has a significant effect on team performance. In a direct comparison there is a slight tendency towards stronger commitment within relationships of persons who have been educated in the same field. Regarding relationship investment this tendency is even more important. It seems that persons of the same educational field put more effort in the management of their working relationship. These results align with Crosby's findings [14].

The relation between relationship management and relationship quality is found to be significant for both groups. There is a strong positive effect of relationship management on the quality of the relationship. However, the results for both groups differ with respect to the dominating influence on team performance. The raw PLS-data indicates that for the group with similar educational field the team performance mainly depends on the quality of the relationship, whist for the group with different educational field team performance is dominated by the management of the relationship. The additional calculation of the total effects using the bootstrapping technique confirms this overall picture.

While the initial results suggest that there is no significant direct influence of relationship management on team performance in the case of similar educational field, the bootstrapping results show that this effect is positive and significant in both cases, but its magnitude is much smaller compared to the effect of relationship quality in case of similar educational field. However, in the respective case of different educational field the effect of relationship quality on team performance is also not significant in the bootstrapping results.

Thus, the results show (see tables below) that in general a significant, positive effect of relationship management on team performance exists. The measures of the PLS model are depicted in Appendix A.

Table 2. Total effects (after bootstrapping)[1]

Same field

	Original Sample	Sample Mean	Standard Error	T-Value	P-Value
Rel Mang -> Rel Qual	0,653	0,631	0,253	2,580**	0,008***
Rel Mang -> Term Perf	0,373	0,492	0,217	1,719*	0,048**
Rel Qual -> Term Perf	0,689	0,566	0,333	2,068**	0,024**

Different field

	Original Sample	Sample Mean	Standard Error	T-Value	P-Value
Rel Mang -> Rel Qual	0,852	0,837	0,137	6,214**	0,000***
Rel Mang -> Term Perf	0,879	0,855	0,132	6,682**	0,000***
Rel Qual -> Term Perf	0,342	0,418	0,270	~~1,268~~	~~0,107~~ ns

Besides the confirmation of the effect of relationship management on relationship quality the results strongly indicate that a major difference exists regarding the dominating influence on the team performance between team members with similar and different educational fields, namely:

- The team performance of teams with members of *similar* educational field is mainly governed by relationship quality.
- For teams with members of *different* educational field it is mainly governed directly by relationship management.

The reason for this behavior may be that for people with similar educational field and thus similar life experiences the team relationships becomes closer and therefore more dependent on their quality. Since this does not equally holds true for people with different educational fields, the performance of teams with members of heterogeneous

[1] T-Values
** t > 1.96 (Error probability 5%)
* t > 1.65 (Error probability 10%)

P-Values
*** $p < 0.01$ ** $p < 0.05$
* $p < 0.1$ ns = not significant

education field more strongly depends directly on relationship management. These results are supported by similar-attraction theory [10, 11].

The results confirm the importance of educational background for team performance in offshoring projects. It strongly underlines that different management strategies need to be used depending on the educational fields of the team members.

6 Limitations and Further Research

This research on the impact of the team members' educational background on team performance in offshoring projects is exploratory. Therefore, the following limitations need to be taken in consideration. Firstly, the survey was conducted only one-sided and not pair-wise, i.e. only one party of the working relationship provided answers on the working relationship. These statements could not be verified by interviewing the respective counterparty. Also the numbers of questioned offshoring suppliers and offshoring customers were not equal. Secondly, the number of participants in the survey proved to be too small for obtaining significant results in all cases. Thirdly, attributes such as culture, gender or personality might have also important effects on the team performance, but are not covered by the model yet. Finally, self-reported surveys are prone to being biased when filled out by the participants.

However, even taking these limitations into account, the study revealed some significant and surprising results. Further research is needed to perform an extended survey (combined qualitative and quantitative study, matching pairs in interviews) and to analyze the remaining influence factors not covered by the present work.

7 Conclusion

This paper presented a research model to study the impact of educational background on team collaboration in offshore outsourcing projects. An exploratory empirical study using self-report surveys was conducted among team members of offshored software development projects.

The empirical data was evaluated by performing multivariate linear regression fits using the PLS method in combination with bootstrapping. Different PLS fits were performed for different groups of participants, namely those with similar or different educational degree and field. Due to the limited number of participants in the survey, only the influence of the educational field provided statistically significant results.

An important difference was observed between team members with similar and different educational fields. For the first group, the team performance is strongly influenced by relationship quality, while for the latter it is directly influenced by relationship management. Thus, for team members with similar educational background relationship quality is of much higher importance then relationship management to successfully complete projects.

Despite the limitations of the presented study the results obtained confirm the general importance of educational background for the team performance in offshoring projects and suggests that different team management strategies need to be used depending on the educational fields of the team members.

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Appendix A

Additional demographical and empirical measures.

Table 3. Number of survey responses grouped according to educational degree and field

Similar educational field	26		Similar educational degree	32
Different educational field	25		Different educational degree	13
Educational field unknown	38		Educational degree unknown	44

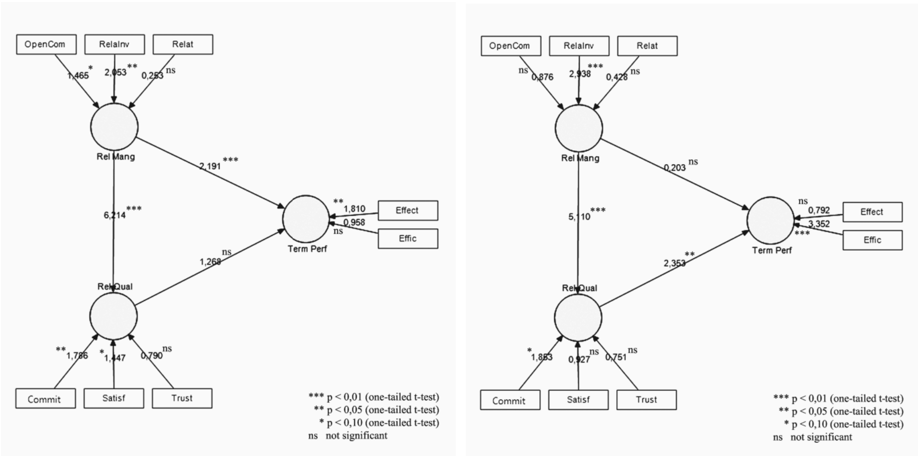

Fig. 2. Standardized PLS results for the path coefficients and the respective statistical significance for partners with similar (left) vs. different (right) education field

Speech Separation Based on Improved Fast ICA with Kurtosis Maximization of Wavelet Packet Coefficients

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Abstract. To improve the separation performance of ICA algorithm, wavelet packets transformation was adopted to reduce the signals' overlapped degree, that was, the mixture speech signals were decomposed into wavelet packets, and the node that had the highest kurtosis was the optimal wavelet packets decomposition node since the kurtosis is a measure of non-Gaussian nature. Thereby, it reduced the signals' overlapped degree in the wavelet domain. Then the separation matrix was calculated by using FastICA algorithm iteratively, and the source signal estimations were obtained finally. Simulation results demonstrated the separation performance improved clearly when compared with FastICA algorithm in time domain and other wavelet FastICA method.

Keywords: wavelet packet FastICA, speech separation, optimal wavelet packets decomposition.

1 Introduction

Blind source separation(BSS) is a method that recovers the original signals which cann't be observed directly from a number of multiple mixed signals[1]. ICA is a main method of BSS, it decomposes signals into several quantities independent of each other[1]. Wavelet transformation is a time-frequency analysis tool with multi-scale multi-resolution characteristic. it can be used to do BSS combined with ICA algorithm. Normally, wavelet transformation is applied to signal BSS with additive noise[2-3],which used wavelet denoising. While, there are a lot of other methods.

Reference [4] combined wavelet ICA with a adaptive step natural gradient algorithm that improved the convergence rate of former algorithm. Reference [5] in view of the single channel BSS, utilized wavelet decomposition and reconstruction, and singular value decomposition generate a new signal. It could eliminate the influence of interference signals and noise, thereby improved the robustness. Reference [6] proposed a BSS algorithm with spatial wavelet distribution, improved the SNR of separation signal. Reference [7] proposed a BSS method based on wavelet packet analysis, done wavelet packet decomposition on signals using Shannon entropy maximization criterion, good results had been achieved.

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In this paper, kurtosis which is a measure of non-Gaussian nature instead of entropy to obtain new signals with the maximum non-Gaussian distribution. Thus, the signals' overlapped degree was reduced in the wavelet domain. Then, FastICA [8] was used for calculating the separation matrix and the source signal is estimated. Simulation experimental results demonstrated that this method is better on source-to-distortion ratio (SDR) than traditional FastICA and the method in [7].

The rest of this paper is organized as follows. The algorithm of Kurtosis in wavelet domain is presented in section 2. The FastICA algorithm is described in section 3. Simulation experimental results are given in section 4 to illustrate the performance of the proposed algorithm. Finally, conclusion and discussion are given in section5.

2 Wavelet Domain Processing

Wavelet analysis is a time-frequency analysis method, it has the characteristic of multi-resolution analysis, and has the ability of denoting local signal characteristics in both time and frequency domain. The discrete wavelet transform is defined as follows[9]

$$d_{j,k} = W_{\psi} f(2^{-j}, k2^{-j}) = < f, \psi_{j,k} > \qquad j,k \in Z \tag{1}$$

$d_{j,k}$ denotes wavelet transform coefficient, j denotes the level of resolution, k denotes amount of translation of wavelet function ψ , f denotes source signals. Wavelet decomposition is a method that decompose the coefficient $d_{j,k}$ of j th level into two wavelet transform coefficients $a_{j-1,k}$ and $d_{j-1,k}$ of $(j-1)$ th level, and so on, until any specified series multi-level wavelet decomposition. Because of the binary scale of wavelet decomposition, it has poor frequency resolution in high frequency band and poor temporal resolution in low frequency band. Wavelet packet analysis can provide a more detailed analysis for signals, which decomposes the high frequency part further, thus raised the time-frequency resolution.

Non-Gaussian nature is a quantity to describe signals deviating from gaussian distribution, be used to measure the degree of independence between mixed signals in BSS. The stronger non-Gaussian nature, the higher independent degree of signals. According to the property of wavelet packet decomposition, and also it is can be seen from Fig. 1 and Fig. 2, only a minority of the wavelet packet coefficients are significant, that is only small amount points significantly greater than zero, it's distribution is more non-Gaussian than source signal. Therefore, this paper chose wavelet packet decomposition to process mixed signals.

Kurtosis is a fourth order cumulant, in BSS problem. According to the magnitude of random variable's kurtosis $k(x)$ signal x can be divided into three categories:

(1) If $k(x) < 0$, call x sub-Gaussian; (2) If $k(x) > 0$, call x super-Gaussian; (3) If $k(x) = 0$, call x Gaussian. In this paper, speech signal is super-Gaussian, so the direction of the kurtosis maximization, is the direction of separation.

In this paper, Wavelet packet decomposition and kurtosis were used to decide the best wavelet packet decomposition node, the coefficients of this node was a approximate representation for source signals which had low overlapped degree than mixed signals.

Kurtosis of wavelet packet coefficients at each node can be calculate by

$$k_4 = E(c^4) - 3E^2(c^2) \tag{2}$$

c denotes wavelet packet coefficients at each node, $E(\bullet)$ denotes calculate mean.

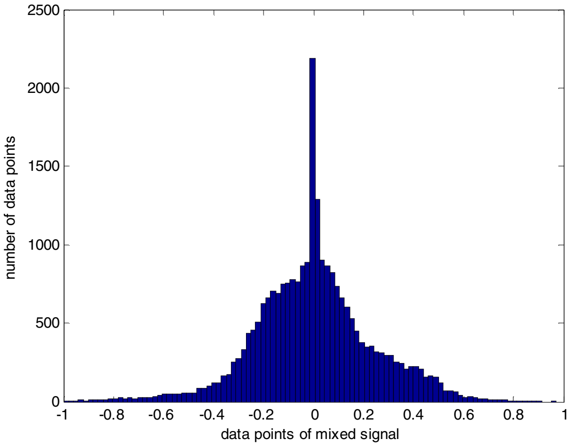

Fig. 1. Normalization histogram of mixed signal distribution

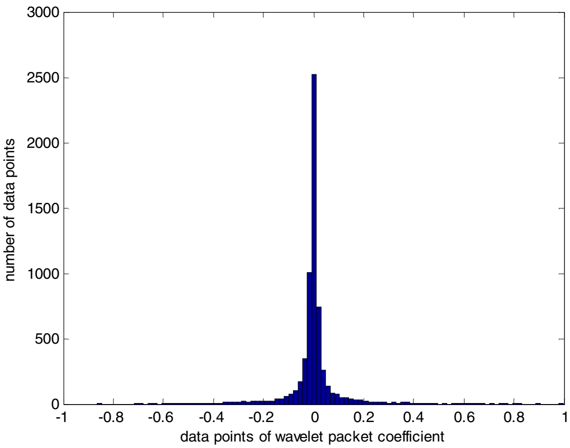

Fig. 2. Normalization histogram of wavelet packet coefficient distribution

3 FastICA Algorithm

The Kullback-Leibler divergence of probability density distribution $p(x)$ of random variable x and gaussian distribution $p_G(x)$ with same variance is a measure of non-Gaussian nature, called negentropy. That is

$$J[p(x)] = KL[p(x), p_G(x)] \tag{3}$$

Adopt negentropy as the criteria, there are

$$\begin{cases} \Delta W_i \propto \dfrac{\partial J(y_i)}{\partial W_i} = \gamma E[Zf(W_i^T Z)] \\ \gamma = E[F(y_i)] - E[F(v)] \end{cases} \tag{4}$$

v denotes $N(0,1)$, Z denotes data after whiting, $f(\bullet)$ is a nonlinear function denotes derivative of $F(\bullet)$. Optimizing former equation by newton iteration method, and after algebraic reduction, elicit

$$\begin{cases} W_i(k+1) = E[Zf(W_i^T(k)Z)] - E[f'(W_i^T(k)Z)]W_i(k) \\ W_i(k+1) \leftarrow \dfrac{W_i(k+1)}{\|W_i(k+1)\|_2} \end{cases} \tag{5}$$

In order to quantitatively evaluate the performance of the algorithm, we need to define performance metrics as follows:

3.1 Source-to-Distortion

In reference [10], there is a new separation performance evaluation criteria, named Source-to-Distortion(SDR).Firstly, define relative distortion as

$$D = (\|\hat{s}_i\|^2 - |\langle \hat{s}_i, s_i/\|s_i\| \rangle|^2) \Big/ |\langle \hat{s}_i, s_i/\|s_i\| \rangle|^2 \tag{6}$$

$\|\bullet\|$ denotes l_2 norm, $\hat{s}_i$ denotes estimation of i th source signal s_i, SDR is obtain by

$$SDR = 10\log_{10} D^{-1} \tag{7}$$

The bigger it is, the better separation performance.

3.2 Similarity Coefficient Matrix

Similarity coefficient matrix is a quantity be used to represent similarity degree between separation signals and source signals. When each row and each column of it has only one element as close to 1, the other elements are close to 0, separation effect is good. It can be calculated by the following equation

$$\xi_{i,j} = \xi(y_i, s_j) = \frac{\left|\sum_{i=1}^{N} y_i(t) s_j(t)\right|}{\sqrt{\sum_{i=1}^{N} y_i^2(t) \sum_{j=1}^{M} s_j^2(t)}} \tag{8}$$

In the equation, $\xi_{i,j}$ denotes Similarity coefficient in i th row and j th column, y_i denotes i th estimation of source signal, s_j denotes j th source signal, M and N respectively denotes the number of source signals and estimated signals.

4 Simulation Experiment and Result Analysis

The simulation signals were two speech signals, which were a male and a female voice speaking German at 16KHZ sampling frequency. 25000 sampling points were selected. In wavelet packet processing stage, this paper selected db4 wavelet of Daubechies wavelet series, and done wavelet packet decomposition of two layers on mixed signals. In separation stage, the Nonlinear function was selected as $f(y) = ye^{-\frac{y^2}{2}}$. Mixed matrix $A = \begin{bmatrix} -0.24036 & 0.36169 \\ 0.56666 & -0.07781 \end{bmatrix}$ is randomly generated by MATLAB.

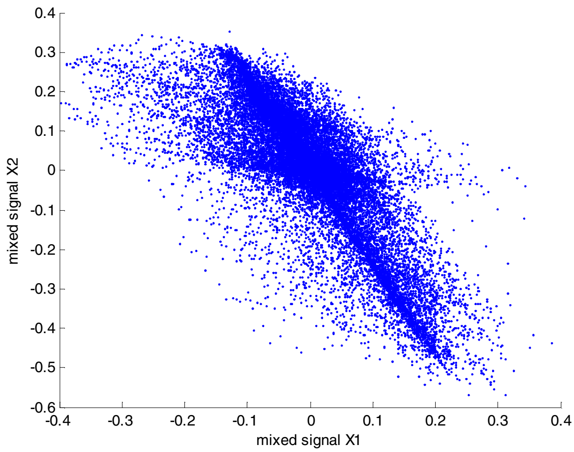

Fig. 3. Joint distribution of mixed signals

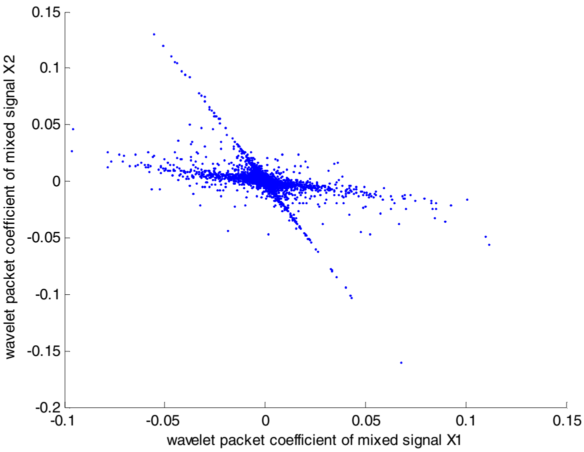

Fig. 4. Joint distribution of wavelet packet coefficient

It could be seen in Fig. 3 and Fig. 4, after wavelet packet decomposition and best node selection using kurtosis maximization, two clear straight lines was obtained, that meaned a non-Gaussian representation of source signals.The overlapped degree was reduced.

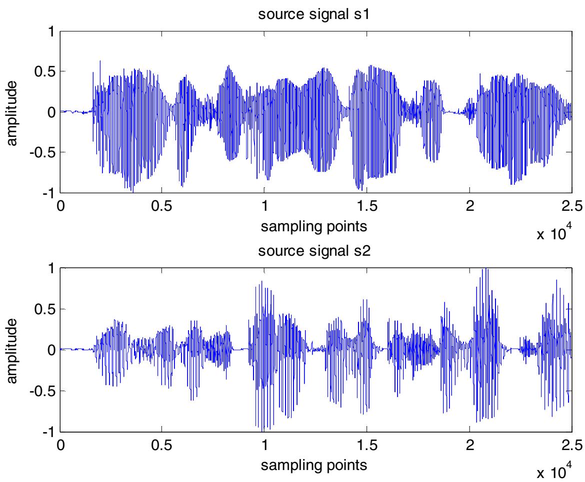

Fig. 5. Source signal waveform

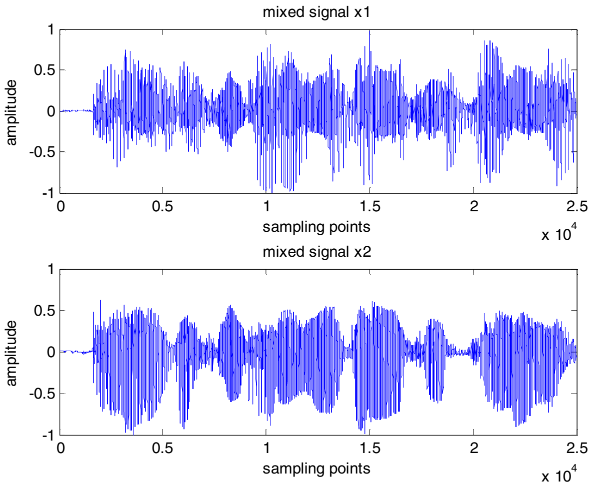

Fig. 6. Mixed signal waveform

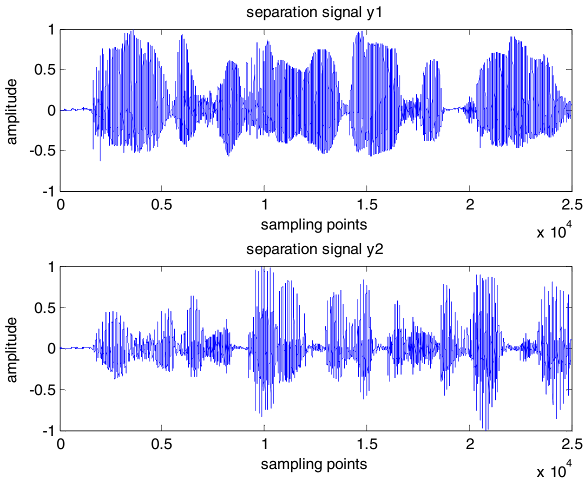

Fig. 7. Separation signal waveform

Table 1. SDR(db) Performance Index

Method	Source Signal S1	Source Signal S2
FastICA	28.53	32.724
Method in [7]	37.25	44.433
Proposed method	45	52.519

It could be seen in Table 1, proposed method, compared to FastICA, SDR raised 16.47db for $s1$ and 19.795db for $s2$, and compared to method in [7], SDR raised 7.75db for $s1$ and 8.086db for $s2$,had better separation effect.

5 Conclusion

This paper proposed a wavelet packet FastICA algorithm using kurtosis maximization criterion for speech separation. Overlapped degree was reduced by best wavelet packet decomposition node selection using non-Gaussian nature, then applied FastICA to obtain estimation of source signal. Simulation results demonstrated that it had better performance than other methods.

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Service Orientation of Information Technology Professionals: The Effect of Personal and Environmental Factors

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Abstract. The roles of information technology (IT) professionals have expanded from technical staff into service providers. However, IT professionals are usually better trained in dealing with computers instead of how to interact with human being. The attitude and behavior of IT professionals' service orientation, that is the ability of service employees to help their customers, affects the service quality of information system as well as IT projects. This study is to identify the personal and environmental factors affecting service orientation in IT service provision. Results showed that IT professional's work locus of control, which is the personal factor, and organizational service climate, which is the environment factor significantly affect IT professionals' service orientation attitudes and behaviors. Theoretical and practical implications of this study are to be discussed in the conference.

Keywords: Service Orientation, IT Professionals, IT service.

1 Introduction

Information technology (IT) professionals have the responsibilities to develop and complete system development on time, within budget and with good quality. The definition of good quality includes both system quality and service quality. System users have increased in demand with a myriad of tasks, such as hardware and software selection, installation, problem resolution, education, and maintenance etc. IT professionals thus provide a wide range of services to their users, instead of just completing the system developed. Their role includes being IT product developers or technical staff plus being the service providers (Kettinger & Lee, 2005; Pitt et al., 1995). Due to this situation, IT professionals increase their need to interact with users more frequently. However, past research indicated that IT professionals have not much training in contacting with users. Instead, they are more comfortable with working alone with machines and systems (Couger et al., 1979). Mathieson (1993) found that many IT departments with good, capable staff frequently are not evaluated as better with higher efficiency in system development but the ability to provide IT good services.

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IT professionals are more technology-oriented whereas IT users are usually more toward problem resolutions. IT users are more concerned with how efficiently they can retrieve the required data while IT professionals are more concerned with instructions needed for executing the specified function. Thus, users and IT professionals often have conflicting perspectives. Moreover, IT professionals lack appropriate abilities/skills to interact with users for delivering high quality IT services. This results in low user satisfaction and further leads to project failure. Scholars start to pay attention on these personal aspects of IT service provision, such as how the service quality of IT professionals can be enhanced; how the soft skill such as interpersonal skills and communication skills affect IT professionals; and the importance of service orientation implementing to IT department (Danziger et al., 1993; Pitt et al., 1995; Bailey & Mitchell, 2006; Mathieson, 1993).

Due to the rising attention in IT service quality, IT service quality scale has been developed to measure IT user satisfaction from the users' viewpoint (Kettinger & Lee, 1994; Kettinger & Lee, 2005; Pitt et al., 1995; Jiang et al., 2002). However, there is a lack of study based on the perspective from service providers (i.e. IT professionals) to examine why the service quality is low or why there is a lack of intention to provide decent service. In the Marketing field, service orientation is the way to examine the service intention from service provider (i.e. service employees) which refers to the ability of the service employees to help their customers (Saxe & Weitz, 1982). Service orientation is also confirmed to have a positive impact on service quality, customer satisfaction, and performance (Kelley, 1992; Stock & Hoyer, 2005). On the other hand, the higher customer/service orientation of service employees will lead to higher quality and satisfaction of customer perception. In this study, the concept of service orientation is applied to IT service provision context.

It is important for organizations to look for the IT professionals' skill especially the non-technical skill or the soft skill which is able to interact with users adeptly. Service orientation is a kind of skill that is important to provide superior service. Organizations could also develop the service orientation attitude of IT professionals by training or creating such environment. In this study, we discuss the antecedents of IT professionals' service orientation as well as its consequences. The research questions for this study are: (1) what are the factors affecting service orientation of IT professionals? (2) Does service orientation attitude bring service orientation behavior in IT context?

2 Literature Review

2.1 Service Orientation

Service orientation is a concept derived from the marketing field which has also been called customer orientation in marketing. Its generalized definition is the degree to which sale people practice the marketing concept by trying to help their customers make purchase decisions that will satisfy customer needs (Saxe & Weitz, 1982). Past researchers have discovered that highly customer oriented salespeople engage in behaviors aimed at increasing long-term customer satisfaction. In addition, they avoid behaviors which might result in customer dissatisfaction. However, Mathieson (1993) noted that many IT departments with highly skilled IT professionals still get poor ratings by their administration and end-users due to their lack of service orientation. While researchers regularly call for IT professionals to improve their customer/service orientation (Bailey & Mitchell, 2006), there is still little research actually investigating this concept in the MIS field. This study is to incorporate this concept of service orientation into the provision of IT service.

According to the literature, MIS researchers have discussed a similar concept called user participation to investigate the project success or performance (Wixom & Watson, 2001; He & King, 2008). However, user participation is only applied in the level of system development which is defined as when users are assigned project roles and tasks, which lead to a better communication of their needs and helps ensure that the system to be implemented successfully (Hartwick and Barki 1994). Service orientation includes a broader range in IT professionals' work condition. In addition to the time that interacting with users, IT professionals in other times (e.g. doing their own jobs or providing the services) can also have the intention to think of users' benefits.

Over the past research, service orientation and similar concept (i.e. user or customer orientation of IT professionals) has many different definitions. Moody (2001) defined service orientation of IS professionals as being demonstrated when IS personnel try to understand the end user's basic business needs and communicates without over reliance on technical jargon. Heinbokel (1996) defined user orientation as the software developers' individual value of producing software for the user and thinking of the user during the development process. Furthermore, Danziger et al. (1993) proposed service orientation of IT professionals as when they make an effort to learn the end users' basic business and are responsive to the end users' needs, they attempt to communicate in the language of the user, work to improve existing systems, and promote new applications whose primary purpose is to help end users.

2.2 Service Climate

Climate has been defined as the shared perceptions of employees who concerned with the practices, procedures, and kinds of behaviors that get rewarded and supported in a particular setting (Schneider, 1990). Because multiple climates often exist simultaneously within a single organization, climate is best regarded as a specific construct having a referent. Therefore, a climate must be a climate for something such as service climate, support climate, innovation climate and so on (Schneider et al., 1994). Service climate in IT context can be referred to the IT professionals' perception of the practices, procedures, and behaviors that get rewarded, supported, and expected from their organization and leaders with regard to user service and user service quality (Schneider, 1994; Schneider et al., 1992; Schneider et al., 1998).

Past research indicated that organizational climate plays a crucial role in guiding employees at work (Schneider & Bowen, 1995). Studies suggested that organizational climate can directly control the behavior of employees' motivation and further enhance the management efficiency, in which managers or organizations themselves are important elements formulating the organizational climate (Litwin & Stringer, 1968). Schneider & Bowen (1995) suggested that the climate should be created for the service delivery in an organization so that a uniformed perception of service delivery may exist and be handled with high quality. Service climate influences employees' behavior through the invisible norms in the working environment (Ajzen & Fishbein, 1980). When employees who perceived that they will get rewards because of providing well service and understanding the service practices which implemented by organization, employees would also enhance their service quality and improve their attitude virtually.

Due to the lack of the ability and skill of IT professionals to interact with users for delivering high quality of service, service climate is studied in this study to examine whether the environment of IT department or organization would impact on IT professionals' working attitude and behavior.

2.3 Personality Trait

Personality trait, as general thinking is the personal characteristics that others can see from one's appearance. The meaning of personality trait includes a variety of individuals inside beyond the surface, such as the subjective emotion which we cannot directly see because people would intentionally hide. It is the factor affecting individual behavior, in addition to individual values and preferences. Moreover, previous study indicated that a person's personality often affect their work behavior. And work locus of control is the most representative personality trait for research in work behavior.

Work locus of control refers to a stable personality trait that describes the extent to which people attribute the cause or control of events to themselves (internal orientation) or to external environmental factors (external orientation) (Kren, 1992) in the working environment. Internal control has been defined as the belief that one's own behavior, characteristics, or attributes determine what one's outcomes will be. External control defined as the belief that what happens to an individual is the result of forces outside his or her own control such as luck, fate, and powerful others (Rotter, 1978). Generally, individual who is high in internal control would give more positive impression to others than externals. Kren's (1992) research further indicated that internals believe that success results from hard work and that failure is an individual responsibility. External control people, in contrast, tend not to believe that success or failure is related to ability or effort.

3 Research Model and Hypothesis

3.1 The Relationship between Service Climate and Service Oriented Attitude

According to the social cognitive theory, individual's behavior will be influenced by the different environment, on the other hand; environment has determined the direction and intensity of behavior (Bandura, 1986). However, employee behavior can behave or act in a desired manner but may not actually have a positive attitude. Only to establish a good attitude might result a spontaneous behavior.

In past research, few studies examined attitude-related aspects of service oriented attitude in the MIS field. In Marketing, Kelley (1992) initiated investigating the relationship between service climate and customer orientation and found that the perception of service climate held by employees can really help them providing customer-oriented service. In addition, Katz and Kahn (1978) proposed that when employees understand the importance of service climate which organization emphasized and the evaluation from customers, then employee will think of providing a better service to customers.

In the context of IT services provision, when IT professionals experiment the belief of pursuing quality service and operation orientation from organizations, these value and attitude will impact IT professionals' action through various managerial systems and measures. That is to say, when the strength of service climate is stronger, IT professionals will be more willing to step into customers' shoes and demonstrate service orientated attitude in their work. Therefore, we hypothesize:

H1: Service climate has a positive effect towards service oriented attitude.

3.2 The Relationship between Personality Trait and Service Oriented Attitude

Rust et al. (1996) noted that personal interaction component of service is often a primary determinant of the customer's overall satisfaction. Bettencourt et al. (2001) considered that personality can be thought to play an important role when it comes to more or less skilled service employees. Further, Vroom (1967) also suggested that employee's self-perception is able to behave in a customer-oriented appearance. Thus, one's personality trait can be considered as a kind of self-perception due to this proposition. In the Marketing field, there are some empirical studies indicated that service orientation is an important and central factor to organization, as well as to help increase performance of employees (Brown et al., 2002; Spivey et al., 1979). In addition, they also believe personality trait as a determinant that leads employees to be more customer oriented. Moreover, scholars found that personality trait are predictive of customer/service orientation and also reflect to the customer satisfaction or job performance (Frei & McDaniel, 1998; Hogan et al., 1984; Mowen & Spears, 1999). According to the literature, personality trait certainly has a significant impact on their customer orientation and performance. Thus, we propose.

H2: Personality trait of IT professionals relates to service oriented attitude.

3.3 The Relationship between Service Oriented Attitude and Service Oriented Behavior

Service oriented behavior is defined as the ability of IT professionals helping their IT users to solve users' problems so as to meet users' needs and generate user satisfaction. Generally, individual behavior is formed by their inside attitude. Theory of Reasoned Action proposed by Ajzen & Fishbein (1977) has been empirically validated and is widely used for predicting and explaining cognitive and affective behavior using the belief-attitude-intention-behavior relationship in social psychology. In this theory, behavior is determined by a person's intention to perform the behavior. Such intention is determined by individual attitudes and subjective norms. Accordingly, if IT professionals need to perform in a service oriented behavior, they must establish a pattern of service oriented attitude. Stocker & Hoyer (2005) proposed that influencing employees' service-oriented attitudes allows the company to establish a more continuous and stable service orientation among salespeople than merely focusing on behaviors. Therefore, we propose:

H3: Service oriented attitude has a positive effect towards IT service oriented behavior.

4 Research Methodologies

This study first explored the current situation of service orientation of IT professionals in different areas including traditional industries and IT related industries. In-depth interviews were conducted to IT professionals from IT departments in organizations. Also the status and issues in service orientation among IT professionals, system users and organizations were also explored in the interviews.

After getting an in-depth understanding of the service orientation of IT professionals and related issues, a proposed research model was developed and revised. Survey methodology was adopted to empirically testify the proposed research framework of this study. Questionnaires were administered to IT professionals including IT project manager, software programmer, system analyst, MIS technical staff, and so on.

A pretest was conducted to IT professionals in order to examine the content validity of the constructs in the proposed model. The final revised version of the survey was administrated to the participants. The invitees were assured that the results would be reported in aggregate to assure their anonymity. Incentives by using the form of gift will be given to participants in order to increase the response rate of the survey.

All measurement instruments are based on existing scales; with a 7-point Likert scales, ranging from (1) strongly agree to (7) strongly disagree. Likert scale is selected due to its effectiveness on measuring attitudes (Nunnally 1978). For the construct measurement, service climate is measured by a 7-item scale proposed by Schneider et al. (1998); work locus of control is measured by a 16-item scale proposed by Spector (1988); both the measurement of user oriented attitude and user oriented behavior contain a 6-item scale proposed by Stock & Hoyer (2005). Demographic information such as gender, age, work experience in IS/IT projects, job position, education level, company size (number of employees), and industry were collected.

Measurement reliability and validity were conducted before the data analysis. For construct reliability, the composite reliability scores (Gefen et al. 2000) was calculated instead of Cronbach's alpha, in which composite reliability has the advantages of not assuming indicators to be equally weighted (Werts et al. 1974). All composite reliability of all variables are greater than 0.7, indicating good reliability according to Fornell & Larcker (1981) . Convergent validity is examined by average variance extracted (AVE) of all variables, while discriminant validity is examined by testing whether the square root of AVE of a variable is greater than the correlation coefficients between self and other variables (Fornell & Larcker, 1981). All constructs and variables indicate good convergent and discriminant validity in this study.

Partial Least Squares (PLS) was used to analyze the proposed model. PLS is a structured equation modeling technique which involves two stages, the assessment of the measurement model, including the reliability and discriminant validity of the measures, and the assessment of the structural model. Structural equation model approach has the ability to address the relationship between latent constructs simultaneously. PLS is gaining an increase use in the academic research which uses a component-based approach, in contrast to the covariance-based approach of other structural equation modeling (SEM) techniques, such as LISREL.

5 Results

The questionnaire was distributed to employees who are working in IT business or department and engaged in system development team or with the professional title as information system project manager, software programmer, system analyst, MIS staff, and so on. The questionnaire is divided into material papers and Internet questionnaire. This study has collected 142 valid respondents.

There are 63.4% of male respondents with 44% aged older than 30. Sixty percent is from the information and computer industry and 40% respondents work in a firm with over 1000 employees. Among all, 52.1% of the respondents are programmers, and the seniority of the respondents is mostly 1-5 years (47.9%) and 6-10 years (26.8%).

Partial least square path analysis was adopted to test the hypotheses. According to the path analysis, service oriented attitude (R^2=26.2%) is significantly affected by work locus of control and service climate. In addition, service oriented behavior (R^2=56.0%) is significantly affected by service oriented attitude. It appears that work locus of control (external work locus of control) has a significant negative effect towards service oriented attitude (β = -0.162; $p<0.05$), and service climate has a significant positive effect towards service oriented attitude (β = 0.511; $p<0.001$). Further, service oriented attitude has a significant positive effect towards service oriented behavior (β = 0.755; $p<0.001$). Therefore, H1, H2 and H3 are all supported.

We further test the relationship between work locus of control and service oriented behavior, and the relationship between service climate and service oriented behavior. We discover that both constructs have no significant effect on service oriented behavior. Therefore, we conclude that the influence of work locus of control and service climate towards service oriented behavior would be mediated by service oriented attitude.

6 Conclusion

Service orientation is an increasingly important theme for the MIS field, especially in the modern society which emphasizes service priority. Users, for the IT professionals are the inseparable cooperative partners. If IT department or organization could provide both high quality of systems and high quality of service that would have greatly increase the competitive advantage of the organization. Therefore, implementing service orientation to IT professionals is one of the best ways to enhance service and user satisfaction. Consequently, this research mainly discusses the antecedents of service orientation which is based on the social cognitive theory. The foundation of theory consists in personal factors (i.e. work locus of control) and environment events (i.e. service climate), are both influenced to behavior (i.e. service orientation). Additionally, we proposed 3 hypotheses which all have significant support by our model testing and confirmed that work locus of control and service climate significantly influence the IT professionals' attitude and have further impact on service oriented behavior. This research provides contributions to academic and managerial practice in the MIS field and IT organizations.

This study examined the antecedents and consequences of IT professionals' service orientation. From the focus group of IT professionals, it is obvious that the service climate of the organizations affect what the IT service providers think and how they react to customers. The personal characteristics of IT service providers also demonstrate different tactics on how to deal with IT customers/users. Empirical study was conducted through survey to verify the proposed research model. Results suggested that the personal characteristics of IT professionals and the service climate of the organization have significant effect on the attitude of IT professionals' service orientation as well as their behavior. The result of this study can provide insights to practitioners on how to enhance IT professionals' service orientation, such as through appropriate training and IT personnel recruitment procedure with certain addition of personality test.

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From Ontologies to Question - Answer Pairs - A Template Language for Automated and Customizable Transformations

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Abstract. A question-answer system is defined as a task through which an automated machine answers arbitrary questions formulated in natural language. The vast majority of existing systems presents problems of different natures, ranging from inability to answer questions that require definitions or explanations up to the fact that they are limited to a single domain, among others. This paper presents a template language capable of solving, in large part, these problems, automatically turning OWL ontologies into AIML databases.

Keywords: question-answer system, ontologies, AIML knowledge basis, template language.

1 Introduction

A question-answer system (henceforth, QAS) is defined as a task through which an automated machine (such as a computer) answers arbitrary questions formulated in natural language. QASs are especially useful in situations in which the user needs to obtain a very specific piece of information and does not have the time - or just does not want to - read all available documentation related to the researched topic in order to solve a problem [1].

After fifteen years since the proposal of The Imitation Game, by Turing, the researcher and professor emeritus at MIT, Joseph Weizenbaum, designed a conversation system called ELIZA. He demonstrated that a simple computer program could successfully run The Imitation Game by using just few tricks, such as answering a question with another question [2 apud [3]].

After ELIZA, several chat systems were developed to undergo the Turing test. In 1990, the Loebner Prize was established. The prize was awarded to the system with the best performance in the test. Founded by Hugh Loebner, along with the Center for Behavioral Studies at the University of Cambridge, he offered a prize of U$ 100,000.00, and a gold coin, for the best project [4].

Parallel to this story, some terms and definitions of this type of system were developed by several researchers. Examples of terms are: chatterbot, conversation system, conversational agent, artificial conversational agent, among others. Some

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authors make a subtle distinction from one term to another, but they end up converging to the same idea, with perhaps some small nuances that differentiate them.

The term chatterbot defines an intelligence capable not only of establishing a conversation, but a program capable of controlling a character in a game category called MUD. In addition to talking to other players, a chatterbot is able to exploit the game world, discover new paths between the various rooms, ask a player about his/her journey, and ask questions about other players, rooms and objects [3].

A compilation of its references simply determines that a chatterbot is a program that attempts to simulate human behavior in conversation. A chatterbot is generally used to clarify doubts about a particular knowledge domain. Its use is more common in web applications, such as e-commerce sites and distance learning on web platforms [5].

It is interesting to note that, historically, the creation of chatterbots has been carried out through different techniques. In [4], a classification is made by means of three generations. The first generation is based on pattern matching and the use of grammatical rules. The ELIZA Therapist and Joseph Weintraub can be cited as examples. The second generation is based on techniques of Artificial Intelligence. Finally, and most important for this work, is the generation characterized by the use of Artificial Intelligence Markup Language (AIML), as is the case with ALICE.

AIML is built on the standards of the Extensible Markup Language (XML) to define response messages to a question [6]. It allows for the creation of a database of question-answer pairs on a certain domain of knowledge. When someone asks a question, it is looked for in the base. If there is a match of the question with a question pattern in the base, then, the answer to this question is given.

The generation of databases of question-answer pairs for chatterbots is an area that has been researched since the beginning of the construction of these systems, when Eliza and Mycin were initially built. At that time, models for the extraction of an expert's tacit knowledge were used to form the knowledge base of the system. Today, it is possible to obtain knowledge bases by means of new forms of knowledge representation established by the research communities. These bases are typically system-independent, i.e., they constitute pure knowledge. Another important factor is that some of them are built on precise and processable language [7].

Currently, several question-answer systems use ontologies as sources of responses [7] but only for open questions.

The primary goal of the ontology is to support the process of "reasoning" in resolving the question, since it supports inference processes. Apart from knowledge representation, ontology can be useful to [3]: a) Share common understanding of the structure of information among people or between agents; b) Allow reuse of domain knowledge; c) Make explicit domain assumptions; d) Separate the knowledge from the field of the operational knowledge; and e) Analyze domain knowledge [1].

However, just using ontologies is not enough to answer questions that require explanations such as factual questions or those of comparison and reasoning [9]. Some systems have other problems, either for not being domain open, or because they do not use knowledge bases in the format established by the OWL (Web Ontology Language), the current standard for describing ontologies for the web.

This paper presents a template language capable of interpreting an ontology for a given domain knowledge, described in OWL, and automatically generating an AIML based question-answer pairs. This solution is provided for general use although it had been previously used for chatterbots. With the TempLang we aim to solve the problems mentioned in the previous paragraph.

This paper is organized as follows: Section 2 presents a basic theoretical and methodological basis for the project development, Section 3 describes the solution encountered, Section 4 contains the project of the solution, and Section 5 presents some provisional conclusions.

2 The Theoretical and Methodological Basis

Our starting point was to investigate the state of the art in order to see how the use of ontologies combined with AIML bases could contribute to the extraction of the answer in a QAS for generic use. In the following sections we will present some theoretical and methodological considerations related to the work conducted in this context.

2.1 OWL and Its Context

To better understand the OWL we chose to follow a path that goes from the origin of XML, as a markup language, through RDF for describing content, then, into RDFS, which added a bit of semantics to RDF. Afterwards, we used OWL, which provides a well defined semantics as it is grounded in Description Logics. Finally, we were led into the extension of OWL, namely OWL2, which has brought about some significant improvements (Fig. 1).

XML, or Extensible Markup Language is a W3C recommendation. It was designed to carry data, whatever their nature, but leaving the responsibility to display them in charge of the application that will interpret them. As for the markings, (also called tags), there are no predefinitions, unlike in the way they are created. Thus, for the structuring, storage and data transportation of each application, previous definitions ought to be made.

XML applications are diverse and perform several tasks such as, a) separating data from HTML; b) simplifying data sharing and transporting; c) simplifying the process of moving from one platform to another; and d) making data more available. They are also used to create new languages on the internet.

2.2 RDF

RDF - Resource Description Framework - is a kind of directed graph to represent information on the Web. It is a framework for describing Web resources widely used to represent personal information, social networks, metadata about digital artifacts such as title, author, date of modification, content and information copyright of a web page. In addition, RDF provides a way of integrating various information sources [10, 11]. Other features of RDF, as found in [11], are:

• RDF was designed to be read and understood by computers.
• RDF was not designed to be displayed to people.
• RDF is written in XML.
• RDF is a part of the W3C Semantic Web Activity.
• RDF is a W3C recommendation.

Besides, RDF can be used for a range of functions, such as [11]

- To describe the properties of shopping items, such as price and availability.
- To describe events schedules for the web.
- To describe information on web pages (content, author, creation and modification date).
- To describe the content and classification for images on the web.
- To describe the content for the search engines.
- To describe electronic libraries.

2.3 Template

Conceptually, a template is a function of a set of attributes / parameters to a text structure. It can also be seen as a textual construction with gaps. These gaps can be filled with expressions that are converted to text when the template is evaluated [12].

In computer science, there are many applications that demand the use of templates, particularly in source code generation. A simple example is the authorship of source programs called IDE - Integrated Development Environment. They commonly have autocomplete functions that insert patterns of structures, such as conditionals and repetitions. In this case, the values of the variables necessary to the text structure are the only elements that need to be altered.

Other very common types of templates are those that provide for a dynamic construction of HTML pages, due to the high demand for production of web-based software.

The template for generating dynamic HTML pages ordinarily composes a well known design pattern called MVC - model-view-control. The “model” is given according to a model, the “control” is a set of functions and the “view” takes care of the process for output of the result. The template comprises the view layer and defines how data will be presented after being treated by the functions. This template is basically formed by a HTML static part and by a programmed part defined via a specific language that uses the functions of the control layer.

It is important that a template may be created and maintained by a language near to the output language because that one is more familiar to the user [13]. If the output is a document in a natural language then it is of interest that the functions of the template are also written in natural language. Regarding the variables that refer to a value or knowledge it is important that their names sufficiently identify their contents.

2.4 Template Language

Initially, we can understand a template language as a language capable of allowing description of how to build the final device through another device constructed according to the grammatical rules of the language. It is also necessary that this language be able to make references to varied information, within a specified database thus allowing each final device to be unique, or at least to have the possibility of being different from others, but still in the template mold. The definition of the template language in [12] helps to complement and further specify what we want to achieve in this article:

> *"A template language is a language for specifying the transformation of structured data into a textual target data representation, by the use of a parameterized object, "the template", and constructs for specifying the template and passing of actual parameters into the template."*

Finally, the process of creating a template should be declarative [5]. A construction, using this type of language, should be a proposition, but should never be confused with a command function, that is, propositions cannot induce action [14].

3 Solution Proposal

The general idea of this work is to generate question-answer pairs (henceforth, QAPs) bases through knowledge bases. The study of related works has shown how such transformations are performed in similar systems. These works were, in general, models that were dependent on a specific language for knowledge representation as well as on a specific language for the representation of the question-answer pairs. Here the intention is, first to generate a generic model and then to determine which languages to use. Another need is generating the documentation or notes on the data, a kind of metadata, so that knowledge can be literally described and these metadata be used as supplemental information for the chatterbots under construction.

3.1 Question of Definition or a Requirement Specification

The first type of question to be worked on is the question of definition. Questions usually follow the format "What is ...?". The taxonomic structure defined for the knowledge base (ontology) will enable the answering of these questions. This will be done by verifying the concepts hierarchically superior to the concept under investigation. The presentation of the restrictions as well as annotations on the properties of this concept may also help to define it.

The analysis of the generation of questions on concepts produces two situations. The first is that, given a parent concept, we want to generate the question-answer pairs, whose answer is the parent concept itself. For example, let us define some concepts such as mammal, which is the parent of the concepts dog, cat, and ox. With these it is possible to define mammal as the answer, and for each of their offspring concepts, a QAP is generated.

In the TempLang it is necessary to have a way to indicate which the parent concept is. From this concept a declaratory function is also needed in order to obtain a list of all of its offspring. Both the indication of the parent and the list of its offspring will complement the composition of the QAPs. If the ontology is increased by new concepts a new interpretation of the template will be needed to generate new QAPs.

Another situation arises, when an offspring concept has more than one parent concept. All parent concepts should be part of the response that defines the offspring concept. If we imagine ox as also being the son of the concept bull, the answer is then composed of a list of parents. Therefore we need a function for browsing this list.

When a query is performed to get a definition for an abstraction, it is usually followed by the format "What / X is?", where X is an individual who belongs to one or more classes. As concepts, the definition of an individual can be increased by the presentation of its properties and annotations.

When we seek for the abstractions of a concept, we need a function that allows browsing through all of them. Furthermore, for viewing an abstraction with the definition of its forming concepts, we need a function that navigates through all the concepts. These functions are analogous to the functions established for the conceptual taxonomy.

The use of these two types of functions in the taxonomy, one that goes top-down and another, bottom-up, enhances the amount of QAPs to be generated. Similarly, the description of the concept or abstraction follows the same course. The top-down function has the ability to generate a list of QAPs, equal to the amount of its offspring. The other, bottom-up, allows the concept or abstraction to list all its parents in the answer.

Other issues were also addressed, such as measurement issues and listing, subconcept abstraction properties, variables - strings, attributes, ontological item lists, textual functions etc. However, they will not be discussed here.

4 The Project

The following elements were initially defined for the project: a language for the ontological representation, a language for the template (henceforth, TempLang), and another one for the QAPs. Input and output languages were also defined, as these will help determine which will be the TempLang. OWL was chosen for the input language, and AIML for the output one. Neither of them needed to be modified because they correspond to our conceptual model. OMDE [13] was chosen for the TempLang, but, for this project, some changes had to be made. Fig 1 shows the transformation of OWL into AIML. In short, an author uses the TempLang for generating the template. The template, in turn, is translated by an interpreter which then generates the QAP based on AIML.

4.1 The Architecture

A general architecture of the proposed system is shown in Fig 1. There, Actors, Author and Expert or Community, are the starting points in the operation of the system. They are the suppliers of the two required inputs for the generation of the AIML, the Template and the Knowledge Base OWL. An expert or a Community of

Experts establishes the concepts of a particular domain. These concepts will be referenced by the author when writing the template.

The TempLang is composed of the following parts: a model of accessing data to OWL, rules for forming lexical and syntactic items on the concept and, a small set of filters on the grammatical rules.

The proposed filters, such as those proposed in OMDE [13] concepts, are based on the semantics of some functions specified in the conceptual model. The language is likely to be enhanced through the introduction of new functions, in the form of filters, which is allowed by the lexical and syntactic rules.

The Template Interpreter is an implementation able to understand the TempLang. Its first function is to read a Template, and an OWL base for establishing the existing relationships between concepts and for providing the knowledge to be manipulated. Following, the Interpreter Template processes the knowledge through the interpretation of the filters designed for this task. Its ultimate function is to format the output according to the filters that set the contexts of the QAPs.

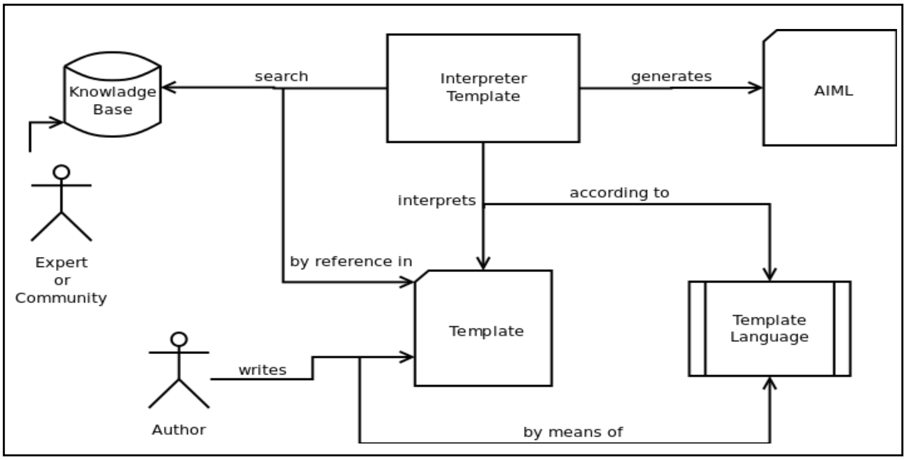

Fig. 1. A general architecture of TempLang

4.2 The TempLang – A Short Example

Let us consider a knowledge structure, or ontology, given by a hierarchy of concepts. In this structure, each concept may have one or more parents. Thus, for a given concept, linked to more than one parent, a list with all of them should be generated. Let us now take a concrete example of this ontology. Figure 2 shows an example of generating a set of QAPs using the format established by the question of definition. By using the class "animal" we intend to generate a QAP for each class of offspring, also called the subclass. If any of these subclasses is an offspring class of some other class, then all their parent classes should be listed. This occurs with the class "ox" which is a subclass of "mammal" and "bull".

```
  [-
        C#mammal:%all_children [- $child -]:
        T#pair: T#question:
        "What is an" : $child:@name: "?":
        T#answer: "In the kingdom of animal it is a " :
        $son:%all_fathers [- $father -] :
        %have_next [- $father -]
      [- $father:@name:%without_underline:" and "  -]
      [- $father:@name:%without_underline: "." -]
-]
```

Fig. 2. Example of a template in TempLang

In short, the construction of *C#mammal* makes a reference to concept *mammal* in the ontology. The constructions of *T#pair*, *T#question* and *T#answer* delimit the spaces established in a document AIML. The constructions beginning with % are functions, and the ones beginning with $ or @ are types of variable. In the end of the interpretation of this code, something like this will be shown:

```
<category>
    <pattern> What is a bull ? </pattern>
    <template>
          In the kingdom of animal it is a
    mammal and a bull.
    </template>
</category>
```

For each *mammal* in the ontology a QAPs, in AIML format, will be generated. Table 1 defines the formation of lexical items and also the allowed syntax. In the left column are non-terminals and in the right one the items, their descriptions. This is the basis for the implementation of an interpreter [15]. To better understand this code in all the detail it is necessary to explain all types of elements in the syntax rules of the TempLang, and the semantic of each filter. This will not be done here. For more detail, the masters dissertation [15] can be consulted.

5 Some Conclusions

In this article, we have presented TempLang, a template language capable of interpreting an ontology for a given knowledge domain. TempLang is meant to work together with OWL, and automatically generate a base of question-answer pairs, in AIML. It can be very useful and widely usable in different contexts, whenever chatterbots are used to mediate communication. This, of course, is facilitated by the fact that TempLang is a general purpose tool, regardless of the context. Transforming OWL-AIML seemed to us unprecedented since nothing exactly similar was found throughout our investigation. However, as TempLang has been developed based on other works with certain similarities, it inherits much of their best features. TempLang also sought to remedy several deficiencies found in those works.

Table 1. Definition of items of TemLang´s Lexical and Syntactic

Non Terminal	**Description**
template	{template item}
template item	comment | filter composition
Filter composition	"[-" filter {":" filter} "-]"
Filter	filter resource | filter function | variable reference | attribute reference | filter attribution | filter AIML | string
filter function	"%" name {filter composition}
variable reference	"$" name
attribute reference	"@" name
name	letter {letter | "_"}
filter resource	resource type “#” resource name
resource type	"C" (*Class OWL*) | "O" (*Object Property*) | "D" (*Data Property*) | “I” (*Individual*) | “A”; (*Annotation Property*)
resource name	any name of a document in the OWL document, accompanied by its respective type feature.
filter attribution	"%atribute" variable reference “=” filter composition
filter AIML	“T#” (“pair” | “question” | “answer”)
name	symbols needed to describe words in the document OWL
string	‘ “ ‘ free text ‘ “ ‘
comment	“!-”free text “-!”

Of all similar works found, the closest to our intentions was the project described in [9], which guided us in our efforts. Similarly, some limitations were found but also largely resolved, such as their transformations based on RDF instead of on OWL. Consequently, they are inflexible and only address concepts and their properties of a given domain. Furthermore, individuals and annotations are not considered. On the other hand, TempLang, due to the use of OWL, becomes more flexible up to the point of allowing the choice of which ontology items would take part in the transformations, and how this would happen.

The first use of TempLang will be within the project CMPAAS (Concept Maps As A Service), a service platform that will provide tools for a "Knowledge Portal" [16] based on conceptual maps, which is also being modeled in our lab. TempLang is also part a larger project, the so called Flexible Multiorganizer of Virtual Workspaces (Morpheus) [17].

Finally, we want to point out that OWL is the language viewed as the present and future of the Semantic Web. It is a W3C recommendation. Therefore, the increase in OWL knowledge bases over time is a driving factor that makes us believe that TempLang puts the creation of AIML on another level of importance as far as human-machine communication is considered.

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An Assessment of Content Quality in Websites of Basic and Secondary Portuguese Schools

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Abstract. Web sites are the face of institutions, but evidence shows that they are frequently overlooked, especially where contents are concerned. The research presented in this paper intended to measure the quality of the data in institutional Web sites of basic and secondary schools. Accordingly, we adopted and adapted a proven measurement approach and carried out a study with a group of teachers from a convenience sample involving basic and secondary schools. Most of the participants in this study stated that the Web sites displayed, completely or partially, most of the thirty three quality attributes, expressing some disappointment with the quality of four attributes only: documentation, interactivity, security and customer support. On the other hand, most of the participants did not express any opinion concerning two of the attributes: novelty and validity.

Keywords: Data Quality, Content Quality, Web Quality, Basic and Secondary School Web Sites.

1 Introduction

Web sites are the face of institutions and, most of the times, they provide the first interaction tool between the institution and its public. Therefore, it is important to know and explore the needs of the Web site users in order to develop and improve these educational institutions, for that is the only way to adapt to their environment. *"For some educational institutions, their Web sites may be the difference between surviving or thriving."…"They also need to know that skills their community member's desire."* [13].

The Web is a great source of information, owing to its interactivity, ease of operation and low cost accessibility. However, amongst other aspects, the available data may not be reliable and may compromise decision making processes. The fact that any person is allowed to publish information on the Web without being subject to any control is one of the main reasons behind the poor quality of the contents made available [16, 22]; Web users can publish contents without referring to norms or rules, which hampers the possibility of finding quality information on Web sites [6, 17].

Aware of this problem and faced with the little investigation work developed in this field [12, 19], we decided to check for the existence of an approach focused on

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measuring the data quality of basic and secondary education institutional Web sites and, existing, if it was possible to adopt and adapt that approach.

This way, we initiated our bibliographical review, which allowed us to understand that Web site quality is indeed strategically important for organizations and customer satisfaction, and quality can be measured considering its three main dimensions: contents, services and technique. This is a groundbreaking perspective and any approach that is based on these three dimensions can offer an in-depth, cross-sectional, integrated and detailed quality measurement of any Web site [1, 19].

The bibliographical research allowed us to identify the existence of several investigation works published in the field of Web site data quality, particularly focused on the technical dimension and frequently inspired by the software quality norm ISO/IEC 9126 [8], and more recently its successor ISO/IEC 25010 [10]. As to data/content quality, only recently did the norm ISO/IEC 25012 [9] emerge. And as far as we know, to this moment, there is no quality norm focusing on the electronic services provided through Web sites.

According to Ruzevicius & Gedminaite [20], different circumstances can determine the choice of the users. Their experience, their knowledge and the season can influence them to perceive more or less value in certain attributes. Thus, when measuring the data quality of Web sites it is also important to consider the field of activity and the profile of the user. Therefore, in the present paper, we put forth an investigation whose main goal was to measure the data quality of institutional Web sites related to basic and secondary schools from the perspective of a category of users, in this case the teachers of the schools whose Web sites underwent an evaluation.

Besides this first section, in which we intended to frame the research that was carried out and present its main goal, this paper is further organized in three other sections. In the second we present the underlying investigation methodology for the work that was developed. In the third section we present the main results. Finally, in the fourth section, we discuss the results and present the conclusions, as well as the directions of future research works.

2 Investigation Methodology

Our investigation methodology followed three steps: in the first we identified the quality attributes for Web site data, based on the bibliography. During the second step we defined a matrix with those attributes. Finally, in the third step, the attributes were measured from the perspective of a category of users (teachers) using an online questionnaire adapted from the approach developed by Caro et al. [3].

2.1 Defining the Data Quality Attributes

In the first step we studied different approaches and norms, developed between 1996 and 2012, and selected the most relevant, that is, the ones that were most frequently quoted by the scientific community and/or made data measurement instruments available. Consequently, we analysed the following works in detail: Wang & Strong

[23], Pipino et al. [18], Eppler et al. [5], Knight & Burn [11], Parker et al. [17], Caro et al. [3], Ruževičius & Gedminaitė [20], Calero et al. [2], Caro et al. [4], ISO/IEC 25012 [9], Moraga et al. [14, 15] and Rocha [19]. From these we compiled the quality attributes for the most relevant data in different Web domains. As a result, we obtained a total of 52 attributes (Table 1) and concluded that the most frequently mentioned attributes amounted to 19, namely: accessibility, comprehensiveness, consistent representation, accuracy, credibility, relevancy, completeness, concise representation, objectivity, value added, suitability, timeliness, currency, traceability, believability, security, reputation, ease of operation and availability.

Table 1. Content quality measurement attributes

	Wang & Strong 1996	Pipino et al. 2002	Eppler et al. 2004	knight & Burn 2005	Parker et al. 2006	Caro et al. 2006	Ruževičius & Gedminaitė 2007	Calero et al. 2008	Caro et al. 2008	ISO/IEC 25012 :2008	Moraga et al. 2009	Frequency
Comprehensiveness	x	x	x	x	x	x	x	x	x	x	x	11
Accessibility	x	x	x	x	x	x	x	x	x	x	x	11
Consistent representation	x	x	x	x	x	x		x	x	x	x	10
Accuracy	x		x	x	x	x	x	x	x	x	x	10
Concise representation	x	x	x	x	x	x		x	x		x	9
Relevancy	x	x		x	x	x	x	x	x		x	9
Completeness	x	x		x	x		x	x	x	x	x	9
Believability	x	x		x		x	x	x	x	x	x	9
Value added	x	x		x			x	x	x		x	7
Timeliness	x	x	x	x			x	x	x			7
Objectivity	x	x		x	x		x	x	x			7
Currency			x			x	x	x	x	x	x	7
Suitability	x	x		x	x	x		x	x			7
Security	x	x	x	x				x	x			6
Traceability			x			x		x	x	x	x	6
Reliability				x		x		x	x	x	x	6
Reputation	x	x		x				x	x			5
Ease of operation		x	x	x				x	x			5
Availability				x				x	x	x	x	5
Validation						x		x	x		x	4
Interpretability	x	x						x	x			4
Expiration						x		x	x		x	4
Response Time			x					x	x			3
Interactivity			x					x	x			3
Novelty						x		x	x			3
Specialization								x	x		x	3
Efficiency				x						x	x	3
Attractiveness								x	x		x	3
Customer Support						x		x	x			3
Applicability			x					x	x			3
Recoverability										x	x	2
Portability										x	x	2
Organization								x	x			2
Flexibility								x	x			2
Duplicability								x	x			2

Table 1. (*continued*)

	Wang & Strong 1996	Pipino et al. 2002	Eppler et al. 2004	knight & Burn 2005	Parker et al. 2006	Caro et al. 2006	Ruževičius & Gedminaitė 2007	Calero et al. 2008	Caro et al. 2008	ISO/IEC 25012 :2008	Moraga et al. 2009	Frequency
Documentation								x	x			2
Conformity										x	x	2
Verifiability											x	1
Usefulness											x	1
Secrecy							x					1
Price							x					1
Navigation				x								1
Error Free		x										1
Readability											x	1
Font					x							1
Easy to Manage							x					1
Effectiveness											x	1
Correct			x									1
Convenient			x									1
Clear			x									1
Adaptable to Needs							x					1
Confidentiality										x		1

2.2 Categorizing the Data Quality Attributes

After the analysis of different approaches and norms it was necessary to organize and categorize the collected attributes. Table 1 was thus developed, where attributes were organized according to the approach used and the total number of times they were mentioned. Then, we elaborated Table 2 organizing the approaches according to the following criteria: source of the work, currency, number of attributes, and whether they made a measuring instrument available or were quoted in other research works; this encouraged us to adopt and adapt the approach developed by Caro et al. [3, 4] for the completion of our study. The selection of this approach was based on the following motives: i) The approach of Wang & Strong [23] served as a basis for their study; ii) data quality is perceived by them as a multidimensional concept [18]; iii) they make available a questionnaire that addresses a total of 33 data quality attributes, and which incorporates the 19 most frequent attributes, described in Table 1; iv) the consolidation of the approach developed by Caro et al. [3] began with the PDQM (Portal Data Quality Model) project, followed by Calero et al. [2] who developed the PoDQA (Portal Data Quality Assessment) tool from the PDQM, and Caro et al. [4] who, based on these two projects, created an approach that claimed to measure the data quality of Web portals in any field, an approach that was later extended in a project by Moraga et al. [14]; i) their study constitutes an approach that can be administered in Web portals of any field, including basic and secondary education portals.

Table 2. Criteria behind the selection of the approach

Approaches	Year	Source of the work	Att. Nr.	Evaluation Tools	Quotes in other works
Wang & Strong	1996	Academic	15	Yes	Eppler et al. (2004) Knight & Burn (2005) Parker et al. (2006) Caro et al. (2006) Ruževičius & Gedminaitė (2007) Calero et al. (2008) Caro et al. (2008)
Pipino et al.	2002	Academic	16	No	Eppler et al. (2004) Knight & Burn (2005) Calero et al. (2008)
Eppler et al.	2004	Academic	16	No	
Knight & Burn	2005	Academic	20	No	
Parker et al.	2006	Academic	18	No	
Caro et al.	2006	Academic	15	Yes[1]	Calero et al. (2008) Caro et al. (2008)
Ruževičius & Gedminaitė	2007	Academic	14	No	
Calero et al.	2008	Academic	33	Yes[2]	Caro et al. (2008) Moraga et al. (2009)
Caro et al.	2008	Academic	33	Yes	
ISO/IEC 25012	2008	Business	15	No	Moraga et al. (2009)
Moraga et al.	2009	Academic	34	No	

2.3 Measuring the Data Quality Attributes

This step was based on the enforcement of the questionnaire adapted from Caro et al. [4]. Accordingly, we carried out a study which solicited the opinion of users (teachers) of basic and secondary school Web portals as to the features they considered important in data quality.

According to Santos [21], a questionnaire is composed by a significant number of questions that are posed to people in writing. The goal is to objectively understand opinions and attitudes, as to the usability of the questionnaire. Questionnaires can, generally speaking, be composed by open-ended or closed-ended questions. The type of question depends on the type of data that needs to be collected. To render the analysis process of the obtained questions easier we must prioritize the closed-ended questions, where the user specifically agrees, disagrees or manifests his or her indecision, and also his or her preference and agreement, and, additionally, can choose an item from a list. Opened-ended questions can lead to great ideas but are generally more difficult to analyse and quantify.

[1] http://freeonlinesurveys.com/v1/rendersurvey.asp?sid=140254
[2] http://podqa.webportalquality.com

The goal of the administered questionnaire was to assess the experience of the users (teachers) and to appraise their opinion concerning the quality of the data provided by their schools Web sites. The questionnaire was structured in two parts: A – Characterization of the Respondent; and B – Data Quality. In part A we adopted the quantitative method, which presupposes the identification of variables that are "the pre-existing characteristics of the participants of a study (…) generally comprised by demographic data." [7]. In this case, the variables were intended to characterize the teachers that participated in the research, and included: educational establishment, age, gender and teaching group.

Part B was composed by 33 closed-ended questions, each one corresponding to a data quality attribute (Table 3) and one opened-ended question, which gave the respondents the opportunity to add any aspect they considered relevant for data quality.

Table 3. Attributes measured in the questionnaire by Caro et al. [4]

Attributes		
Attractiveness	Interactivity	Reputation
Accessibility	Interpretability	Accuracy
Currency	Novelty	Expiration
Applicability	Objectivity	Ease of operation
Suitability	Timeliness	Flexibility
Completeness	Organization	Documentation
Believability	Relevancy	Customer support
Availability	Concise Representation	Response time
Duplicates	Consistent Representation	Traceability
Comprehensiveness	Reliability	Validation
Specialization	Security	Value added

The quality of each data attribute was measured using the *Likert* scale, that is, the 33 closed-ended questions were integrated in a scale from 1 to 5, where:

1. Completely disagree
2. Partially disagree
3. Don't agree nor disagree
4. Partially agree
5. Totally agree.

According to Fortin [7], questionnaires should be subject to tests that verify their efficiency and value, to estimate the answer time for a reduced sample of the target population and also to determine if all the questions included produce relevant data. Therefore, a pre-test was carried out with 20 teachers, whose characteristics resembled those of the respondents, and a number of suggestions were made:

1. Indicating the average answer time in the questionnaire;
2. Adding questions concerning the accessibility of disabled people to the Web sites;

3. Separating the question "The available data is not ambiguous and is clear and easy to understand" in two.
4. Dividing section B of the questionnaire in two pages, indicating in the beginning the number of pages.

As to the first suggestion, we included the average answer time of the questionnaire in the email that was sent to the participants requesting their collaboration in its completion. As to the second suggestion, we did not introduce any change in the questionnaire, since it concerned the measurement of an attribute that did not relate to data quality. Question 14 could not be separated in two, to the extent that the measurement of the comprehensiveness attribute would lose its coherence. However, the question was reformulated, in order to increase its understanding, as follows: “The available data is clear, unambiguous and easy to understand.” Finally, in section B, the 33 questions that were presented in a matrix format were divided in several pages, in subgroups of 6 questions, with the indication of the page number in the beginning of each page.

The questionnaire was prepared and published *online*[3] with the SurveyMonkey tool. The statistical treatment of the data and the development of the graphics were carried out with Microsoft Excel.

The questionnaire was sent to 9 educational establishments, 4 basic and 5 secondary schools (Table 4).

Table 4. List of the Selected Educational Establishments

County	Educational Establishment
Póvoa de Varzim	Eça de Queirós Secondary School 2,3 de Aver-o-Mar Basic School
Vila do Conde	2, 3 D. Pedro IV Basic School José Régio Secondary School
Matosinhos	2,3 de Perafita Basic School
Porto	Aurélia de Sousa Secondary School
Almada	Cacilhas-Tejo Secondary School
Albufeira	Albufeira Secondary School 2,3 Francisco Cabrita Basic School

Our goal was to have a sample that included most of the Portuguese mainland territory. We selected schools located in the North, Centre and South of Portugal. The sample of the selected schools is a convenience sample. Our selection was based on the privileged contacts we had with those schools, which led to the participation of a greater number of teachers. The questionnaire was presented to the Governing Board of each school in person or by email, to be forwarded by these management organs to their respective teachers in a way that would raise the awareness of the prospective participants to collaborate in its completion.

[3] `http://www.surveymonkey.com/s/LVHQW8F`

During the months of June and July 2012, 96 respondents answered the questionnaire but only 66 were considered valid, which amounts to a success rate of 68,8%. Every questionnaire that was started but not finished was not considered valid.

This project was developed according to the ethical principles that underlie the practice of research. Fortin [7] defended that the investigation practice must be carried out in full respect of the people's rights. Consequently, the questionnaire was anonymous, ensuring that none of the respondents or collected data was recognized, both by the researchers and the readers.

3 Results

After the descriptive statistical treatment of the data collected in the questionnaire we concluded that the majority of participants was female (77,3%), worked in basic education schools (84,7%), belonged to the science teaching group (55,7%) and was aged between 40 and 59 years old (66,6%).

Table 5 resumes the opinion expressed by the teachers that completed the 66 questionnaires considered valid, concerning the quality of data in Portuguese basic and secondary education Web sites.

After the analysis of Table 5, as to the 33 attributes, we concluded that:

- An absolute majority of respondents agreed, completely or partially, that 23 of the attributes (attractiveness, accessibility, currency, applicability, adequacy, completeness, believability, availability, comprehensiveness, specialization, reputation, accuracy, ease of operation, flexibility, interpretability, objectivity, timeliness, organization, relevancy, consistent representation, reliability, response time and value added) were available in the Web site of their school;
- A relative majority of respondents agreed, completely or partially, that 5 of the attributes (duplicates, expiration, novelty, concise representation and traceability) were available in the Web site of their school.
- On the other hand, a relative majority of respondents disagreed, completely or partially, that 4 of the attributes (documentation, interactivity, security and customer support) were available in the Web site of their school;
- A relative majority of respondents had no opinion concerning 2 of the attributes (novelty and validation);
- 1 attribute (interactivity) obtained 3,0% of no answers;

9 attributes (accessibility, applicability, duplicates, comprehensiveness, documentation, novelty, objectivity, reliability and traceability) obtained 1,5% of no answers.

Table 5. Results obtained for each attribute of Web site data quality

	Completely or partially disagrees	**Undecided**	**Completely or partially agrees**	**No answer**
Attractiveness	10,6%	18,2%	**71,3%**	0,0%
Accessibility	3,0%	19,7%	**75,8%**	**1,5%**
Currency	9,1%	18,2%	**72,7%**	0,0%
Applicability	12,1%	16,7%	**69,7%**	**1,5%**
Suitability	13,6%	24,2%	**62,1%**	0,0%
Completeness	15,1%	27,3%	**57,6%**	0,0%
Believability	4,5%	15,2%	**80,3%**	0,0%
Availability	19,7%	21,2%	**59,0%**	0,0%
Duplicates	12,1%	42,4%	**44,0%**	**1,5%**
Comprehensiveness	7,6%	19,7%	**71,3%**	**1,5%**
Specialization	18,2%	27,3%	**54,6%**	0,0%
Reputation	9,1%	25,8%	**65,1%**	0,0%
Accuracy	12,1%	24,2%	**63,7%**	0,0%
Expiration	13,6%	36,4%	**50,0%**	0,0%
Usability	10,6%	22,7%	**66,6%**	0,0%
Flexibility	13,6%	24,2%	**62,1%**	0,0%
Documentation	**36,3%**	33,3%	28,8%	**1,5%**
Interactivity	**50,0%**	24,2%	22,7%	**3,0%**
Interpretability	3,0%	13,6%	**83,3%**	0,0%
Novelty	19,7%	**39,4%**	**39,4%**	**1,5%**
Objectivity	7,6%	37,9%	**53,0%**	**1,5%**
Timeliness	12,1%	24,2%	**63,7%**	0,0%
Organization	18,2%	30,3%	**51,5%**	0,0%
Relevancy	7,6%	18,2%	**74,2%**	0,0%
Concise representation	18,2%	37,9%	**44,0%**	0,0%
Consistent representation	15,2%	27,3%	**57,6%**	0,0%
Reliability	16,7%	30,3%	**51,5%**	**1,5%**
Security	**36,3%**	33,3%	30,3%	0,0%
Customer support	**47,0%**	30,3%	22,8%	0,0%
Response time	31,8%	16,7%	**51,5%**	0,0%
Traceability	27,2%	33,3%	**37,9%**	**1,5%**
Validity	31,8%	**43,9%**	24,3%	0,0%
Value added	4,5%	22,7%	**72,8%**	0,0%

4 Discussion and Conclusion

Having studied different approaches we concluded that Wang & Strong [23] were the great pioneers in the evolution of data quality measurement of Web portals from the perspective of the user. Additionally, we concluded that Wang & Strong [23] were the authors that were most frequently quoted by other authors mentioned in this paper, and that most of the approaches developed to measure the data quality of Web sites was based on their work.

In the course of our research we also concluded that the features that were most frequently referred by the different authors under study were:

- 11 times – accessibility and comprehensiveness;
- 10 times – consistent representation and accuracy;
- 9 times – believability, relevancy, completeness and concise representation;
- 7 times – objectivity, value added, adequacy, timeliness and currency;
- 6 times – traceability, reliability e security;
- 5 times– reputation, ease of operation and availability.

Fourteen of the nineteen attributes most frequently referred to were proposed by Wang & Strong [23].

After analysing the instruments made available by the authors under study, we chose to adopt and adapt the approach developed by Caro et al. [3, 4], which assumed as a starting point the study by Wang & Strong [23] and followed the reasoning of Pipino et al. [18], stating that data quality should be perceived as a multidimensional concept, that is, it should account for individual subjective perceptions.

Consequently, we adapted the questionnaire proposed by Caro et al. [3, 4] for the educational field, more specifically to the Portuguese basic and secondary education. With this questionnaire we were able to collect the opinion of 66 teachers concerning the quality of data in Portuguese institutional basic and secondary education Web sites. The results allowed us to conclude that a relative majority of the respondents identified an absence of interactivity with the contents, the lack of protection against manipulation and unauthorized accesses, the not identification of authors and/or sources, as well as the absence of online support in the Web sites to clarify questions involving the contents. However, the vast majority of the participants stated that the data was presented in an attractive, believable, accurate and consistent way, in a suitable language that was easy to interpret and always made available in a timely and quick access manner. They also mentioned that the data was current, accurate, comprehensive and relevant, as well as impartial, useful, clear and easy to enforce, operate, control and understand, and, concurrently, relevant and adaptable to specific user needs. The amount of data was also considered suitable and sufficiently detailed. Data sources were correct and worthy of great respect. We could also observe that the content organization followed visual control criteria, which can benefit the users and be adapted to their needs.

A relative majority also stated that the data is well documented, being easy to verify and assign a source, as well as to measure its currency. The contents were considered new and impacted the knowledge and decision making processes, being displayed in a concise form without superfluous data nor duplicates.

A relative majority of the respondents expressed no opinion as to the novelty of the contents or their impact in their knowledge and decision making processes, or the possibility of being assessed and validated from the perspective of the user.

After analysing the results of the questionnaire a doubt emerged, since a considerable percentage of users (36,3%) indicated the impossibility of identifying the authors and/or sources of the data while 65,1% of the respondents stated that both the data and its sources were correct.

Considering the type of research that was carried out we were able to achieve the proposed goal of measuring the quality of data in institutional basic and secondary school Web sites, from the point of view of one category of users (teachers), and we were also able to adopt and adapt an assessment approach for Web sites in the educational field.

This investigation contributed in some extent to the knowledge in this field, namely: i) the bibliographic systematization of the theme; ii) the adaptation of the questionnaire developed by Caro et al. [4], validated to measure the data quality in institutional basic and secondary school Web sites; and iii) the state of the art concerning the quality of data in institutional Web sites of Portuguese basic and secondary schools, building a basis for the development of more in-depth studies in the area.

In the future, we intend to extend this study to a sample that is representative of the country. We intend to develop a more in-depth and cross-sectional study to measure data quality in institutional basic and secondary school Web sites, analysing the three main dimensions (contents, services technique) considered and proposed by Rocha [19]. Finally, we intend to create a best practice guide for the availability of data in institutional basic and secondary schools Web sites.

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Language Technology for eGovernment – Business Cases

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Abstract. Language technologies and tools, such as text mining, information extraction, and question and answering systems, have been developed during many years. These technologies are becoming mature and should be ready for deployment in private and public organizations. However, little focus has been paid to how these technologies can be applied to tackle real-world problems within organizations. In this paper, we present a set of business cases where language technologies can have a significant impact on public organizations, including their business processes and services. We describe how each business case can influence the service quality, as seen from a consumer perspective, and the business processes efficiency, as seen from a public organizational perspective. The business cases are based on, and exemplified with, cases from large Swedish public organizations.

Keywords: language technology, eGovernment, business cases, text mining, information extraction, question and answering systems, business intelligence.

1 Introduction

Public organizations face increased demands regarding efficiency, overall quality, and openness. Modern citizens demand quick responses to their request, and use an increasing number of communications channels in their interactions with the public organizations. At the same time, initiatives such as the open government initiative (EOP, 2009) points to the need of having transparency and well documented processes in the public organizations. Traditional requirements, such as the ability to handle each case regarding citizens and private organizations in a fair way, and to avoid biased decisions, as well as newer ones related to efficient use of public resources, are put on top of these new requirements.

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To handle their operations, public organizations can employ a wide range of IT systems. One common way of handling cases regarding citizens and private organizations is to employ case management systems, workflow systems and/or content management systems. These systems provide excellent support for managing cases and routing documents between handling officers. However, the focus of these systems is to manage well-structured information, and they are not so efficient at managing less structured information, such as free text and speech. Thus, there is high potential in combining these systems with technologies that focus on managing unstructured information.

One promising type of technology for managing unstructured information is *language technologies*. In this paper we define language technology as a collection of techniques for processing human language, including semantic techniques (e.g. natural language processing and information extraction) and statistical techniques (e.g. text retrieval and text mining), as well as a combination of these. By combining language technology with case management systems, workflow systems and/or content management systems, public work can become more resource efficient, i.e. reducing processing time and the amount of manual labor, even when the information is unstructured. Moreover, such a combination can result in improved quality for the citizens in their interaction with public organizations.

However, in order for public organizations to invest in language technology, business and IT managers in public organizations need to understand which language technologies exist, how they can be applied in the organization, including how they can be combined with systems such as case management systems, workflow systems and/or content management systems. It is also important for the managers to understand benefits and issues related to applications of the language technologies. Therefore, the problem that we address in this paper is that it is unclear for business and IT managers in public organizations which language technologies exists; how language technologies can be applied in public organizations; and what benefits and issues are related to their applications. In this paper, we present a set of business cases that shows the potential of using language technologies in public organizations, and how the organizations can be beneficial from applying the cases, as well as possible risks when applied. To structure the business cases we describe the problem that each case solves, the current technical state of art for the language technologies used in the cases, and any risks involved in applying the cases. To make the business cases concrete and easy to understand, an illustrative example for each case is presented as well.

The business cases described in this paper are drawn from analysis of case management processes in Swedish public organizations, and design of use cases that describe future use of language technology within these processes to enhance efficiency and service quality. The analysis of case management processes and design of use cases were carried out as part of an ongoing research project, called IMAN2, described in next section.

The paper is structured as follows: Section 2 describes the research methodology used. Section 3 presents the business cases, Section 4 concludes the paper.

2 Research in the IMAN2 Project

The research presented in the paper was carried out in the context of the IMAN2 research project and follows a design science research approach. The IMAN2 project's goal is to develop innovative e-government solutions for case management processes by the use of language technology with the aim to simplify and improve the interaction between public organizations and the actors they serve, such as citizens or private organizations. The project is a collaboration between researchers in language technology at Stockholm university, Royal Instituite of Technology, Sweden, the business intelligence company Gavagai, the process improvement companies Visuera, and the IT consultant company Cybercom. Furthermore the project includes a number of Swedish public organizations on national as well as local level: the Swedish Transport Administration, the Swedish Pension Agency, and four local governmental organizations, Nacka, Bollnäs, Söderhamns and Klippan municipalities. These public organizations all have the need of a well structured way of managing case management processes and general requests from citizens using language technology. The role of the participating public organizations is to provide research issues to the project based on analysis of their case management processes; to participate in design of solutions using language technology; as well as to act as test beds for the solutions, i.e. software prototypes that the project aims to develop. In this paper we also include some experiences from a previous research project, IMAIL, in which the Swedish Social Security Agency participated.

The research methodology used in the research presented in this paper is design science research (Hevner, 2004), (Peffers, 2007). Design science has its origins in engineering disciplines, and aims at creating innovative artifacts for solving practical problems. Design science is carried out to change the state of affairs by using an innovative artifact. Commonly the design science process consists of several activities that leads to an artifact. We use the activities presented by Peffers et al (Peffers, 2007) as follows. To *identify problem* (activity 1) we engaged the project participants in process modeling workshops, where existing business practices where discussed and problems identified. After this we defined *objectives* for the solution to be developed (activity 2). While working in the project it was evident that the potential of using language technologies in public organizations was high, but it was difficult for business and IT managers in public organizations to understand what technologies exist. We thus set the objectives that the artefact should focus on applicability, understandability and modularity of language technologies solutions. As a next step *design and development* commenced (activity 3). With help from the consulting companies Cybercom and Visuera several use cases representing the problems in the organizations were created. These use cases were generalized, modularized and refined to be applicable to a larger set of organizations. The result of this activity is the business cases as presented in this paper. In order to *demonstrate* (activity 4) the utility of the business cases each case includes examples from the organizations participating in the project, thus the cases are empirically grounded in several organizations. A last step, evaluation (activity 5) is to be performed when the project progresses.

3 Business Cases Using Language Technologies

In this chapter a set of business cases describing possible use of language technologies in public organizations are presented. The business cases can be used by business and IT managers in order to better understand what language technologies can be applied in their organizations, how they can be applied and their possible effects. To structure the description of the business cases we describe each case using the following template:

- *Business case* - provides a short definition of the business case.
- *Problem* - describes a practical problem that can be solved by applying the business case.
- *Applicable technical solution* - provides a short definition of the applicable language technologies for the case.
- *Technical state of art* - gives an overview of current research within the technology field.
- *Effects* - describes the positive effects of applying the business case. The effects can be both internal and external. An internal effect is seen in the perspective of the public organization, while an external effect describes the positive effect of applying the business case from the perspective of the citizens.
- *Risks* - identifies a set of risks, or unwanted effects, of applying the case
- *Example* – provide illustrative examples of how the business case can concretely be applied in a public organization. The examples are based on process analysis and design of use cases carried out in context of the IMAN2 project, but in some cases also from the research project IMAIL.

3.1 Automatic Message Answering

Business Case: Automatic message answering is a business case in which citizens' requests for information are managed automatically by a system sending back answers instantaneously without human involvement.

Problem: Public organizations are spending a considerable amount of resources answering simple questions from citizens since these questions are commonly managed by human employees. From the citizens' perspective, the citizens may expect instant answer to simple questions. However, citizens often have to wait in a telephone queue before getting in contact with a public agent answering the question, or, when using email or a web form, waiting for a public agent reading the question, write and send an answer back. Moreover, public agents are usually only available during working hours. This means that simple questions cannot be answered in the evenings or in the weekends.

Applicable Technical Solutions: Automatic message answering is making use of language technologies to lookup pre-specified responses to common requests. The response can be either an answer to a question, or contain references to resources that help to manage the request.

Technical State of Art: In domains dealing with a few subjects, automated FAQ retrieval has proved practical. Sneiders (2009) has identified three approaches to FAQ retrieval: (i) statistical techniques, which are useful if a large number of existing question-answer pairs are available. These question-answer pairs can be analyzed and statistical techniques can be applied to relate appropriate answers to a number of questions, (ii) natural language processing and ontology-powered FAQ retrieval, which make use of ontologies or conceptual models (i.e. models describing what concepts exists and their relationships) as instruments to provide an appropriate answer to a question, and (iii) template/text-pattern based techniques which are useful if little or no training data is available. These make use of pattern matching techniques, essentially matching patterns in the incoming questions to pre-defined answers. Sneiders (2009) demonstrates a system in a self-service environment that answers about 70 percent of all questions with about 90% accuracy.

Similar to the text classification task is matching incoming e-mail messages to a list of frequently asked questions (FAQs). Iwai et al. (2010) makes an observation that 30-40 percent of an e-mail flow addresses often reoccurring topics, and presents a system for developing an FAQ list and matching these FAQs to future e-mails. Also Itakura et al. (2010) matches FAQs to e-mails. Both Iwai et al (2010) and Itakura et al (2010) use basic statistical techniques: cosine similarity, tf-idf weights, Jaccard coefficient, Support Vector Machine. On the contrary, Sneiders (2010) assigns manually created text patterns to FAQs, and then matches these text patterns to query e-mails.

Effects: The use of this business case can have an effect on both quality and efficiency. In this case the efficiency can be increased by swiftly responding to requests without any person being involved. This makes the solution ideal for handling large volumes of queries. The quality can be increased by creating high-quality answers for the most common request. Creating high-quality answers could for example entail ensuring that the answers are legally correct and independent of individual agents subjective opinions and level of expertise.

Risks: A negative effect, or risk, of employing this case is that the response has not considered important aspects of the request. Simply put, there is a risk that the wrong response is sent. Furthermore, automatic answering might not be appropriate when the user has a vague question.

Example: The Swedish Social Security Agency get a large amount of mail asking questions about compensation for sickness leave, parental leave and so forth. In a pilot case it was shown that at least 5% of the incoming mails could be correctly answered. Besides lowering the load on the customer service the automatic answering of mail also led to a quicker response time.

3.2 Case Routing

Business Case: Case routing is a business case in which a case is automatically routed by a system to an expert with the right knowledge to handle the case.

Problem: Even small organizations have personnel that have their own domain of expertise. Thus, an incoming request needs to be *routed* to the person who has the right knowledge to handle it. For large organizations it can be a problem to find the right person/role to route a request to, this requires extensive knowledge about the organization and its capabilities. The person managing the routing of cases also needs to be informed when changes occur that affects the routing. Moreover, to manually go through each request is time and resource consuming. In the worst case a single request need to go through several manual steps before it reaches the person who can handle it.

Applicable Technical Solution: Automatic case routing is the process of categorizing requests and based on a set of rules route the request to a receiving agent. The categories used for classifying incoming request can swiftly be changed. The categorization can both be based on meta-data, such as the form used for the request, and on free text contained in the request.

Technical State of Art: Document routing can be viewed as a task of text categorization, where a text category is routed to a certain role and employee. Text categorization employs a number of machine learning techniques. Colas & Brazdil (2006) compare the text categorization techniques SVM, kNN and Naïve Bayes; SVM has superior text categorization accuracy while kNN and Naïve Bayes are faster and consume less computing power. Hao et al (2007) demonstrates a modification of SVM which achieves classification accuracy above 90% for many text categories taken from Reuters-21578 corpus of news stories. Often, however, "off-the-shelf" statistical text categorization methods demonstrate insufficient text categorization accuracy, which leads to a requirement to customize these methods. A problem during such customization is the trade-off between high level of automation in deployment and maintenance of statistical methods versus higher quality and also higher labor costs offered by knowledge-intensive methods that make use of domain knowledge.

For email the problem is the small number of words that statistical methods can work with. Dalianis et al (2011) discovered that e-mail messages to the Swedish Social Security Agency contain 65 words on average, some are longer, some shorter. Often, subject specific words appear in a message only once. E-mail answering techniques (see the case Automatic message answering) may be applied also for routing the messages. Using this case, we can expect high precision but somewhat lower share of the messages being automatically routed.

Effect: The use of case routing enables requests to be swiftly sent to the right agent within an organization. When implemented successfully a large set (typically 80 percent) of the incoming request can be automatically routed, thus saving resources and lessening the burden on the expert personnel handling the remaining requests. This could lead to faster responses from the citizens' perspective.

Risks: The main risk when employing automatic case routing is that it, if not tuned correctly, can lead to erroneous categorizations, thus sending request to the incorrect agent, delaying the management of a case. Furthermore, if it is not possible to successfully identify distinct, non-overlapping, categories, there is a risk that only a few requests can be routed automatically. A single request can contain sub-requests, each belonging to a certain category. This kind of request can be difficult to handle using automatic case routing.

Example: The Swedish Transport Administration handles about 2 000 written request per month. The agents handling as well as the requests are divided into customer services and case handling officers. The customer service handles request that can be quickly resolved, for example, requests regarding the current highway status, temporary routes. The case handling officers handles cases concerned with a number of sub-categories: railway, highways, ferries, transport logistics and large projects. One possible use of automatic case routing would be to first sift out the “small” cases that the customer service can handle promptly. The remaining cases could then be routed to a case handling officer. The category “large projects” is an example of a category that is changed often, and thus an automatic categorization must be updated to cover new projects as they are planned. An example of a project in the domain of the transport administration is the creation of a new turnpike. The creation of a new turnpike could cause a lot of questions from the citizens.

3.3 Phone Call Summation

Business Case: Phone call summation is a business case in which a telephone conversation between a public agent and citizens or employees in private organization is automatically transformed into a written summary by a system, thereby providing a documentation of the conversation in text form.

Problem: A part of handling a case could be a conversation with citizens or others. This type of interaction can cover an extended discussion that leads to resolving the case, or that the handling of the case is forwarded to another case officer. The problem with this kind of conversation is that nothing, or very little is documented. This can be an issue if another case officer gets involved, or if the case needs to be reviewed later on.

Applicable Technical Solution: A summation of phone call is providing a written summary of a conversation. The summary could both contain excerpts from the conversation, as well as selected keywords. These summaries and keyword can be used later to review the case, and to be able to search for cases.

Technical State of Art: In recent years speech recognition technology has improved to the point where it is reasonable to expect a word error rate (WER) of less than 10% for dictation software out of the box, and around 1-5% after speaker adaptation. However, for call center applications, where the speech data is much noisier and displays a great variability of speaker style, dialect, age, caller's calling equipment, etc., it is reasonable to expect a WER of 33% or even 50% (Zweig et al., 2006, Mamou et al., 2006). This means that every third word to every second word is misrecognized. Because of this, call center applications first on centered on call steering (see e.g. Chu-Carroll and Carpenter 1999, Boye and Wiren 2007), where the user states his reason for call and the application steers the call to an appropriate service agent or self-service; system-directed self-services e.g. for troubleshooting (Acomb et al. 2007, Boye 2007), or speech analytics, where problematic calls are identified and the service given by the human service agent is evaluated (see e.g. Mishne et al. 2005, Kim 2007, Zweig et al. 2006).

For call summarization, standard text summarization techniques based on sentence selection are not immediately applicable because of the high WER usually obtained from call center speech data. Rather researchers have focused on call segmentation and extraction of topics and important phrases used in the call (Roy and Subramaniam 2006, Mishne et al 2006, Kummamuru et al. 2009). Such phrases and topic labels can be used as a succinct summary or classification of a call.

Effect: By providing an automatic summary it is possible to drastically reduce the time spent documenting a conversation. Since the automatic summary is inexpensive, it is possible to larger extent document cases, that is, more cases gets documented. Having cases documented can also have long-term effects, for example it enables analysis of the cases.

Example: The Swedish Pension Agency handles request via both mail, e-mail and phone. Particularly elderly people are inclined to ask questions via phone. With the use of call summation it would be possible to extract structured information from the phone call and use that before, while and after handling the requests. For example, one type of case that the pension agency handles is applications for housing supplementary allowances. While in contact with an agent, the system could aid the case handler document ingwhat is being said. Today this kind of documentation is done manually and partially after the conversation has ended. With support for text summation it would be possible to perform the documentation automatically, allowing the agent to focus on the conversation.

3.4 Competitive Intelligence Analysis

Business Case: Competitive intelligence analysis is a business case in which external information that affects an organization's activities is collected. This information is analyzed to make long-term strategic decisions and short-term resource re allocations.

Problem: Modern organizations, whether public bodies or commercial entities, are highly dependent on understanding their external business environment. Public organizations act on behalf of the general public, with a charter broadly defined by the needs of the society around them, which the actions of the public organization in question influences and affects. To perform its duties appropriately, a public organization needs to acquire some sense of what the mindset, mood, and attitude of the public opinion is, and to aggregate that information into actionable information for both strategy and immediate action.

Applicable Technical Solution: Competitive intelligence analysis is the process of gathering external views and events in the immediate business context and environment which affects the activities of an organization. Analysis can be based on sources such as newspapers, TV, and radio channels, and on information from social media.

Technical State of Art: Competitive intelligence analysis methods range from interviewing focus groups and distributing questionnaires, to aggregating business intelligence based on data mining of key performance indicators from e.g. sales data or customer service data. Gradually supplanting these traditional methods which are based on sampling or in-house information, we find today numerous technical solutions which have been developed to monitor internet-scale feeds of information. Generally, these solutions can be divided into active and passive collection tools (Bose, 2008). Active collection is targeting a specific question for a limited time, whereas passive collection targets an ongoing information need. Both types of solutions commonly rely on a set of integrated technologies. Two central technologies are clustering and linkaging (Fan, 2006). Clustering is the process of grouping text documents, or parts of documents into categories. One example is the use of entity extraction to find people or places that are referred to in the texts. Linkaging, sometimes referred to as relation extraction (Aggarwal, 2012), find connections, or links, between texts in different clusters. The result of using these tools can either be a list of relevant documents, or a summary of the frequencies in which certain key words occur.

Effect: By using competitive intelligence analysis, it is possible to get a constant feed of information concerning external views and events. Thereby, it is possible to discover upcoming problems, and to react early. Traditionally, feedback can be collected using questionnaires. However, the automated business environment analysis can be performed continuously. This, for example, allows for the reallocation of resources.

Example: The customer support at the Swedish Pensions Agency is highly dependent on its environment in the form of traditional and social media. For example if a minister makes an announcement about desired changes in the pension system, the customer support will immediately get a lot of phone calls about how this affects the individual pensionnaire. By the use of business environment analysis it is possible to monitor traditional press and social media to early discover if a debate is rising. This would allow the pension agency to allocate the necessary resources to their customer support.

3.5 Sentiment Analysis

Business Case: Sentiment analysis is a business case in which customer views and sentiments are collected during the interaction with customers.

Problem: Ordinary categorization of cases gives a structured way of sorting and analyzing data based on what the case contains. However, when using traditional categorization, it is easy to, firstly, miss how customers express values and opinions about offered services. And, secondly, by using pre-defined categories it might also be easy to miss details in the cases.

Applicable Technical Solution: Sentiment analysis is the process of identifying values and details in a customer interaction. These values and details are usually not considered using an ordinary case management system. The analysis can be performed automatically, for example based on mail, or manually.

Technical State of Art: Sentiment analysis utilizes the same techniques as competitive intelligence analysis. Furthermore, sentiment analysis can make use of telephone call summation as it creates data for sentiment analysis. Note that existing technologies can support both sentiment extraction from text that is aimed at expressing an opinion, such as a review, and from a more general text that is not focused on expressing an opinion (Pang, 2008).

Effect: By applying sentiment analysis, it is possible to get information about how customers view the organization and its products. Thereby, the organization and its case handling practices can be adapted to become more customer oriented. Sentiment analysis is thus an instrument for business improvement, rather than aiming at improving a single case.

Risks: Some organizations are not used to handle analysis of sentiments. If this is the case, there is a risk that the result from sentiment analysis is not used to improve the organization. The risk is that the analysis creates information that is not actionable, which in turn leads to no organizational improvement. Another risk is that sentiments are often considered as a personal opinion, and the handling could thus lead to ethical issues.

Example: As a regular part of the Klippan municipality, the citizens can express their view on for example planned buildings projects, the schools etc. These opinions are registered using a case handling system. The Klippan municipality is now looking into how to extract opinions from other forms of communication with the citizens. For example, while asking about the opening hours of the local library the citizens might express their satisfaction or dissatisfaction with the opening hours. To improve the library service it is important to pick up these kinds of sentiments.

3.6 Scanned Document Completeness Validation

Business Case: Scanned document completeness validation is a business case in which a traditional scanning of documents is supplemented with error detection and validation based on language technologies.

Problem: Even though electronic documents and services are becoming more prevalent, there is still a need to handle traditional paper forms. Paper documents are for example, still considered a straightforward way to collect signatures. When paper documents are converted into digital documents there is a risk that the conversion process, the scanning, introduces errors. Detecting and correcting these errors is time consuming, and can cause delays in the process.

Document scanning is not a new business, and a lot has been achieved in improving the quality of images and optical character recognition. One problem remains, though. While scanning multiple-page documents, one cannot be sure that all pages have been scanned flawlessly and the scanned version of a document is a complete copy of the original document.

Applicable Technical Solution: Document scanning error detection makes use of language technologies to automatically detect errors that was introduced during scanning. Assuming that the software solution knows what the scanned document should look like, the software solution ensures that the scanned copy has no missing parts.

Technical State of Art: Abecker et al (2000) shows a bird's-eye view on a semi-automated workflow of scanned documents, but document completeness validation is not a part of the workflow. The easiest way of identifying completeness of scanned copies would be to check page numbers if they are available. Another option is to verify document structure if the pages have some known document structure (e.g., Namboodiri et al (2007)). Documents with a large amount of free text can be inspected for the presence of expected pieces of textual content, where technical solutions are similar to those used in document routing (see Section 3.2).

Effect: By detecting errors early in the process it is possible to correct them before a case handling officer starts working on a case.

Example: The Swedish Transport Administration handles the application for and production of driving licenses. As a part of the handling of driving licenses the transport administration receives forms that are later on scanned into a digital format. During the scanning process several different errors can occur. For example pages can be missing, or come in the wrong order. These kinds of error are discovered later, when the forms are processed. In order to ensure completeness of scanned documents, the Transport Administration does manual inspection of the scanned copies. Consequently, the Transport Administration is looking for an opportunity to replace the routine job of manual inspection with a piece of software.

4 Conclusions

Public organizations are under the pressure to serve citizens requests swiftly and with high quality. While many public organizations have, and are developing, online services that give citizens direct access to information, there is still a large need to improve how the handling of information requests are done. In this paper we highlight the possibility of using language technologies to improve the situation. To make it easy for public organizations to discern when and how to use language technologies we present a set of *business cases*. Each business case describes a certain language technology, what problem it solves, and also the desirable and sometimes undesirable effects of applying the technology. Furthermore, the cases are exemplified with real-world cases from the Swedish public administration. The intension with the set of business cases is to support organizations to apply, understand and combine language technologies.

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Methodology for Clustering Cities Affected by Natural Disasters

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Abstract. This study aims to present a methodology to form clusters by analyzing historical data of disasters in the state of Santa Catarina - Brazil, using the k-means method as a tool for pattern analysis. It can therefore assist in the strategic coordination, in the definition of priorities and in the share of experiences between cities. Therefore, the proposed methodology aims to identify similar regions in order to standardize and suggest a method of prevention and, thus, improve and assist the processes of decision-making regarding the events of Humanitarian Logistics. A computational experiment, applying the proposed methodology, was performed and the obtained results are presented and analyzed at the end.

Keywords: Humanitarian Logistics, Clustering, Natural Disasters.

1 Introduction

Humanitarian aid agencies coordinate billions of dollars annually in the relief for victims of natural disasters, civil conflicts and wars. Its main task is the timely mobilization of funding and of assets of international donors and relief administration for vulnerable beneficiaries in disaster sites around the globe. As such, logistics is essential for their activities and strategic for their missions.

According to [1] in the year of 2010 there were more than 370 natural disasters worldwide, with approximately 296,800 deaths and a total of 207 million people affected, with a damage estimated at 109 billion dollars. Comparing the number of natural disasters in 2010 such as droughts, earthquakes, high temperatures, floods, earth movements, storms, volcanoes and fires with the average of the decade from 2000 to 2009 it was found that there was no growth on the number of natural disasters in the world. Brazil was the 13th country most affected by natural disasters in 2008, where nearly two million people were affected mainly by the action of rains and about 1.5 million people suffered from the disasters in the state Santa Catarina [2]. According to statistics from the Civil Defence of Santa Catarina state, only in the months from January to March of 2011, there were recorded 152 events such as flooding, erosions, pests, storm surges, gales and floods being the latter the predominant event, with 143 occurrences.

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In all these cases the assistance to the disasters was difficult and complicated. Many factors, such as the large number of actors involved in the humanitarian aid and the lack of sufficient resources, contributed to the difficulties in the relief coordination [3]. There are few success stories of coordination, so that coordination is still the fundamental weakness of the humanitarian action [4]. The coordination can be referred to the coordination of resource and information sharing, centralization of the decisions, the realization of common projects, the regional division of tasks, or a system based on partnerships. Studies by international humanitarian organizations show the need to improve the effectiveness of the humanitarian response, ensuring greater predictability, accountability and partnership. Researches related to disaster management are being developed in order to decrease the difficulties in coordinating the various types of disasters [5, 6, 7, 8, 9, 10, 11, 12, 13].

Given this context, this article aims to contribute to the Humanitarian Logistics using a methodology to generating profiles based on historical events of natural disasters by combining frequency of occurrences in municipalities in order to identify similar regions to further assist in the strategic coordination in defining priorities and sharing of experiences in certain regions. This will allow standardize a method for prevention and response, helping the competent operational agencies in decision making regarding the necessary training, investments in infrastructure, forecasts of demand or inventory, and partnerships, in addition to enabling discover the geographic range of disasters and relief assistance chain.

The paper is structured as follows. In the next section, we introduce some basic concepts about Humanitarian Logistics and Disaster Management. In section 3 we show the methodology for pattern analysis in Humanitarian Logistics and in section 4 we illustrate a implementing the proposed method. Section 5 concludes this paper and provides an outlook on future works.

2 Humanitarian Logistics and Disaster Management

Humanitarian Logistics (HL) proposes the effective use of logistics concepts adapted to the specific chain of humanitarian assistance. These concepts can be the big difference in minimizing actions of improvisation, very common in these instances, maximizing efficiency and response time to the emergency situation.

However, HL has to deal with special circumstances and enormous challenges [14]. The specific feature in this context is the involvement of human life, which depends on the efficient and effective performance of the response operations, which means that in the humanitarian logistics, the aid must reach its destination accurately and on time, always focusing in the relief of suffering and in the preservation of life. Aspects linked to infrastructure, assistance centres location, resources allocation, coordination of processes (people, information, and goods) are worth mentioning in the logistic processes systematized in the humanitarian logistics.

To better understand the chain of humanitarian assistance is essential to understand disaster management which can be defined as the set of activities designed to maintain control over disaster and emergency situations and provide a framework to help people at risk situations. This deals with situations that occur before, during and after the disaster and the objectives are to prevent or reduce loss of human lives, physical and economical suffered by individuals, society and by the country in general, reduce the suffering of the people and accelerate the recovery of the affected area [15, 11, 6, 13].

2.1 Phases and Cycles of Disasters Relief

The coordination of disasters involves three phases: pre-disaster (prevention, mitigation and preparedness), focus of this research, response (warning, impact and emergency response) and post-disaster (transition, rehabilitation and reconstruction). In the pre-disaster phase occurs the prevention, mitigation and preparedness for emergency situations and the response performance to the disaster is related to the level of preparedness and to the methodologies used in this phase [11].

This work turns to the region of clustering and risk analysis proposed in the first item of the Logistics Process Model of Relief in International Disasters (MLSCI) of [5], which consists of three functions: (i) determine the profile of the length of each disaster, based on the analysis of data obtained from the past disasters. The profile can be identified through a historical analysis; (ii) identify threatened regions and main threats, resulting in different scenarios regarding the impact of different types of disasters, resources and projected needs; (iii) the combination of information obtained from the performance of the first two functions allows creating profiles of resources requirements, depending on the region as well as on the type of disaster. Thus, different regions with similar levels of criteria will be gathered to form clusters.

When working with a clusters system, it is intended to assist in the strategic coordination in defining priorities and in the share of experiences. A common approach is the risk analysis, which takes advantage that each region or municipality contributes with its knowledge and experience so that, finally, a common understanding returned to the planning can be applied in several regions.

3 Methodology for Pattern Analysis in Humanitarian Logistics

In this section, we will be presented the proposed methodology for the clusters formation, as well as the computational experiment for validation and verification of the presented model, using for that real data on such natural disasters of the state of Santa Catarina – Brazil.

This was motivated due in a most specific bibliographical survey we found a quantity with small representativeness of works using methods of cluster historical data and k-means algorithm in humanitarian logistics operation of natural disasters. We can emphasize papers presented by [16, 17, 18, 19, 20, 21] where, in a general manner, utilize specific methods of grouping with for example k-means, fuzzy c-means, hierarchical clustering, seeking to develop an analysis and categorize the data in different events related to natural disasters.

It is worth emphasizing the work done by [22] where the main objective was to suggest ways to predict demand for goods and services for relief operations in humanitarian logistics. With the use of historical data related to humanitarian assistance information was available order to understand and predict future demand and identify the main standards in terms of needs and demand response. It is noteworthy that the methodology proposed in this paper resembles the proposal by [22] to search for patterns in major humanitarian logistics analysis using historical data, however differentiates itself in the process and objective.

It should be noticed that the purpose of this work is related to the pre-disaster phase, it may be a policy of preparation to be used by responsible organizations in attendance to respond to disaster situations. It is considered that the same disaster could reach different municipalities at the same time, requiring the coordination between them for the development of actions of relief or aid. Moreover, the impact of a disaster on a specific municipality may require the assistance of other municipality, either in the form of rescue units, or on loan of equipments, expert assistance or recollection of donations. The operations in these situations may have very specific traits. They are characteristics that make the coordination of these operations very difficult if there is not a standardized system, common for planning and implementing of the actions.

4 Implementing the Proposed Method

There were used data of disasters occurred in the period between the years of 2000 and 2010 in the state of Santa Catarina. These data were collected through the database of the CEPED - University Centre for Disaster Studies and Research at the UFSC. This database used official documents such as AVADANS - Damage Assessment Form; NOPRED - Preliminary Notification of Disaster; DECREE - Municipal Decree; ordinances, damages reports and other considered as non official such as the newspaper (CIVIL DEFENSE, 2011). These documents are being referenced as recorded events in this work.

Initially the occurrences of natural disasters were separated according to the state's municipalities. Then, as data of the CEPED included various types of disasters, there were filtered from the databases only the occurrences of natural disasters, resulting in 3.247 selected events. There were considered the types of natural disasters as classify the Secretary of National Civil Defence (CIVIL DEFENSE, 2011). Fig. 1 shows the total of events presented in the selected period by natural disasters.

As data from CEPED were already organized, it was not necessary pre-processing or cleaning of the data before proceeding with the database clustering, such as removal of incomplete data or elimination of data repetition. Thus, for the purpose of this work, data were processed into a matrix containing the frequency of each type of natural disaster by municipality. This matrix has become, then, in the database to be exploited by the k-means algorithm aiming at the formation of clusters based on the number of municipalities impacted by natural disasters in Santa Catarina.

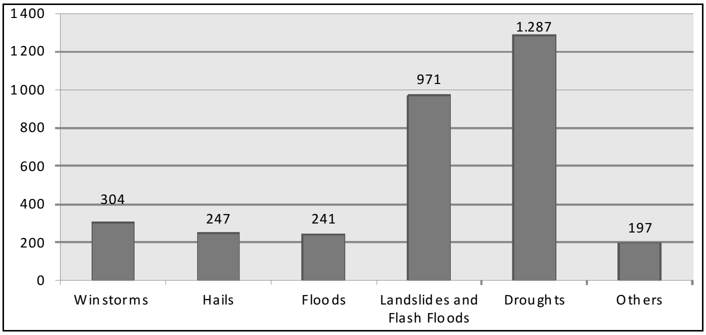

Fig. 1. Sum of events recorded by type of disaster

4.1 Results and Discussion

In general, clustering techniques calculate the matrix partition $[\mu_{kj}]_{K\times n}$, where μ_{kj} represents the degree of belonging to *j-th* point x_j, of the clustering C_k, $k = 1, ..., K$. Thus, $\mu_{kj} = 1$ if the point x_j belongs to C_k and $\mu_{kj} = 0$, otherwise [24]. To carry out the processing of the information and determine the clusters, we used the *K*-means algorithm. This algorithm performs a sequence of iterative procedures that form *K* compact spherical clusters over input data, with the objective of minimizing

$$J = \sum_{j=1}^{n}\sum_{k=1}^{K} \mu_{kj} D^2(z_k, x_j) \tag{1}$$

where $D^2(z_k, x_j)$, in our work, is the Euclidean distance of x_j to z_k; and $z_1, z_2, ..., z_K$ are the centroids of the groups.

According to [24], the algorithm, first of all, randomly initializes the *K* centroids. These are used to partition the data by assigning each point to the cluster of its closest centre. Succeeding, for each cluster, the mean value of all the data points assigned to it is computed, and this is considered as the new centre. This completes one iteration of the *K*-means clustering. Next iteration uses the newly computed centres for reassigning the data points to the *K* clusters, and the process continues until the measure of *J* falls beneath a certain threshold or a maximum number of iterations have been executed.

To set the number of clusters, it was analyzed the mean of the centroid distribution and the Davies Bouldin index [23], which is based on the measurement of dispersion and a measure of similarity between the clusters. On this basis, we decided that the number of 4 clusters responds to the computational test expected in this article. Soon, running the k-means algorithm it was come to the result summarized in Table 1.

Table 1. Result of the k-means algorithm

Cluster	Occurrence of Events						Total Events	Municipalities
	Windstorms	Hails	Floods	Runoffs	Droughts	Others		
1	87	73	22	100	845	33	1160	90
2	125	101	133	316	174	36	885	54
3	35	32	33	201	145	78	524	42
4	57	41	53	354	123	50	678	108

Graphically Fig. 2 shows the percentage of influence of each type of disaster, as well as the number of events in each cluster, Fig. 3 shows the disasters average compared with the overall average, and Fig. 4 shows the geographically clusters distributions. Detailed results are given as follows.

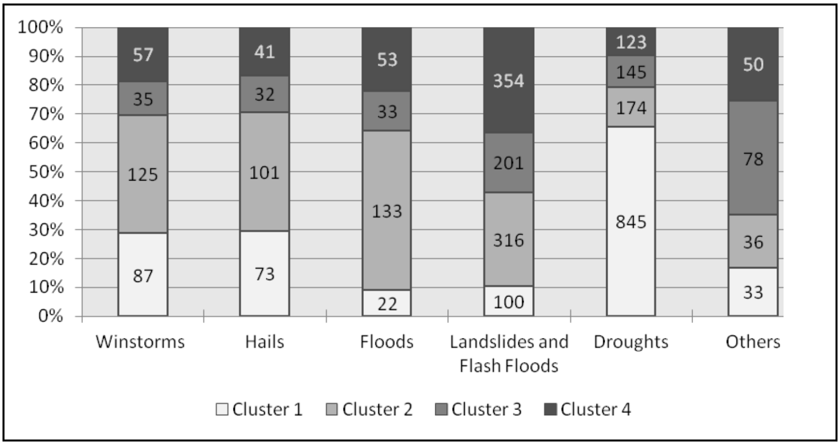

Fig. 2. Importance and quantities of each cluster by disaster

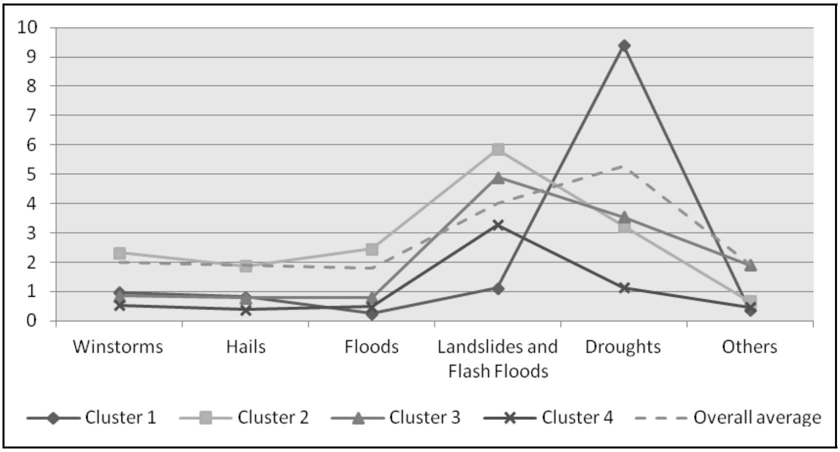

Fig. 3. Averages of occurrences for each cluster relative to the total average

The cluster 1 has as main feature events drought, and its average was far above the overall average for this disaster and showed values below the overall average for the other attributes. Notice that the geographic distribution of this cluster was quite concentrated in the western of the state and covered a portion of the mountain region (Fig. 4). The droughts events due to its higher recurrence rate attracted to itself a particular cluster.

Cluster 2 differs by having the municipalities with the highest recurrence disaster, containing the highest averages in the event of windstorms, floods and runoffs. Although it has only 54 cities, is present in all regions of the state. In terms of flooding it is the most critical cluster having 37.05% of all occurrences.

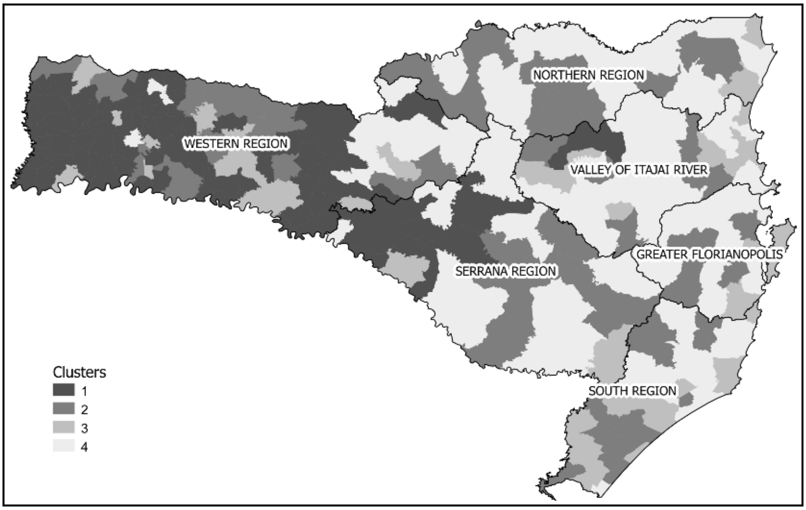

Fig. 4. Geographical distribution for resulting clusters

In the case of cluster 3, its characteristic has owning the smallest amount of affected municipalities, but having the second highest average for runoff events. That is, has a high frequency of these events in just a few areas of the state. Many municipalities that compose this cluster are situated on the coast of the state.

Finally cluster 4 has the highest number of municipalities affected by runoffs, however presents the smallest averages in the other events. That is, although the large number of cities, the recurrence of the events is low. This cluster covers the largest number of municipalities that have a low frequency of disasters. Their lower range is in the region west of the state.

We can notice also that both types of disasters most significant in the state have peculiar characteristics and distinct from each other. The occurrences of drought are strongly concentrated in western Santa Catarina economy where most municipalities revolves around agricultural activities, so this event causes elevated economic damages to the region. Already, most of the municipalities affected by the flash flood are mainly in the Vale do Itajai, Great Florianópolis and north of the state. Most of these municipalities have the particularity of irregular relief favoring the landslides. Thus, the impact generated reaches more urbanized areas. The urbanization process which results in several implications and hence the disordered occupation aggravate the impacts caused by flash floods.

5 Conclusions

In this paper there were presented some concepts involved in Humanitarian Logistics and Disaster Management in order to locate the focus of the research. There were discussed concepts and features of a clusters system having the intention to verify the application of the clusters algorithm to profile municipalities affected by natural disasters.

In this work, due to the unavailability of data, we do not take into account the intensity or geographic area affected by natural disasters, as well as costs and number of people affected to data analysis. This demonstrates the weakness in Brazilian public policies that address planning for humanitarian crises. Thus, another question which this paper aims to contribute is to demonstrate the importance of having methodologies keepers of historical data against natural disasters.

Thus the responsible organizations will be able to develop standards for a different form of prevention method ,that is, it is verified the profile of each cluster and the decision making regarding which method can be adapted to the groups of municipalities considering the typical behaviour of this group. For each of the clusters of municipalities, the experiences and knowledge can be shared, which could serve as a basis for integrated planning, aiming the preparation and the logistics processes on the imminence of the disasters.

It can be verified that the proposed methodology corresponds to the expectations and brings satisfactory results. These results could be either used as a previous step or as an input data for a big process, which aims to identify potential donors or form partnerships with suppliers during the pre-disaster phase, since it could be useful to assist in evaluating the kind of products required for each type of disaster, prediction of demand and generating inventories. As future work, we intend to further investigate the clusters validation indices and to evaluate the results found in this paper using the k-means algorithm with other clustering algorithms as well.

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Real-Time Statistical Speech Translation

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Abstract. This research investigates the Statistical Machine Translation approaches to translate speech in real time automatically. Such systems can be used in a pipeline with speech recognition and synthesis software in order to produce a real-time voice communication system between foreigners. We obtained three main data sets from spoken proceedings that represent three different types of human speech. TED, Europarl, and OPUS parallel text corpora were used as the basis for training of language models, for developmental tuning and testing of the translation system. We also conducted experiments involving part of speech tagging, compound splitting, linear language model interpolation, TrueCasing and morphosyntactic analysis. We evaluated the effects of variety of data preparations on the translation results using the BLEU, NIST, METEOR and TER metrics and tried to give answer which metric is most suitable for PL-EN language pair.

Keywords: Machine translation, Speech translation, Machine learning, NLP, Knowledge-free learning.

1 Introduction

Automated translation of Polish-English speech, as compared to the other languages, is a formidable challenge. It is complicated declension, leading to a very wide range of vocabulary, its grammatical components and rules, cases, gender forms (7 and 15, respectively) for nouns and adjectives that drive its complexity. This complexity impacts both the Polish language data and data structures necessary for the Statistical Machine Translation (SMT).

Polish and English are very different in their syntax. Since English lacks declension endings, the way in which words are ordered in an English sentence is very significant for their meaning. English sentences follow a Subject-Verb-Object (SVO) pattern. The syntactic order often completely determines the meaning of a sentence.

On the other hand, syntactic order in Polish does not significantly influence the meaning of a sentence. It does not require any specific word order. For example, the English sentence "I went to cinema with my wife." is equivalent in Polish to many sentences like "Byłem w kinie z moją żoną.", "Z moją żoną byłem w kinie.", "W kinie byłem z moją żoną.", "Z moją żoną w kinie byłem.", "Byłem z moją żoną w kinie.", "W kinie z moją żoną byłem.".

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Translation is greatly complicated by these differences in syntactic order between the two languages. This is particularly arduous when no additional lexical data is available and a phrase model [1] is used, which is often the case in the SMT systems.

The optimal input data for the SMT systems should have restricted subject domains like medical texts, historical books, European Parliament proceeding etc. It is very difficult for the SMT system to perform well using diverse domains. There are few Polish language corpora available to be used as input to the SMT systems. As a result, good sets of parallel Polish-English data have limited availability.

The baseline datasets used for this research were: Trans-language English Database (TED) [2], the Open Parallel Corpus[1] (OPUS) of movie subtitles, and the European Parliament (Europarl)[2] proceedings texts. The choice was not random. The TED represents lectures with no specific domain, OpenSubtitles are also not limited to any domain but they are a great example of casual human dialogs, that consist of many short sentences (easier to be translated by the SMT system), Europarl is an example of good quality in-domain data.

2 Data Preparation

There are approximately 2 million un-tokenized Polish words contained in the TED talks, 91 million in OpenSubtitles corpora and 15 million in Europarl. Preprocessing of this training information was both automatic and manual. Many errors were found in the data. Because of errors, dictionary size was increased and spelling errors degraded statistics. We extracted a Polish dictionary [3] containing 2,532,904 distinct words. Then, we created a dictionary containing 92,135 unique words from TED. Intersection of TED's dictionary with Polish dictionary, led to a new dictionary of 58,393 words. So, 33,742 Polish words that included spelling errors or named entities were found in TED. Very similar situation occurs in OpenSubtitles data but in the other hand, Europarl did not include many spelling errors, but it contained a lot of names and foreign words. After dealing with problems, final Polish-English TED, OpenSubtitles, Europarl corpora contained 134,678; 17,040,034; 632,565 lines respectively.

First, we used perplexity metrics to determine the quality of the available data. We used some data from the OPUS and some from the Europarl v7project. The rest was collected manually using web crawlers[3]. We created: PL–EN dictionary (Dict), newest TED Talks (TEDDL), e-books, Euro News Data, proceedings of UK Lords, subtitles for movies and TV series, Polish parliament and senate proceedings.

Table 1 provides the perplexity [4] metrics for our data. This shows, the perplexity values with Kneser-Ney smoothing [5] for Polish (PL) and for English (EN). Parallel data was noted in BI column. We used the MITLM [5] toolkit for that evaluation. The development data was used as the evaluation set for tuning. We

[1] www.opus.lingfil.uu.se
[2] www.statmt.org/europarl
[3] www.korpusy.s16874487.onlinehome-server.info

randomly selected text from each corpora for development and testing, 1000 lines for each purpose. These lines were deleted from the corpora for more reliable evaluation. The perplexity of the data was later analyzed.

Table 1. Data Perplexities

	TED		EUROPARL		OpenSubtitles		Vocabulary Count		
Data	*EN*	*PL*	*EN*	*PL*	*EN*	*PL*	*EN*	*PL*	*BI*
Baseline	223	1,153	29	30	32	33	11,923	24,957	+
Btec	580	1,377	756	1,951	264	620	528,712	663,083	+
Ebooks	417	2,173	726	3,546	409	688	17,121	34,859	-
ECB	889	2,499	436	1,796	859	1,108	30,204	56,912	+
EMEA	1,848	3,654	1,773	4,044	1,728	1,233	167,811	228,142	+
EUB	950	3,266	219	874	1,276	2,120	34,813	45,063	+
EUNEWS	435	1,467	410	1,667	435	723	287,096	-	+
GIGA	610	-	415	-	822	-	343,468	480,868	-
Other	415	3,001	469	1,640	352	576	13,576	24,342	+
KDE4	499	1,277	931	3,116	930	1,179	34,442	62,760	+
News	919	2,370	579	-	419	-	279,039	-	-
NewsC	377	-	595	-	769	-	62,937	-	-
OpenSub	465	-	1,035	6,087	695	1,317	47,015	58,447	+
Dict	594	2,023	8,729	59,471	2,066	1,676	47,662	113,726	+
TEDDL	8,824	40,447	539	1,925	327	622	39,214	39,214	+
UK Lords	644	-	401	-	721	-	215,106	-	-
UN Texts	714	-	321	-	892	-	175,007	-	-
IPI	-	2,675	-	774	-	1,212	-	245,898	-
Lodz	-	1,876	-	1,381	-	720	-	71,673	-
Senat	-	1,744	-	1,307	-	868	-	58,630	-
Subtitles	-	2,751	-	4,874	-	5,894	-	235,344	-
TED TST	-	-	-	-	-	-	2,861	4,023	+
EU TST	-	-	-	-	-	-	3,795	5,533	+
OP TST	-	-	-	-	-	-	1,601	2,030	+

EMEA designates texts from the European Medicines Agency. KDE4 is the localization file of user GUI. ECB is the European Central Bank corpus. OpenSubtitles are movie and TV series subtitles. EUNEWS is a web crawl of the euronews.com web page. EUBOOKSHOP comes from the bookshop.europa.eu website. BTEC is a phrasebook corpora, GIGA shortcut stands for a comprehensive archive of newswire text data that has been acquired by Linguistic Data Consoctium[4]. News and News Commentary data were obtained from WMT2012[5]. IPI is a large, morphosyntactically annotated, publicly available corpus of Polish[6]. SENAT stands for proceedings of the Polish Senate. Lastly, TEDDL is additional, TED data. Lastly we represent vocabulary sizes on each of data sets (TST suffix).

As can be seen in Tables 1 every additional data is much worse than the files provided in the baseline system, especially in case of Polish data. Due to differences in the languages and additoinal data, the text contained disproportionate vocabularies

[4] `www.catalog.ldc.upenn.edu/LDC2011T07`

[5] `www.statmt.org/wmt12`

[6] `www.korpus.pl`

of 92,135 Polish and 41,163 English words as an example of TED data. Bojar [6] describes the use of word stems to address this problem. Convertion need was addressed by using the Wroclaw NLP tools [7]. The tools enabled us to use morphosyntactic analysis in our SMT system. This process also included tokenization, shallow parsing, and generation of feature vectors. The MACA framework was used to relate to the variety of morphological data, and the WCRFT [7] framework was used to produce combined conditional random fields. After it 40,346 stems remained in the PL vocabulary. This greatly reduced the disparity between the EN-PL lexicon size.

3 Factored Training

For training we used the open source Moses toolkit[8] that provides a range of training, tuning, and other SMT tools. The toolkit enables to use efficient data formats, large variety of linguistic factors, and confusion network decoding.

Phrase-based translation models, used in many SMT systems, are unable to leverage many sources of rich linguistic information (e.g. morphology, syntax, and semantics) useful in the SMT. Factored translation models try to make the use of additional information and more general representations (e.g. lemmas vice surface forms) that can be interrelated.

The use of a factored model [8] affects the preparation of the training data, because it requires annotation of the data with regard to the additional factors. The Moses Experiment Management System(EMS)[9] supports the use of factored models and their training. We used the Moses's Parts of Speech (POS) tagger, Compound Splitter, and Truecasing tools to create additional linguistic information for our factored systems. The POS processing utilized the MXPOST tool [9].

The Polish language allows compounding, i.e. generation of new, long words by joining together other words. Final, longer compound word is known as a periphrase. Periphrases present an additional challenge to SMT systems. We used the EMS's compound splitting tool [10] to split the data compounds into word stems by comparing the geometric mean of the steams frequency to the compound word frequency.

We also used the TrueCaser tool from the Moses toolkit to convert the input words to upper case or lower case, as appropriate to improve SMT output quality. Using truecasing should improve the quality of text and enable the use of uncased and poorly cased text as corpora for SMT.

4 Evaluation Methods

To obtain quality measurements on the translations produced by various SMT approaches, metrics were selected to compare the SMT translations to high quality

[7] www.nlp.pwr.wroc.pl
[8] www.statmt.org/moses
[9] statmt.org/moses/?n=FactoredTraining.EMS

human translations. We selected the Bilingual Evaluation Understudy (BLEU), U.S. National Institute of Standards & Technology (NIST) metric, Metric for Evaluation of Translation with Explicit Ordering (METEOR), and Translation Error Rate (TER) for our research.

According to Axelrod, BLEU [11] uses textual phrases of varying length to match SMT and reference translations. Scoring of this metric is determined by the weighted averages of those matches.

To encourage infrequently used word translation, the NIST [11] metric scores the translation of such words higher and uses the arithmetic mean of the *n*-gram matches. Smaller differences in phrase length incur a smaller brevity penalty. This metric has shown advantages over the BLEU metric.

The METEOR [11] metric also changes the brevity penalty used by BLEU, uses the arithmetic mean like NIST, and considers matches in word order through examination of higher order *n*-grams. These changes increase score based on recall. It also considers best matches against multiple reference translations when evaluating the SMT output.

TER [11] compares the SMT and reference translations to determine the minimum number of edits a human would need to make for the translations to be equivalent in both fluency and semantics. The closest match to a reference translation is used in this metric. There are several types of edits considered: word deletion, word insertion, word order, word substitution, and phrase order.

5 Experimentation

We conducted experiments on phrase-based system as well as factored system enriched with POS tags. The use of compound splitting and true casing was optionary. Some language models based on perplexity measure were chosen and linearly interpolated [3].

We used the EMS to conduct the experiments. In addition, we implemented 5-gram language model training using the SRI Language Modeling Toolkit [4], together with interpolated Kneser-Key discounting. MGIZA++ tool [12], was used to align texts at the word and phrase level and the symmetrization method was set to grow-diag-final-and [12]. We binarized the language model using the KenLM tool [13]. In this set, we used the msd-bidirectional-fe model for lexical reordering. [14]

The Table 2 shows partial results of our experiments. We used shortcuts T (TED), E (EuroParl) and O (OpenSubtitles), if there is no additional suffix it means that test was baseline system trained on phrase-based model, suffix F (e.g. TF) means we used factored model, T refers to data that was true-cased and C means that a compound splitter was used. If suffix is I we used infinitive forms of all polish data and S suffix refers to changes in word order to meet SVO schema. In EuroParl experiments suffix L stands for bigger EN in-domain language model. H stands for highest score we obtained by combining methods and interpolating extra data. G suffix stands for tests on translation of our data by Google Translator.

Table 2. Experiment Results

	PL -> EN				*EN->PL*			
	BLEU	NIST	MET	TER	BLEU	NIST	MET	TER
T	16,02	5,28	49,19	66,49	8,49	3,70	31,73	76,39
TC	15,72	4,99	48,28	69,88	9,04	3,86	32,24	75,54
TT	15,97	5,25	49,47	67,04	8,81	3,90	32,83	74,33
TF	16,16	5,12	48,69	68,21	9,03	3,78	32,26	74,81
TI	13,22	4,74	46,30	70,26	9,11	4,46	37,31	74,28
TS	9,29	4,37	43,33	76,59	4,27	4,27	33,53	76,75
TH	20,88	5,70	52,74	64,39	10,72	4,18	34,69	72,93
TG	19,83	5,91	54,51	60,06	10,92	4,07	34,78	77,00
E	73,18	11,79	87,65	22,03	67,71	11,07	80,37	25,69
EL	80,60	12,44	91,07	12,44	-	-	-	-
ELC	80,68	12,46	90,91	16,78	67,69	11,06	80,43	25,68
ELT	78,09	12,41	90,75	17,09	64,50	10,99	79,85	26,28
ELF	80,42	12,44	90,52	17,24	69,02	11,15	81,83	24,79
ELI	70,45	11,49	86,21	23,54	70,73	11,44	83,44	22,50
ELS	61,51	10,65	81,75	31,71	49,69	9,38	69,05	40,51
ELH	82,48	12,63	91,17	15,73	-	-	-	-
EG	32,87	7,57	68,45	50,57	22,95	6,01	60,75	46,33
O	53,21	7,57	66,40	46,01	51,87	7,04	62,15	47,66
OC	53,13	7,58	66,80	45,70	-	-	-	-
OT	52,63	7,58	67,02	45,01	50,57	6,91	61,24	48,43
OF	53,51	7,61	66,58	45,70	52,01	6,97	62,06	48,22
OG	22,98	4,76	48,08	68,21	16,36	3,69	35,79	77,01

6 Discussion and Conclusions

We concluded that the results of the translations, in which the BLEU measure is greater than 70, can be considered as effective enough within the text domain. Such system already works in real time and can be connected into a pipeline with an automatic speech recognition and synthesis systems, which is our plan of future work.

Cleaning and converting of verbs to their infinitive forms improved EN-PL translation performance. However, this produced the opposite effect in PL- EN translation, perhaps due to reduction of the Polish vocabulary. Changing the word order to SVO is quite interesting. PL-EN translation scores degraded in this case, which we did not anticipate. On the other hand, some improvement could be seen in EN-PL translation. BLEU fell dramatically, and TER became slightly worse. NIST and METEOR showed better results than the baseline system. Hypothetically this is the result of each metric's evaluation method and that phrases were mixed in the SVO conversion phase. This phenomenon is worth further investigation.

Compound splitting proved to improve translation quality but mostly in PL-EN translation. Factored training models also provide better translations but we gained improvement mostly in EN-PL experiments. Most likely reason is more complex

Polish grammar. Truecasing did not act as anticipated, in most experiment scores were worse. We assume that data was already correctly cased.

In the future, there will be additional experiments performed with the use of extended language models. Tuning of training parameters for each set of data is required to be done separately (just like training higher order models). Training language model based on neural networks[10] also can be an interesting experiment.

Using other tools instead of GIZA, like Berkeley Aligner or Dyer's Fast Align or different phrase model (Hierarchical or Target Syntax), is also our plan for future work. We would also like to try out the factored training with Stemmed Word Alignment. Most probably using additional out of domain data and adapting it using for example Moore Levis Filtering could obtain further quality improvement.

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Toward a Cloud Based Knowledge Management System of E-learning Best Practices

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Abstract. Knowledge management, particularly, tacit knowledge management, is a significant guarantee for the development of sustainable educational systems in the e-learning field. The transfer of instructor's tacit knowledge is a key point in promoting the capitalization and exchange of teaching best practices which ensures quality in the learning process. Instructors should be able to share and integrate their teaching know how efficiently within their professional communities of practice. Given the highly interactive nature of Web 2.0 technologies and the benefits of Cloud Computing, managing and sharing of teaching best practices within a knowledge management system for diverse communities represents an interesting opportunity and a real challenge. The aim of this paper is to present a Cloud-based Knowledge Management System that manages gathering and sharing of best teaching practices in e-learning. The proposed system promotes teaching experience exchange and supports the creation and management of communities of practice in a Cloud environment.

Keywords: Knowledge Management, Best Teaching Practice, E-learning, Cloud Computing.

1 Introduction

Knowledge is a key asset in the information age. Nowadays, the performance of organizations is determined more by their knowledge than by their physical resources [1]. Knowledge management can be seen as the set of activities that involve capturing all the best practices and knowledge that people acquire and storing them in a computer system in the hope that one day it will be useful [2]. It can be defined as the process of continually creating new knowledge, disseminating it through the organization, and representing it quickly in new products, services, technologies, and systems thus achieving changes within the organizations [3]. The challenge of

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knowledge management is to ensure that new knowledge is effectively incorporated into practices and it is accessible when needed [4].

The term knowledge worker has been used widely by researchers to emphasize that individual employees typically bring a wealth of specific experiences and personal heuristics in planning, selecting, and performing their assigned tasks [5]. Instructors are prime examples of knowledge workers, in that they have substantial personal maturity and responsibility in analyzing, developing, and applying their curricular objectives [6]. Knowledge of teaching differs noticeably from knowledge in other professions. It tends to be rather imprecise and tentative, bound tightly to personal experience, and not always connected to well-defined measures of learning outcome [7]. Knowledge of teaching, instructors' knowledge, and best teaching practices are synonymous and mean the "knowledge that teachers generate as a result of their experience as teachers" [8]. Best teaching practice is a key influence on student learning - a desired outcome and primary goal of higher educational institutions. Therefore, university instructors struggle to meet the principles of best practice in an effort to provide the best learning experience for their students [9].

Knowledge management, particularly, tacit knowledge management, is a significant guarantee for the development of sustainable educational systems in the e-learning field. The transfer of instructor's tacit knowledge is a key point in promoting the capitalization and exchange of teaching best practices which ensures quality in the learning process. Instructors should be able to share and integrate their teaching know how efficiently within their professional communities of practice.

As new technologies and paradigms emerge, businesses have to make new potentials to appropriately get aligned with them, particularly in knowledge management area. The emergence of a new class of Web-based and Cloud-based applications, and the manners in which those applications are being incorporated into academic environments, have introduced new possibilities for teaching and learning [10]. Today the Cloud Computing paradigm is becoming more and more popular, due to the great reduce in time, cost and effort for meeting software development needs. It also provides a large means for gathering and redistributing knowledge. Therefore, it has a great ability for providing knowledge management services that can be used extensively for business intelligence and competitive advantage [11].

This paper presents an architecture of a Knowledge Management System in the Cloud environment that allows university instructors to manage gathering and sharing their best teaching practices for different types of users.

2 Literature Review

2.1 Cloud Computing

The concept of Cloud computing has long history [12]. It came into sight in 1960 when John McCarthy proposed a computation model as a public utility. The first public usage of the term "Cloud" as a metaphor for the internet appeared in 1996 [13]. However, the initial step towards this modern term was taken by Salesforce.com in 1999, which paved the way for delivering business applications through the Web [14].

By 2008, Cloud Computing was receiving extensive research interest and had exceeded grid computing in the amount of received interest in the media [15].

Cloud Computing refers to both the applications delivered as services over the Internet and the hardware and systems software in the data centres that provide those services [16]. The services themselves have long been referred to as Software as a Service (SaaS) while the data centres hardware and software are called a Cloud [16]. The goal of this computing model is to make a better use of distributed resources, put them together in order to reach higher throughput and be able to deal with large scale computation problems [17]. Consequently, application systems can gain the computation strength, the software service and the storage space according to its demands [18]. The emergence of this latest phenomenon represents a primary change in the way information technology (IT) services are created, developed, installed, scaled, updated, maintained and paid for [19].

2.2 Knowledge Management Systems in E-learning

Learning management systems (LMSs) are mainly used by universities and other education institutions as course management software, and as a distance education service. While they focus on supporting instructors in creating and holding online courses, they do not consider the individual experience of instructors who have an accumulation of personal knowledge and best teaching practices that can be exploited to promote the academic development for both instructors and students communities [20].

There are a few number of research projects that have developed KMS for managing individual experience of instructors in universities. These projects are Web-based projects deployed the concept of KM in a rather narrow scope: teaching one or few subjects. Moreover, they used a traditional survey method to make tacit knowledge explicit.

Projects that fall under the aforementioned category include the BIKE environment [21]. This system is a personalized IT support for knowledge management within industrial R&D and especially for teaching and learning. The BIKE environment is demonstrated as an alternative to learning management systems based on the Web 2.0 technologies. The system uses WritingPad as a supportive informatics tool for the conversion of tacit knowledge into explicit knowledge, and the recording and sharing of explicit knowledge within a customer oriented KM.

Another system was developed by Massey University, New Zealand. This system is a Web-based prototype to aid in exploring the potentials of knowledge management in teaching database normalization. It aims at setting up a suitable electronic educational environment to assist in database design courses [22].

One last system under this category includes a framework of establishing knowledge management system for university instructors based on native database Tamino [23]. The system uses Tamino instead of XML as a way of storing and processing knowledge due to the overwhelming data of XML. This KMS is composed of three layers: universal data service layer, application layer, and a valid terminal client layer. Actually, Tamino is still immature and the system also needs further improvement.

3 Knowledge Management at the University

Knowledge is the most important asset of any academic institution. Knowledge management is helpful to promote the professional development of university instructors as well as to improve instructors' scientific research ability and teaching level. Therefore, instructors need to continually update their knowledge, access to academic knowledge, and use this knowledge in teaching and scientific research [24].

In response to the growing need for staff development among university instructors, the universities have to think seriously to develop a methodology for staff development on topics of high national concern [25]. The ability to adeptly manage the diverse types of knowledge used by academics is crucial for the sustainable improvement in the performance of the academic institution as a whole. The importance of the study derives from the ability of exploring how to facilitate the creation of knowledge (more specifically from Tacit to Explicit) and the transfer of best teaching practices (traditional teaching and e-learning) among different types of users in the Cloud. The value of this understanding results from the increasingly importance of the development of KMS to support instructors because they are responsible and accountable for designing and delivering a high quality of learning and teaching practice. Building such a KMS will allow the universities to a better utilization of the instructor's knowledge which is the Intellectual Capital of the university.

4 Cloud-Based System Architecture

The development of KMS architecture using the Cloud Computing approach is a step toward more effective and user-oriented distributed KMS solution in organizations. The three perspectives of Cloud Computing: Software as a Service (SaaS), Infrastructure as a Service (IaaS) and Platform as a Service (PaaS) allows organizations to develop new models of KMS integrating additional systems, collaborating with other organizations and facilitating knowledge exchange [26]. Cloud-based KMS automatically reduces the cost of organization expenses and offers more powerful functional capabilities. In other words, Cloud Computing gradually can remove the hardware costs, software license costs and maintenance costs of KMS respectively provided great flexibility to the business management [27]. The adoption of the Cloud Computing approach allows knowledge workers to integrate freely content from private and public Clouds, using Web 2.0 tools (such as Mashups, Wiki, Blogs etc), and building their own virtual working place facilitating knowledge transfer [25]. Moreover, knowledge workers have the opportunity to quickly and economically access various application Cloud service platforms and resources through the online or Web pages to obtain their KM demand [27].

Cloud Computing offers three services for KMS: infrastructure services (e.g., storage and communication, etc), knowledge services (e.g., knowledge creation, knowledge sharing and knowledge reuse, etc.) and platform services (e.g., operating system and databases, etc) [28]. Fig. 1 illustrates the main users of the proposed system from the perspective of the three Cloud models. Instructors, learners, and developers use Cloud services according to their authorities. The KMS resides on the servers of the SaaS Cloud provider and is accessed online. Any necessity for additional hardware and disk is performed promptly online by the IaaS Cloud provider. In addition, KMS developers may design, build and test applications that are executed on the infrastructure of the Cloud provider and deliver those applications directly from the servers of the provider to the final users. Generally, the final KMS will be provided to the users as Saas, and the KMS provider uses IaaS for hosting their SaaS KMS.

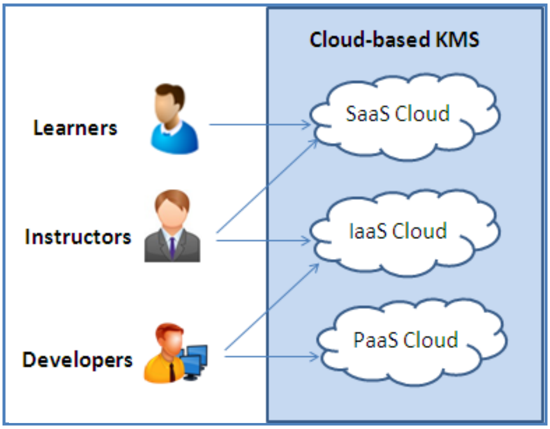

Fig. 1. The main users of Cloud-based KMS in University

The proposed architecture for managing best teaching practices in the Cloud environment is illustrated in Fig. 2. As the figure shows, the instructors and learners can access and maintain learning resources through a user interface. The main goal of the knowledge interface is to create an environment that is more intuitive to domain specialists to enter and review professional knowledge. The interface supports two main functions. It hides the complexity of the underlying encoding of domain knowledge from the user and it provides intelligent guidance to the user through the knowledge creation process. Reference ontology indicates the common terminology with respect to the specific domains, which lays the foundation for semantically interconnecting the distributed learning repositories. Other core modules include: knowledge acquisition, knowledge refinement, and knowledge retrieval.

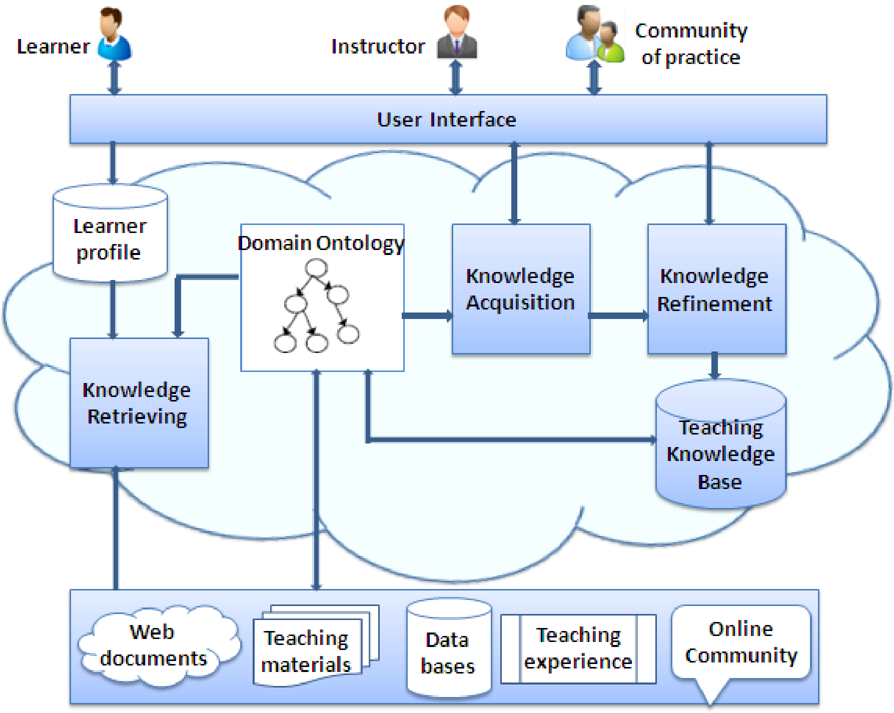

Fig. 2. The KMS architecture

The following are the core modules of the system:

a) Knowledge Acquisition

Knowledge acquisition examines how to acquire knowledge for the solution of a specific problem from various heterogeneous distributed knowledge sources. Knowledge is multi-source and diverse in the Cloud, which includes not only great explicit knowledge, but also a substantial amount of tacit knowledge. Various resources will be shared largely when knowledge is effectively managed and used. There is a range of knowledge sources such as: databases, online learning materials (courses, workshops, tutorials, visual labs, and simulations), e-books, technical papers, teaching experiences, and Web documents (Fig. 3). Knowledge acquisition processes include knowledge extraction and knowledge representation. Ontology defines a common vocabulary for instructors who need to share information in a domain; it expresses knowledge and knowledge structure of the field with the recognized terminology sets and the relationships between them.

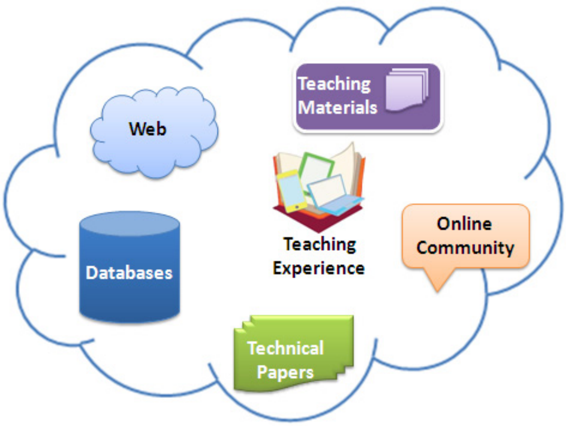

Fig. 3. Instructors' knowledge resources

b) Knowledge Refinement

Best teaching practices are usually submitted in the form of a document as the system facilitates processing documents. Knowledge refinement comprises relevance checking and classification. The relevance checking module determines whether the knowledge items (e.g. questions, metadata) link to the appropriate topics in domain ontology depending on the use of background knowledge about the context where statements appear to assess their relevance [29]. On the other hand, the classification catalogs texts into appropriate classes depending on the textual descriptions given by users [30].

c) Knowledge Retrieval

Both instructors and learners need to retrieve teaching content for teaching and learning respectively. Content Retrieval (CR) can be classified into conventional keyword-based content retrieval which does not take context information into consideration, and context-aware content retrieval, where learning contents need to be provided according to learners' contexts. Context-aware CR is adapted to objective factors of learners, like time, place, device, activity, and peers etc. Hence, the same query run in different contexts could obtain distinct results [31].

5 Case Study

We will use the following case study to illustrate how best practices are managed in our KMS: Mohammed is a lecturer at the university. He teaches the "Principles of Databases" course at the university for bachelor students. It is about a formative core course for the students in the Information Systems department. One of the main topics in this course is Normalization which consists in a set of techniques that aim to design good quality relational database schemas. Strong with many years of experience in teaching the database subject, Mohammed has developed as set of teaching practices that he judges are very efficient to explain normalization. He decided to share with his colleagues the experiences he gained in this field. The system uses a fair exchange method for sharing knowledge among instructors. Mohammed wants to present a list of guidelines that helps students to quickly find the primary key among a list of candidate keys which is a crucial step in normalization (Fig. 4).

Guidelines to find the primary key among a list of candidate keys?

1. Keys that comprise fewer number of attributes are preferred than keys that comprise larger number of attributes (e.g. (**Student ID**) is better than (**Name, Address**))
2. Numeric attributes are preferred than string data type attributes (e.g. **SSN** is better than **NAME**).
3. Small fields are preferred than large fields (e.g. **INT** which requires 4 digits is better than **DATE** which requires 10 digits).

We follow these guidelines in order from first to last.

Fig. 4. An example of a best teaching practice

To be able to enter his best practice, Mohammed needs to log into the system via a graphical user interface (GUI). The system provides a variety of templates to help domain specialist in knowledge creation step (Fig. 5). He chooses the appropriate template and then enters the language, level of students, course name, topic, brief description, and an explanation of his experience in teaching Normalization. When he finishes and submits the new best practice, the system checks its relevance and classifies the new practice in the Knowledge Base.

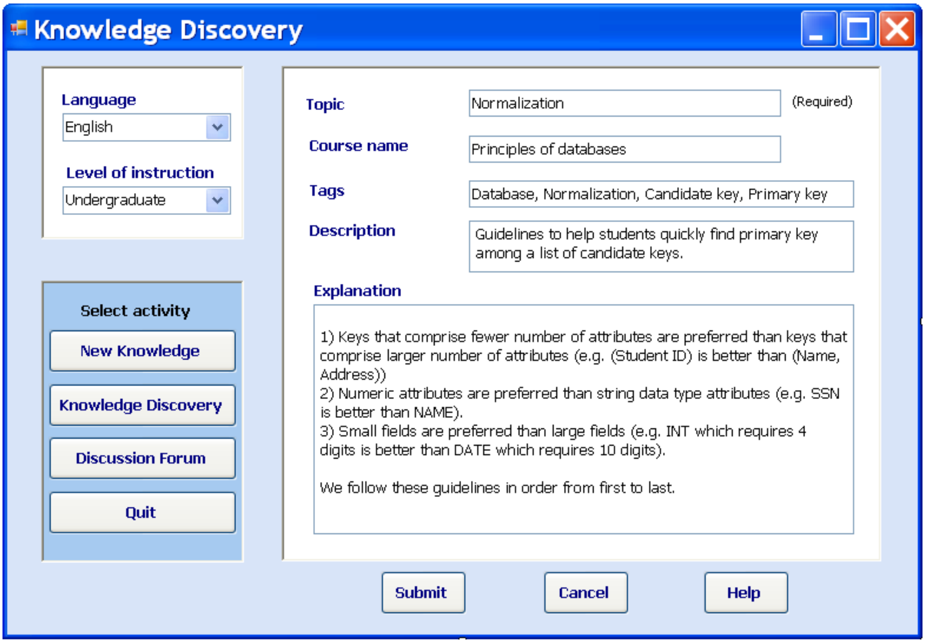

Fig. 5. Knowledge Creation Template

On the other hand, Hassan is a novice lecturer at another university. He will teach Databases course for the first time. He decided to benefit from others' experiences to teach the material in a professional manner. He can log into the system and search about any specific topic. Searching can be done via one or more criteria, such as: topic, course name, keywords, language, and level of instruction. For example, when Hassan enters a keyword-based query like "Primary key", the system will select a range of possible related knowledge based on the query from the Knowledge Base and knowledge discovered from other data/information sources among them the experiences of others. To get further clarification on a specific post, he can send email. Moreover, he can use the discussion forums to ask and answer questions on a variety of topics, which is especially useful for discussion involving multiple viewpoints or multiple problem solutions, or for straightforward questions requiring a quick response.

6 Conclusion and Future Work

The capitalization of best teaching practices in an educational environment can help to a great extent the exchange of competencies among instructors. This can be done through knowledge management where tacit knowledge of experienced instructors is transferred to explicit knowledge in order to be stored, retrieved, and shared between communities in the technology based learning field. The paper presented an architecture of a Cloud-based knowledge management system that provides instructors and communities with a suitable platform for acquiring, refining and reusing instructors' best practices in a university environment. The KMS allows instructors to propose their new teaching practices while others can access them through a nice graphical user interface. The proposed KMS aims to provide an integrated, scalable and easy-to-use environment for diverse instructors to manage and exploit their tacit knowledge and the growing teaching resources on the Web.

The proposed KMS has many advantages: it (i) promotes learning quality; (ii) supports the creation and management of communities of practice in a Cloud environment; (iii) enhances the professional development of university instructors; (iv) facilitates the creation of knowledge (more specifically from tacit to explicit); and (v) reduces the cost of organization expenses and offers more powerful functional capabilities.

The initial KMS is encouraging us to go further in many directions to develop a full operational system. In particular, more work is planned in the future to define formally the knowledge specification related to best teaching practices in the Cloud in order to fit the diversity of users and their contexts. Also, we are planning to deploy the full KMS as a Cloud based service and test it in a practical environment.

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Expanding Scientific Knowledge Frontiers: Open Repositories in Developing Countries Supported by NRENs

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Abstract. The current scenario of Internet operation has brought many challenges and opportunities to science as result of the evolution of technologies and network infrastructures, key enablers to information access at distinct levels. Regarding research and teaching, scientific Open Access (OA) repositories play a key role in the production, dissemination and sharing of knowledge. OA repositories improve the visibility, accessibility and availability of results from teaching and research activities, contributing to the knowledge society through the provision of scientific publications without restrictions.

Taking worldwide OA initiatives and the Portuguese experience as case study, this paper analyzes technical challenges and strategies for building open repositories supported by National Research and Education Networks (NRENs) in the African context. Considering Mozambique as the main target of this paper, the study of: (i) existing national and international initiatives; (ii) MoRENet - the Mozambique Research and Education Network; and (iii) SABER repository, will support the proposal of a set of directives and policies for the development and sustainability of a common OA platform for scientific and academic national production.

We believe that this open repository will bring an undeniable added value for Mozambique knowledge growth, fostering the country development at both scientific and social levels.

1 Introduction

Scientific Open Access (OA) repositories aim to provide unrestricted access to academic and scientific literature resorting to information systems that store and give access to data. Therefore, an OA repository is a collection of documents in electronic format, freely available to users through the Internet. The debate on unrestricted access to academic and scientific literature has emerged mainly due to the limitations associated with the marketing of works published on scientific journals. Scientific journals are used as tools to disseminate research

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results in different fields of knowledge. The results of scientific work conducted by researchers, which are in most cases financed by funds or grants from the researcher institution, are submitted free of charge to scientific journals. Contrarily, the monopoly of commercial scientific publishers oblige the institutions libraries to buy the same publications, a fact which motivated the OA movement [1]. As result, national and institutional self-archiving policies have been adopted, particularly in Europe and United States, as a way to encourage OA. Self-archiving means that authors deposit their scientific production in platforms or repositories, which will make them available publicly through the Internet. However, due to imposed restrictions, this process may incur in a 6 to 12 months latency, within which the documents are not available. In the case of research and education institutions, one of the easiest ways of self-archiving has been through OA repositories.

In this context, Portugal is seen as a success case due to the creation of the Portuguese Scientific Open Access Repository (*Repositório Científico de Acesso Aberto de Portugal* - RCAAP). This meta-repository is supported by *Fundação para a Ciência e a Tecnologia* - FCT (through *Fundação para a Computação Científica Nacional* (FCCN) unit), the national entity responsible for managing the National Research and Education Network (NREN), which provides high-speed connectivity and advanced services to academic and research institutions.

In the African context, there are still many challenges regarding the implementation and evolution of OA repositories. In the case of Mozambique, the national repository SABER, created in 2009, is the only repository in the country, however, most of the Mozambican institutions are not yet integrated. Regarding the infrastructural support, the Mozambique Research and Education Network (MoRENet) is the national NREN under deployment which is expected to bring connectivity and added-value services to the involved institutions.

Facing this scenario, this article aims at discussing the challenges and opportunities in the development and sustainability of OA repositories in the African context, focusing on Mozambique and its NREN. Having this purpose, it is important to study and define technical, organizational and funding aspects, taking into account: (i) national and international OA initiatives; (ii) national strategies for education, science and technology; (iii) the existence of open source software for the implementation of repositories; (iv) the alliance of NRENs in Eastern and Southern Africa (UbuntuNet Alliance); (v) the project AfricaConnect, supported by the European Commission, that aims to interconnect NRENs in sub-Saharan Africa.This article addresses these multiple components involved in the development of the OA national repository in Mozambique supported by MoRENet.

This article is organized as follows: Section 2 discusses OA initiatives, related promotion strategies and policies for OA self-archiving; Section 3 describes the Portuguese case study, involving its national repository; Section 4 presents the African context; Section 5 discusses the challenges and directives toward the evolution of OA repositories in Mozambique; and Section 6 presents the main conclusions of this work.

2 Open Access Initiatives and Strategies

One of the first international OA initiatives with major impact was promoted in 2001 by the Open Society Institute (OSI) in Budapest. This event brought together researchers, higher education and research institutions leaders to discuss OA strategies. This meeting established the meaning and scope of OA, yielding one of the most important documents and initiatives spearheaded by the OA movement: the Budapest Open Access Initiative (BOAI). The defined strategies consider mainly journals and authors self-archives in OA repositories [2], [3], [4]. The Berlin Declaration, signed by representatives of several scientific institutions, was an important step in the realization of the OA movement strategy as it defines OA and encourages researchers and grant holders of scientific institutions to publish their works in accordance with the principles of OA [5][6]. The action plan adopted by the world leaders of United Nation state members in the World Summit on the Information Society - WSIS, lay the foundations for an information society for all, reinforcing the importance of OA [7].

OA considers two types of documents: the final version of journal articles after peer reviewing (postprints) and unreviewed versions (preprints), in case of preliminary reports of new results. BOAI has defined two major pathways of OA: *green* OA proposes that authors through self-archiving deposit their publications in a OA repository, even if the article is published in a scientific journal; *golden* OA corresponds to the publication of OA scientific journals exempt from subscription or fees restricting the access to the published articles. These OA scientific journals present some similarities compared to traditional scientific journals, namely peer reviewing, editing and publication, differing in terms of access level, as signatures or other charges are not required.

At present, several types of repositories have been implemented: institutional; governmental; and thematic, adding up to 2516 repositories worldwide [8]. Table 1 illustrates the global landscape of OA repositories. As shown, the ranking is led by the European continent with 1169 repositories, followed by North America and Asia. Regarding the African continent, with a total of 86 repositories, South Africa is the forefront country with a total of 27 OA repositories.

Regarding the implementation of repositories, there are several open source tools available, being EPrints and DSpace the most used. Currently, DSpace [9] has been the choice for implementing most repositories, about 1047 compared to 369 from EPrints [10]. One of the main advantages of DSpace is its simplicity, being able to run from simple to more sophisticated machines, as long as the server is capable of storing and processing data. The reduced cost on equipment is an advantage specially for institutions with limited financial resources and developing countries.

Open Access Policies. To encourage the practice of self-archiving, it is essential to define OA policies in two fronts: institutional and national levels. Different governments aim to break the monopoly of commercial scientific publishers, especially as regards scientific publication resulting from public funds. In 2007, the U.S. government took actions regarding the OA policy, resulting in a change

Table 1. Repositories in the World

Region	# Repositories	Top country/region	# Repositories
Africa	85	South Africa	27
Asia	438	India	65
Australasia	59	Australia	47
Central America	12	Costa Rica/El Salvador	6/6
North America	518	EUA	430
South America	216	Brazil	75
Caribe	16	Cuba	17
Europe	1169	United Kingdom	219
Oceania	3	Fiji	2

in the biomedical and life sciences, with the adoption of a specific law for the National Institutes of Health (NIH), which requires all researchers funded by this institution to deposit their articles published in scientific journals in the PubMed Central repository. In early 2013, the U.S. government extended the action taken for NIH to all institutions in the country.

The European Union (EU), following the strategies pursued by U.S., has developed several projects under the Seventh Framework Programme (FP7) for the period 2007-2013, highlighting OpenAIRE and MedOAnet (for mediterranean countries) that are supported by the European Commission [11]. Horizon 2020, the new European funding program for research and innovation, which will start in 2014, reinforces recommendations previously defined, extending them to the availability of data and scientific literature in OA.

3 NRENs and OA: Portugal as a Case Study

National Research and Education Networks - NRENs are supported by nonprofit organizations with the mission of providing advanced services to the research and higher education community. In 2010, 62% of countries in the world have a NREN, and the recognized European model was followed in various regions of the world. The international connectivity between NRENs of the European continent is provided by GEANT, enabling the collaboration among the members [12], [13]. Regarding the Portuguese NREN, supported by FCT, the evolution of its network infrastructure has allowed the developing of projects to support research and teaching, being RCAAP of major importance.

3.1 RCAAP

RCAAP, the Portuguese scientific OA repository created in 2009, has as main objectives: to increase the visibility, accessibility, dissemination of results of academic activity and national scientific research; to integrate the country into a number of international initiatives facilitating the interoperability and interconnection with other research centers, organizations financing research and higher education institutions with OA repositories worldwide. RCAAP is a meta-repository aggregating 35 institutional repositories and 5 journals, allowing free access to a vast number of scientific national publications. In 2010, to enhance the visibility of scientific contents in Portuguese idiom, a Luso-Brazilian memorandum was established, aggregating OA sources from Portugal and Brazil, and the annual CONFOA conference was created. Internationally, RCAAP also collaborates with European projects, namely OpenAIRE and MedOAnet. As a successful Portuguese initiative, the number of documents aggregated in RCAAP exceeds currently the 120 thousand.

Presently, RCAAP has available a new service: the Institutional Repositories Hosting Service (*Serviço de Alojamento de Repositórios Institucionais* - SARI). SARI is a cloud-based repository service for institutions that do not want to assure technical aspects related to the implementation of repositories, such as servers, connectivity, maintenance, backups, upgrades and monitoring. This service is provided centrally, and institutions only have to worry with administrative aspects. From the 35 repositories participant in RCAAP, 10 are aggregated and 25 are hosted in SARI. Another service associated with SARI is the common repository, available for institutions that do not have their own repository due to their small size or low publications volume. Later on, an institution taking part of the common repository may evolve for an hosted repository, according to RCAAP policies. These concepts are illustrated in Figure 1.

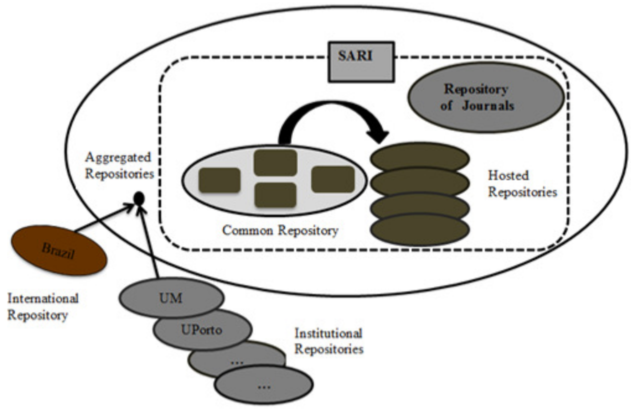

Fig. 1. National repository model - RCAAP

4 Open Repositories in the African Context

NRENs in Africa began to emerge about 10 years ago, especially in Eastern and Southern Africa. The high cost of broadband access and the lack of national and international infrastructures based on optical fiber are factors that have limited their development. Currently, with the deployment of intercontinental connections using optical fiber submarine cables and terrestrial fiber, broadband connectivity is expected to be available in most of African countries, although still very expensive compared to other world regions. The TENET in South Africa, the KENET in Kenya and the MAREN in Malawi are some success stories of NRENs operating in Africa.

Similarly to other continents, such as TERENA in Europe, the UbuntuNet Alliance is the association of African NRENs created in 2005 by 5 members established in Eastern and Southern Africa, MAREN (Malawi), MoRENet (Mozambique), KENET (Kenya), RwEdNet (Rwanda) and TENET (South Africa). To interconnect African NRENs with each other and with NRENs worldwide are the main goals of the alliance [14]. Currently, it has 14 members.

AfricaConnect project is one of the examples of the international collaborative effort, supported by the European Commission. AfricaConnect wants to interconnect NRENs in sub-Saharan Africa to an international network of high capacity, fulfilling the goals of the UbuntuNet Alliance. The interconnection of the association members through GEANT will support research and education in Africa, through the integration into the global research community [11].

The Euro-Africa Cooperation Forum on ICT is the forum for cooperation on ICT between Africa and Europe resulting from a joint strategy adopted at the Lisbon Summit in 2007 [11]. The forum aims to foster cooperation and sharing of experiences between the two continents.

The challenges of deploying OA repositories in Africa has been recently addressed in [15]. Regarding the overall picture of scientific research, the author stresses that despite its ethnic and cultural diversity, and abundance of natural resources, Africa faces problems of post-colonial era: poverty; political instability; corruption; diseases and armed conflicts that undermine their growth.

Currently, Africa has 85 repositories [8] spread over only 19 of the 54 independent countries. As illustrated in Figure 2, South Africa is on top of the list

Repositories in Africa			
UbuntuNet Alliance Countries	**Number**	**Other Countries**	**Number**
South Africa	27	Egypt, Nigeria	7
Kenya	11	Zimbabwe	4
Tanzania	5	Algeria, Ghana	3
Namibia	3	Senegal, Tunisia	2
Uganda	2	Botswana, Cape Verde, Cameroon, Lesotho	1
Ethiopia, Mozambique	1	Other 35 of 54 African countries	0
Madagascar, Malawi, Congo Democratic Republic, Ruanda, Somalia, Sudan, Zambia	0	**Total of Repositories in Africa**	**85**

Fig. 2. Distribution of open access repositories in Africa

with 27 repositories, followed by Kenya with 11, both members of UbuntuNet Alliance. From the five CPLP countries located in Africa, only Mozambique and Cape Verde take part of the list, being the repository "Knowledge Portal of Cape Verde" physically hosted at University of Minho (UM) in Portugal.

Scientific journals play a key role in the global knowledge society. The production of scientific OA journals in Africa is still scarce according to Directory of Open Access Journals (DOAJ) [16], as illustrated in Table 4 (UbuntuNet Alliance countries in grey). The "Open Access for Africa" event is a recent initiative promoting the discussion of issues related to scientific research, the quality of higher education and the role of OA journals in the African continent [17].

Table 2. Distribution of journals in Africa

Egypt	Tunisia	Morocco	Ethiopia	Algeria	Libya	D.R. Congo, Ivory Cost, Ghana, Burundi
459	9	7	6	5	2	1each
South Africa	Kenya	Uganda	Tanzania	Zambia	Madagascar	Ruanda
67	7	4	3	3	1	1

5 Sharing Scientific Knowledge in Mozambique

Mozambique, located in Southern Africa, is independent since 1975 and has Portuguese as its official language. With about 24 million people, 62% live in rural areas, having an average lifespan of 50.7 years and 54% of Mozambicans live below the poverty line. The 2013 report of United Nations Development Program (UNDP) puts Mozambique in the 185th place, the third country with the worst Human Development Index (HDI).

Despite being one of the world's poorest countries, Mozambique is a steady growing country, and the International Monetary Fund (IMF) report of October 2013 [18] forecasts a growth of 8.5% in 2014. Currently, economic growth is the central concern of the country, especially for government and entrepreneurs, and the lack of skilled national workforce is a gap that must be solved. In this sense, the Mozambican government has endeavoured to create conditions for the country technological development, setting up several strategies, being one of the most relevant the Strategy for Science,Technology and Innovation.

5.1 SABER – The National Repository

The lack of scientific information is a reality in Mozambique and to reduce this limitation, the National Repository SABER was created in November 2009, to serve as a common platform for the involved 6 institutions: Judicial Training Centre; Higher Institute of Science and Technology of Mozambique; University Eduardo Mondlane (EMU); Pedagogical University; Polytechnic University; and

University of St. Thomas of Mozambique. As reference, in 2011, Mozambique has 44 institutions of higher education, including public and private.

SABER holds scientific and academic documents produced in or related to Mozambique [19], being supported by the Ministry of Education and the World Bank for resource acquisition. The technical collaboration with UM in Portugal was revealed very helpful for setting up the repository, facing the experience of UM in this area. SABER is physically hosted at EMU, the oldest institution of higher education in the country, which is responsible for the technical support. The software adopted to implement the repository is Dspace. The administrative workflow tasks related to the deposit of documents in the repository is shared between the participant institutions. SABER has nearly 3,000 documents since its creation [8].

SABER is the first repository in Mozambique, and the first in CPLP countries in Africa. Currently, it is evident the need to establish policies aiming at involving a larger number of institutions in SABER. In addition, the ministry of science and technology has shown interest in collaborating with resources and maintenance to support the evolution of SABER.

5.2 MoreNET – Mozambique NREN

MoRENet is the result of IT actions taken by Mozambican government. The adoption of IT policy in 2000 as a framework for the development of information society in the country, defines as main objectives: combating poverty and improving Mozambicans life conditions. One relevant aspect of this policy is ensuring the production and access to knowledge, in order to turn the country into a relevant and competitive partner in the global information society. The strategy plan for implementing this policy was adopted in 2002, and includes the implementation of MoRENet, coordinated by the Ministry of Science and Technology (MCT). Following this IT policy, in 2006 a new strategy was adopted - the Strategy for Science, Technology and Innovation of Mozambique (ECTIM), with a horizon of 10 years, which *aims to establish a framework conducive to the achievement of strategic objectives and programs that promote the development of an integrated system of science, technology and innovation.*

As regards the implementation of MoRENet, there is still much work to do and there is a strong commitment and pressure to become operational in 2014.

5.3 Directions for the Evolution of a Common Open Access Platform

From the discussion above, several points regarding OA may be stressed. OA Repositories are seen as one of the main resources used to deliver, store, and disseminate scientific and academic literature. The number of repositories has evolved to more than 2,500 in the world. The Berlin Declaration encouraged institutions in defining their OA policies based on the principles of self-archiving. The U.S. government has undertaken actions involving all institutions in the country based on the believe that scientific research output resulting from the support of public funds should be made available in OA repositories, as well as the scientific data resulting from it. The EU also recommended member states to develop national policies considering OA. All these measures represent the conscience of governments about the benefits of OA, creating policies and collaborative projects in this context.

The European NRENs model, where GEANT provides connectivity and collaboration among members, has been determinant to the success of NRENs in Europe. In Africa, with the deployment of intercontinental and local connections through fiber optic cables, the problem of broadband connectivity may be solved in most African countries, despite the high costs involved. AfricaConnect project represents an international collaborative effort to achieve the goals of the UbuntuNet Alliance regarding NRENs. In the case of Mozambique, the concretization of MoRENet will be an important step to offer connectivity and support services such as repository SABER.

RCAAP can be considered a successful national repository model supported by a NREN and may be followed by other countries. It also reveals the importance of government support through institutional collaboration (FCT and UM). SARI service provided by RCAAP is also a key aspect influencing the growth of repositories in the country. The creation of the Luso-Brazilian directory of repositories is a step forward in international collaboration.

Keeping in mind all these aspects, concrete actions fostering the evolution of SABER and the integration of distinct communities should be taken, considering: (i) journals and repositories, institutions and their departments, non-governmental partners, national initiatives, publishers, professional associations and research groups; (ii) the evolution of the Mozambican scientific production may result in the implementation of new repositories hosted in MoRENet infrastructure and the emergence of new OA journals; (iii) apart from the technical issues of deploying repositories, the creation of institutional and national policies for self-archiving involving the government, MoRENet, SABER, and other partners, will enable the growth of the number of documents deposited in SABER and the number of existing repositories; (iv) regarding the institutions integrated into MoRENet, they should be involved in the NREN and OA projects to understand their needs for services, according to their location, since the country is vast and heterogenous regarding technology and social development.

6 Conclusions

Taking the relevance of OA repositories for expanding knowledge frontiers, this paper has focused on the challenges and strategies for developing open repositories in the African context. By studying OA initiatives and policies worldwide, and taking the Portuguese experience as case study, it was possible to identify the main difficulties and directions for the deployment and sustainability of OA repositories in Mozambique. NRENs play a key role in supporting research and teaching activities both at national an international levels, being an important vehicle for knowledge dissemination and growth. Therefore, we encourage the initial support of a common OA repository by the national NREN MoRENet.

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Benefits Management Enhances the Organizational Competitive Advantage

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Abstract. To gain competitive advantage organizations need to have something that the competitors do not have and cannot achieve in the short-term. In the past organizations invested large amounts of financial resources to the finest equipment to increase competitiveness. Today, the paradigm has changed and so the quest is more knowledge and innovation driven, where the answer relies on the people's capacity to create and modify processes and generate business value. The investments in information systems and technology (IS/IT) have not always generated the business value or the financial revenue that should be expected. Benefits management focuses on how business areas will improve from business changes and provides a framework for identifying, planning, monitoring, evaluating and actively managing these benefits. In this paper, the authors show how benefits management reinforces firms to identify more clearly the path to obtain the strategic objectives and the related benefits promoting the organizational competitive advantage.

Keywords: The Five Competitive Forces, Resource Based-View, Competitive Advantage, Benefits Management.

1 Introduction

"Since at least 1911, scholars have tried to answer the question. Why do some firms persistently outperform others? " (Barney & Arikan, 2001, p.124) [1]. In the present, firms must compete in a complex and challenging context that is being transformed by many factors from globalization, frequent and uncertain changes in the growing use of information technologies (DeNisi, Hitt & Jackson, 2003)[2]. Every business in order to survive and thrive in a competitive business environment needs to possess a certain level of strategic capability. The type of strategic capability that the company needs at a specific time is determined by the legitimizing forces and the threats/opportunities in the future business environment (Ansoff, 1984) [3]. The purpose of strategic management focuses on searching for ways to understand the factors which contribute to the sustainable competitive advantage for organizations (Porter, 1980) [4] (Porter, 1985) [5] (Rumelt, 1991) [6]. There are many determinants that have an important influence on the ability of companies to achieve a sustained competitive advantage through a positioning facing the cost (Porter, 1980) [4], the

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ability of product differentiation (Caves & Williamson, 1985) [7], (Porter, 1980) [4], the ability of organizations to establish and cooperate on strategic alliances (Kogut, 1988) [8]. It is also mentioned with some frequency the role of systems and information technology (IS/IT) as enhancers of sustained competitive advantage for firms (Barney, 1991) [9] (Clemons, 1986) [10] (Clemons, 1991) [11] (Clemons & Kimbrough 1986) [12] (Clemons & Row, 1987) [13] (Clemons & Row 1991) [14].

In the 1990s, some strategic thinkers (Barney, 1991) [9], (Grant, 1996a) [15], (Wernerfelt, 1984) [16] began to suggest an alternative view of strategy in contrast to Porter's proposals. They argue that the greatest variation in profitability between firms was not between firms in different industries, but between firms in the same industry. This suggests that it is not so much difference in the structural factors within the industry that determines profitability of firms, but what is inside an organization, the resources or assets that allows them to compete. If these resources, competencies and capabilities are valuable, rare, inimitable and non-substitutable they can be used to implement value creating strategies that will provide sustainable competitive advantage (Wernerfelt, 1984)[16], (Barney, 1991)[9]. The only purpose of undertaking any business activity is to create value. If undertaking the work destroys value the activity should not be started. The challenges faced by organizations to increase value from there IS/IT investments, the low-level of organizational competencies in exploiting IS/IT was revealed and an underlying cause of the difficulty in dealing with these challenges. Several studies found no direct relationship between IS/IT investment and productivity at the level of firms, industries, and the economy (Strassmann, 1990) [17]. One of the most widely cited quote by Solow in 1987 is, "we see computers everywhere except in the productivity statistics". This phenomenon is commonly known as the "Productivity Paradox", which states that IS/IT investments do not affect productivity growth. Willcocks & Lester (1996) [18] reviewed de IS/IT productivity paradox debate and found that an important part of the uncertainty about the IS/IT payoff relates to weaknesses in measurement and evaluation practice. According to Hochstrasser (1993) [19] the productivity is static while the IS/IT expenditures are rising and Thorp (2001) [20] says that the organizations still exhibit *"silver bullet thinking"* when it comes to IS/IT. They act as if, once determined, the benefits associated with an investment will automatically happen. However, simply identifying and estimating benefits will not necessarily make them happen. For organizations to stay competitive in a dynamic business environment, they have to understand how to manage IS/IT strategically. Managers in the information age face a business environment characterized by change and uncertainty (D'Aveni, 1995) [21]. The new competitive landscape emphasizes flexibility and speed in responding to fast-changing environments. One particular strand of thinking, which recognizes that many markets are becoming increasingly turbulent and volatile, has suggested that is such environments competitive advantage is transient, rather than sustainable (Eisenhart & Martin, 2000)[22], (Teece et al., 1997)[23]. Managers must concentrate on renewing rather than protecting their sources of competitive advantage. They must be able to combine these resources in new ways to gain additional capabilities, *"dynamic capabilities"*.

2 Competitive Advantage

One of the questions that have been asked repeatedly both in industry and in the academic literature is: "*How the organizations reach a sustainable competitive advantage?*" Traditionally, there are two main approaches to strategic thinking about the possible reasons of how a company obtains and retains its competitive advantage. The focus on competitiveness analysis in the specific environment of the industry (Porter, 1980) [4] and the perspective of the resource-based view (RBV), which emphasizes the use of specific resources (Wernerfelt, 1984) [16], (Barney, 1991) [9]. Teece et al., (1994) [24] and Teece et al. (1997) [23], however, support the idea that companies must develop dynamic capabilities to ensure their sustainable competitive advantage. Focuses on knowledge as the most important strategic resource, the knowledge-based view (KBV) is concerned about how knowledge affects strategic management, the coordination within the firm, the organizational structure, among other issues (Grant, 1996a) [15]. For many organizations the competitive advantage is a continuous performance improvement in a search for best practices and the development of new capabilities. Looking for higher efficiency organizations change and create new processes, produce organizational changes, implement new systems and technologies, introduce new products and services and also develop dynamic capabilities (Teece et al., 1997) [23] to give a quick response to permanent market changes. Prahalad & Hamel (1990) [25] argue that sustainable competitive advantage is dependent upon building and exploiting core competencies. Porter's work emphasizes the need for firms and countries to broaden and upgrade their internal advantages in order to sustain and extend competitive advantages (Porter 1991) [26], (Porter, 1992) [27]. Firms obtain sustained competitive advantage by implementing strategies that exploit their internal strengths through responding to environmental opportunities, improving internal weaknesses and eliminated the external threats (Barney, 1991) [9]. For organizations, the challenge is to identify, protect and develop a set of resources and capabilities in order to provide a sustainable competitive advantage and, therefore, a higher return on capital (Amit & Schoemaker, 1993) [28].

3 Five Competitive Forces View

The mainstream think in strategic management has been the prospect of Porter *"the five competitive forces"*, based on the work of Edward Mason and Joe Bain (1959) [29] published in *"Industrial Organization"*. In this book, the authors emphasize the relation between the company and the industry as a crucial link to survival organizations. In turn, Porter analyses the industry structure and the profitability of the company that is influenced by its size relative to its rivals, suppliers and customers (Porter, 1985) [5]. The proposed model takes into account the joint action of five forces: the rivalry among competitors, threat of substitutes and competitors and the bargaining power of suppliers and buyers. The theory is based on the concept of profit maximization and the competition is based on the primary goal of the organization that is to maximize long-term profit and develop a sustainable competitive advantage over rivals in the external market (Porter, 1980) [4]. In this approach the key to sustained competitive advantage in this choice of appropriate industry and the organizational strategic positioning within that industry. This view also considers the competitive edge as a position of superior performance that a company can achieve by choosing one of the following generic strategies (Porter, 1985)[5]: (1) Cost leadership - although not neglecting quality and service emphasizes low cost relative to competitors. (2) Differentiation–requires that a firm creates something, product or service, recognized as being unique, thus permitting the firm to command higher than average prices. (3) Focus strategy – the firm concentrates on a particular group of customers, markets or product line segments. These three generic strategies represent three broad types of strategic groups, and thus the choice of strategy *"can be view as the choice of which strategic group to compete in"(*Porter, 1980, p.149) [4]. The firms that stays *"stuck in the middle",* will be failing to develop its strategy along at least one these three categories and is *"almost guaranteed low profitability"* (Porter, 1980, p.41) [4]. Several important critics were made to the Porters model: (1) To Kay (1993) [30] competitive advantage is synonymous with superior relative financial performance. When reading the Porter statement (Porter, 1985, p. xv) that "*competitive advantage is the heart of a firm's performance in competitive markets"* we have an entirely tautological concept: Financial performance is the heart of financial performance (Klein, 2001) [31]. (2) A quality defined only in terms of outcomes cannot exist before those outcomes have occurred; this means that competitive advantage can only be used to explain competitive performance (Klein, 2001)[31]. In practice, competitive advantage is used before, e.g.*,"competitive strategy is the basis on which a strategic business unit might achieve competitive advantage in its market"* (Johnson & Scholes, 1999, p.547) [32]. (3) The competitive advantage is more sustainable if they are inimitable, the most competitively valuable competitive advantages might be precisely those that cannot be identified, and therefore copied (Klein, 2001) [31].

4 Resource-Based View

We can say that companies' success depends on the strategic competitiveness, achieved when it develops and puts into practice successful strategies not easily reproducible in the generation of value (Hitt, Ireland, Hoskisson, 2003) [33]. One of the most significant changes in the field of strategic management has been the search for competitive advantage looking into companies in the form of resource-based view, core competencies and dynamic capabilities (Barney, 1991) [9] (Hoskisson et al., 1999) [34] (Penrose, 1959) [35], [Teece et al., 1997) [23]. The core of the RBV is to achieve a state of sustained competitive advantage through the acquisition and control of resources, valuable, rare, inimitable and non-substitutable, name VRIN capabilities (Barney, 1991) [9] (Barney & Hansen, 1994) [36] (Barney 2002) [37]. This view is shared by several other analyses related, mainly, core competencies (Hamel & Pralahad, 1994) [38], the dynamic capabilities (Helfat & Peteraf, 2003) [39] (Teece et al, 1997) [23] and the view-based knowledge (Grant, 1996b) [40]. The RBV has emerged as a complement to Porter's theory of competitive advantage (Barney & Arikan, 2001) [1]. The RBV has three key contributions: The first of Wernerfelt (1984) [16] recognizes that resources specific company, as well as competition between firms based on their resources may be essential for organizations to gain advantages in implementing strategies product market (Barney & Arikan, 2001) [1]. The second contribution was presented by Rumelt (2003) [41] focuses on the rents with the creation of a theory of income generation (Barney & Arikan, 2001) [1]. Furthermore, Rumelt (1984) [42] offered many features that were later associated with the resource based view, e.g., "*Firms as collections of productive resources*" or *"isolating mechanism"* (Barney & Arikan, 2001) [1]. The third article of RBV was published by Barney (1986) [43] who introduced the concept of strategic factor market where companies develop the resources and capacity to implement their market strategies and product. These three items form the basis of what was later known by the resource-based theory. Resources are factors that can be classified as strengths and weaknesses of the company, such as skills, assets, processes and knowledge (Barney, 1991) [9] and can be tangible or intangible. Resources and capabilities possessed by competing firms are heterogeneously distributed and can be a source of competitive advantage. Resources and capabilities possessed by competing firms are heterogeneously distributed and may be a source of competitive advantage when they are valuable, rare, difficult to imitate, and not substitutable with other resources (Barney, 1991) [9], (Wernerfelt, 1984) [16]. At the same time, resources and capabilities are a source of sustained competitive advantage that is, differences may be long lasting (resource immobility) when protected by barriers to imitation (Mahoney & Pandian, 1992) [44] or isolating mechanisms such as time-compression diseconomies, historical uniqueness, embeddedness and causal ambiguity (Barney, 1991) [9], (Dierickx & Cool, 1989) [45], (Peteraf, 1993) [46].

Various critiques and limitations have been referred by several authors, such as; (1) RBV misses substantial managerial implications or *"operational validity"* (Priem & Butler, 2001a) [47]. RBV tell managers to develop and obtain VRIN resources, but it is silent on how it should be done (Connor, 2002) [48], (Miller, 2003) [49]. (2) RBV entails an infinite regress (Collis, 1994) [50], (Priem & Butler, 2001a) [47], *"A firm that has the superior capability to develop structures that better innovate will, in due course, surpass the firm that has the best product innovation capability today…*" (Collis, 1994, p.148) [50]. (3) Gibbert (2006a) [51], Gibbert (2006b) [52] argues the notion of resource uniqueness, heterogeneity and immobility, denies the RBV any potential for generalization. (4) RBV unsuccessfully reaches for a theory of the firm. The proposition that RBV could be considered a new theory was mentioned by Conner (1991) [53] and Kogut & Zander (1992) [54]. (5) The RBV is a tautology that fails to fulfil the criteria for a true theory. Lockett et al. (2009) [55] and Priem & Butler (2001a) [47], Priem & Butler (2001b) [56] argue that the RBV does not contain the law-like generalizations expected.

5 Creating Value from IS/IT Investments

Since the 1980s, IS/IT has positioned itself as a strategic tool that through agility and innovative ways of conducting business can produce superior performance (McFarland, 1984) [57], (Farley et al., 1993) [58], (Porter, 2001) [59]. As a result, the relationship between investments in IS/ IT and improving organizational performance has been the subject of many studies (Melville et al., 2004) [60]. The issue remains controversial, as evidenced by articles in major business magazines (Carr, 2003) [61] (Farrell, 2003) [62]. A helpful theoretical model tries to explain the steps involved in creating value from IS/IT, and highlights the importance of business change in this process has been proposed by Soh and Markus (1995) [63]. This model identifies three distinct processes that must be successfully undertaken (Fig.1).

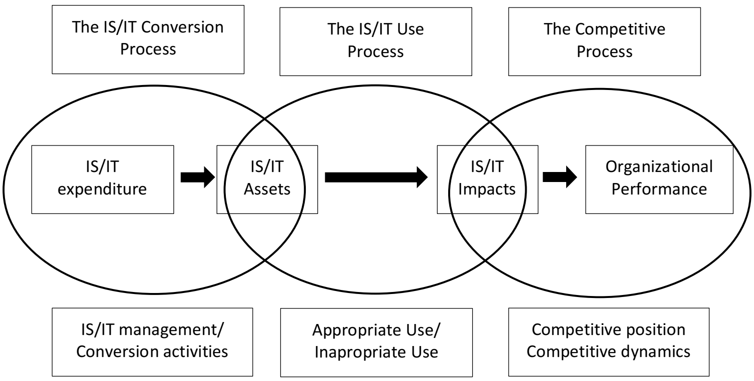

Fig. 1. How IT Creates Business Value (Soh & Markus, 2005) [63]

The first is the conversion of the IS/IT into assets that can be used by the firm. The second is the effective use of those assets of the firm, which captures the need to undertake a business change in order to achieve effective use. Finally, this effective use must be transformed into helpful improvements in organizational performance. These three stages relate to the *"ends", "ways",* and *"means"*, view of strategy development. The recognition that IS/IT investments have a strong social, as well as the technical aspect, highlights the need to consider the project from the perspective of those groups or individuals that will be impacted. The use of the "ends-ways-means" model permits characterizing business strategy and its execution; establishing corporate objectives or vision, the *'ends'*; developing a strategy, the *'ways'*; and aligning the resources necessary to implement this strategy, the *'means'*. This model illustrates that IT assets *"means"* have 'potential value'; this value must be defined (Soh & Markus, 1995) [63] as the effective use process, which converts the IS/IT asset into performance improvements through a combination of successful IS/IT adoption and organizational change management. The ability of the organization to create benefits from new or changed ways of working is the key to realizing the value of most IS/IT investments.

6 Cranfield Management School Approach

In 1994, following several experimental studies conducted in European organizations, Ward et al., (1996) [64] from the Cranfield Management School developed an approach for identifying, structuring, planning, monitoring and delivery benefits. The model introduced the idea of a distinct process targeted towards managing the benefits realization of IS/IT projects in order to improve the result. The process of benefits management based on the management model of strategic change developed by Pettigrew and Whipp (1991) [65], by recognizing that the process by which a major change is managed needs to be relevant to the content of the change involved both internal and external. The general perception of the continuous failures of IS/IT investments has forced organizations to seek new ways and approaches to achieving successful projects. The focus should be on obtaining benefits since this is the main justification for the investment (Ward & Daniel, 2006) [67]. The five principles for realizing benefits through IS/IT are the following (Peppard et al., 2007) [68]: (1) Just having technology does not give any benefit or create value; (2) IS/IT enables people to do things differently; (3) Benefits result from changes and innovations in ways of working, only the relevant stakeholders, can make these changes; (4) All IS/IT projects have outcomes, but not all outcomes are. (5) Benefits must be actively pursued to be obtained. In these five principles, it is suggested that the value of implementing IS/IT in an organization is in the interaction between IS/IT and the organization it resides in, and not an inherent value. Against this backdrop, efforts have been made to understand the value that IS/IT brings and how to increase that value. Benefits management can be described as "*The process of organizing and managing such that potential benefits arising from the use of IS/IT are actually realized*" (Ward & Daniel, 2006, p.384) [67]. According to the Cranfield approach (Fig. 2) the process for benefits management follows five stages.

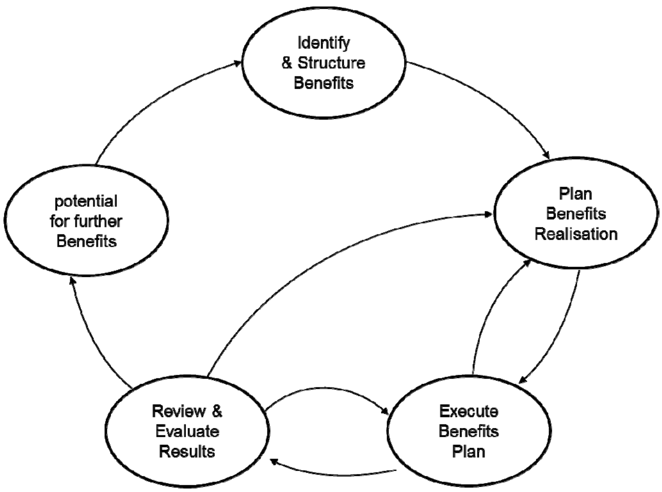

Fig. 2. The benefits management stages (Ward & Daniel, 2006, p.105) [66]

This process is formulated as interrelated tool or framework that can be used to guide and structure the planning and actions need to implement a project successfully. This approach requires an active integrated business methodology and focusing management attention to IS/IT throughout the investment cycle. Developing this competence within an organization also requires the integration of several specialized areas of knowledge, such as change management, risk management, project management, systems development, investment evaluation or portfolio management. To help organizations focus on the delivery of the benefit of investments was introduced in 1996 the process of benefits management that complements existing best practices and existing methodologies. The process, tools and techniques were associated with the work in consecutive years with organizations of various sectors. (Ward & Daniel, 2006) [66], (Peppard et al., 2007) [68]. The process model accommodates a life cycle emphasis that includes not only pre-investment appraisal and post-investment evaluation, but also how organizations can actively manage the claimed benefits towards realization.

The Benefits Dependency Network (BDN) (Fig. 3) is key tool that was introduced for the first time by Ward & Elvin (1999) [69], designed to combine the investment objectives and their resulting benefits, in a structured way, to business and IS/IT changes required to realize those benefits. The BDN construction commences with the understanding of the drivers acting on the organization; the agreement on the investment objectives for the particular initiative or project; then proceeds to the identification of the business benefits that will result if the investment objectives are achieved. Then, it is necessary to identify the changes to the way's individuals and groups work, a necessary part of realizing the potential benefits identified (Ward & Daniel, 2006) [66]. The changes identified in the BDN can be categorized into two types: business changes and enabling change. The business changes are permanent changes to working practices, processes or relationships in contrast the enabling changes were doing just once and are the pre-requisites for making the business changes in effective operation. The monitoring results compare the benefits of the projects with the plan benefits realization during the course of the project and assesses whether external or internal changes affecting the delivery of planned benefits (Ward & Daniel, 2006) [66].

There should be a formal review of what was and was not been achieved after the new technology, system and business change has been implemented. Benefits review is the process by which the success of the project in terms of benefits delivery is addressed, opportunities for the realization of further benefits are identified and lessons learned and opportunities of improvement in future projects are identified (Ashurst & Doherty, 2003) [70]. We call attention now to some of the debates about the management benefits of investments in IS/IT. It is unlikely that the benefits previously identified automatically arise from the introduction of a new technology. It's getting to be rigorously planned and managed (Lin & Pervan, 2003) [71], (Markus, 2004) [72]. The benefits are often identified in the initial phase to build the business case and sell the idea to interested parties. The absence of a monitoring procedure to assess their achievement is frequent, and problems will arise after the

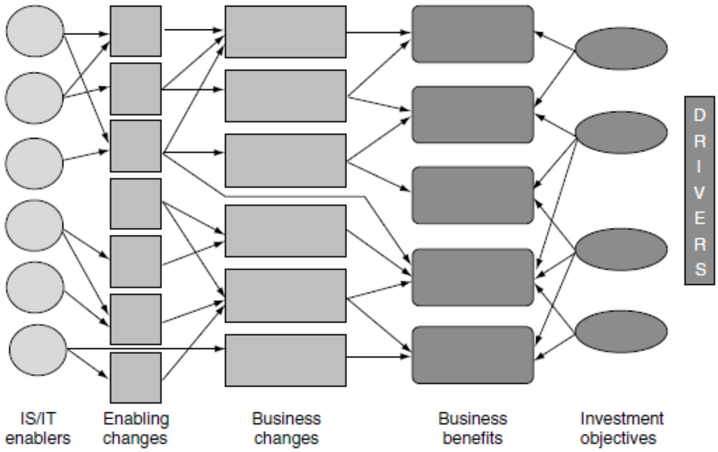

Fig. 3. Benefits Dependency Network (Ward & Daniel, 2006, p.134) [66]

system delivery when it is necessary to show the realization of the benefits previously defined (Remenyi et al., 2007) [73]. In benefits management cycle, several authors are unanimous in recognizing the crucial importance of the early stages. Bennington and Baccarini (2004) [74] suggest that the benefits should be identified process involving a mixed approach of interviews and workshops with key stakeholders. Benefits at this stage should be structured so as to clarify the relationship between the effects of technology, the necessary changes in business and organization goals (Widestadh & Sakar, 2005) [75]. One common factor of many projects and programs is the imprecision in benefits identification and gives its failure (Reiss et al., 2006) [76]. Without clearly defined goals, it is hard to stay focused when problems occur later. However, Bennington and Baccarini (2004) [74] argue that most organizations do not follow the development of benefits by the following reasons: (1) Lack of experience and/or knowledge of the business. Focus on results, rather benefits. (2) Lack of focus on people who will enjoy the benefits. (3) Emotional commitment to continuing the project and therefore is not open to changes that could threaten the viability of the project. (4) Lack of tools to help ensure that the benefits will be delivered.

7 Discussion

As described before, the ability to create value for its buyers that will exceed the cost of its creation (Porter, 2005) [5], the implementation of a value creation strategy different from the strategies of its competitors (Barney, 1991) [9], a sustainable above-normal returns (Peteraf, 1993) [46], earning a higher level of profits than its competitors (Grant, 2002) [77], are some evidence of the competitive advantage concept. Many of the most recognized authors of RBV (Peteraf and Barney, 2003) [78], (Amit and Schoemaker, 1993) [28], (Peteraf, 1993) [46], (Mahoney and

Pandian, 1992) [47], (Conner, 1991) [53], (Barney, 1991) [9], (Wernerfelt, 1984) [16], recognizes that the RBV and Porters five competitive forces, complement each other and combine in order to explain the sources of the competitive advantage and the long-term sustainability of the organizations. These two approaches, according to Lioukas and Spanos (2001) [79] have similarities since they share the vision that persistent above-normal returns are possible. Both perspectives seek an explanation for the sustained competitive advantage, assuming of course that the ultimate goal of the company is improving its performance. However, Porter´s view and RBV do not use the same unit of analysis, the industry versus internal resources. The main focus of the Porter´s view lies on the factors of the company's competitive advantage concerning the industry, not analyzing the set of features that enable companies to achieve their strategic ploys (Foss, 1996) [80]. The accumulation of resources is part of the strategy implementation dictated by the conditions and the restrictions of the external business environment. The RBV, in contrast, suggests that the organizations' resources are the basis for strategy and the strategy should enable the organizations to a better performance of its resources in relation to the competitive environment. Organizations should carry out a regular strategic analysis to understand and interpret its business drivers and revise the long-term objectives.

The benefits management promotes wokshops between all the relevant stakeholders for discussion and decision on which strategic objectives and benefits to consider, and about which the important changes that the company must perform to fulfill the strategy and achieve the expected results. The benefits management proactively encourages stakeholders to explore the multitude of relationships that exist between technology, organizational change and benefits, keeping benefits very firmly on the agenda, facilitating a benefit-oriented communications amongst all system's stakeholders. The range of changes required to deliver the objectives and benefits should be identified and carefully described. The map of projects and initiatives, mapped on the BDN, can show the dependencies among them. The BDN also represents a powerful communication tool, with the mission to disseminate to all organizational levels, how the strategic objectives and benefits will be reached, and each one´s role.

The key issues to realize the benefits and enhance an organization competitive advantage are a clear understanding of the intended benefits and agree on how to prioritize them, if trade-offs are needed to optimize resource allocation to pursuit the overall outcome. The benefits management approach promotes the usage of an effective organizational change management capability to manage all of the other factors necessary to make effective use of the assets created by projects/programs. This includes training and operational support as a means to facilitate the necessary cultural changes within the organization.

8 Conclusions

Competitive advantage is seen as the main source to explain the superior performance of firms, and thus comes to represent the fundamental aim of strategic management.

As presented above, competitive advantage has different definitions and interpretations. However, all the revised strategic approaches support the idea that the ability to create value above-normal can lead organizations to a sustainable competitive advantage.

In this multi-strategic choice, the benefits management approach can be used in the strategic planning process to reinforce and enable organizations to face, prepare and manage their competitive environments. In terms of business strategy choice, preparation and execution, benefits management, strengthen the need for organizations to carefully analyze their business drivers, amongst other relevant industry and market inputs.

Furthermore, it also deals with organizational internal changes in working processes, supported by IS/IT implementations, as a means to more easily achieve competitive advantage.

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An Empirical Study of the Factors Affecting Mobile Social Network Service Use

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Abstract. This research analyses the application of Mobile Social Network Services (MSNSs) in regard to their nature of being new ICT (Information and Communication Technology) tools. It is recognised that MSNSs are fast, responsive technologies centred on facilitating mobile commerce. This research aims to identify a number of the factors impacting MSNSs acceptance and usage in the context of the Kingdom of Saudi Arabia. In an attempt to achieve sound insight into the market of Saudi Arabia in relation to mobile communication, which is recognised as being a very valuable sector, a survey was carried out targeting a sample of 363 citizens, with a suggested conceptual model based on the UTAUT framework tested. The findings of this study indicate that performance expectancy is the most important offsetting element, with final cost and effort expense following subsequently. Nevertheless, social influence is not impacted in regard to the intention to utilise MSNSs.

Keywords: Saudi Arabia, Mobile, UTAUT, MSNS.

1 Introduction

Mobile Social Network Services (MSNSs from here on in) are commonly acknowledged as providing a future tool for mobile commerce (m-commerce), as highlighted by scholars and professionals in the field [1]. It is recognised that such tools are critical in regard to m-commerce, as has been established through a research carried out recently, which shows that 91% of all mobile subscribers are, to some degree, involved in social computing applications. Moreover, a large portion (79%) are also desktop users [2]. In the context of Saudi Arabia The total number of mobile subscriptions grew to around 53.7 million by the end of 2011, up from only 2.5 million in 2001[3], 60% of the mobile users own smart phones. By comparison, the market penetration of Smartphones in the U.S. was 44 % [4]. Moreover, in Saudi Arabia 85% of the Smartphone users have access to the internet [5] 88% of those accesses to the internet daily [6].

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During modern times, a huge population makes use of Facebook, with 400 million users utilising mobile applications [7]; Also, over 200 million WhatApp application users [8]. With this taken into account, it is relevant to highlight that the revenue generated through Facebook Mobile amounts to approximately $152.6m[9], Also, by 2015 more that 60% of twitter revenue is coming from mobile ads[10].

As may be considered through the above statements, MSNSs are recognised as becoming fundamental to not only users but also to suppliers/organisations. Accordingly, the aim from this study is to achieve a greater understanding in regard to those elements impacting utilisation behaviours demonstrated by users, there will be the analysis of the UTAUT revised framework so as to achieve insight into the most critical elements affecting MSNSs application.

2 Theoretical Background

In 2003, Venkatesh presented the UTAUT framework as a theory mixing eight different theories, notably C-TAM-TPB (combined TAM and TPB), IDT (Innovation Diffusion Theory), MM (Motivational Model), MPCU (Model of PC Utilisation), TAM, TPB (Theory of Planned Behaviour), TRA (Theory of Reasoned Action), and SCT (Social Cognitive Theory). After the completion of an empirical analysis, it was found that the model has the capacity to verify around 70% utilisation intention variance; this significantly exceeds the variance suggested through other theories.

So as to facilitate the application of the UTAUT framework in various situations of IT implementation, including that of MSNSs, various reviews and corresponding amendments must be implemented, as suggested by [12]. Furthermore, as outlined by Heijden [13], a number of application behavioural elements could arise from different IS utilisation. In this regard, the Voluntariness moderator was removed as a moderator owing to its relevance only when technology application is fundamental [12,14]. Importantly, however, this is not relevant in regard to this particular study. With this noted, as a result of the novelty associated with the concept of MSNSs, there are three factors regarded as less valuable and powerful in terms of identifying user acceptance in regard to MSNSs, namely age, experience and gender. The view is also highlighted that the eradication of such elements because of the paper limitation.

Throughout this study, there will be the implementation of the UTAUT model as a theoretical base for the examination of users' intention to use MSNSs. The research will centre on the Kingdom of Saudi Arabia (KSA).

3 Conceptual Model and Hypothesis

The research analysed in this study may be viewed in Figure 1, with the associated contracts and hypotheses further supported throughout studies carried out in the past in the context of information systems.

Performance Expectancy (PE)

Performance Expectancy (PE) is recognised as providing performance improvements when new technologies are applied by users. With this taken into account, this specific concept is a fundamental elements widely utilised when describing consumer behaviours, such as in those studies conducted recently in relation to IT [15-19].

H1: Performance Expectancy will significantly impact behaviour usage intention in regard to MSNSs.

Effort Expectancy (EE)

Effort Expectancy (EE) is defined by Venkatesh *et al.* [2003] as the extent of ease linked with system utilisation. Through this approach, effort expectancy is recognised as a critical element of the application of m-commerce [20,21]

H2: Effort expectancy has a considerable and positive effect on the intention to use MSNSs.

Social Influence (SI)

Social Influence (SI) as a concept refers to the degree to which people recognise that surrounding people, with valuable opinions, believe the system should be adopted [12] . Various empirical studies conducted emphasise the importance of social influence on the application of IT [22-24].

H3: Social Influence has a considerable positive effect in regard to the intention to use MSNSs.

Perceived Financial Costs

Financial costs is an important aspect associated with establishing and delivering MSNSs. In relation to users' acceptance surrounding m-commerce, there are various important elements recognised by scholars [20,24-26] in the arena of empirical analyses, with many holding that there are fundamental effects associated with behavioural intention on a number of factors, including cost. Accordingly, the hypothesis detailed below has been formulated:

H4: perceived financial cost has a considerable negative impact on users' intent to usage MSNSs.

Behaviour Intention (BI)

As noted through the work of Jaccard & King (1977, cited in Liang *et al.*, 2008), behavioural intention can be described as a 'perceived notion between oneself and some action'. Furthermore, behavioural intention is always seen to relate to future behaviours, as noted by various academics in the field [12,27,28].

As recognised by Irani [29] , the majority of studies centred on technology application have utilised behavioural intention in order to estimate adoption. Furthermore, it has been emphasised by Ajzen [27] that behavioural intention may be linked with actual usage. The assessment of behavioural intention involves the intention and predicted adoption of m-commerce-associated services.

H5: Behavioural intention will positively affect actual usage of MSNSs.

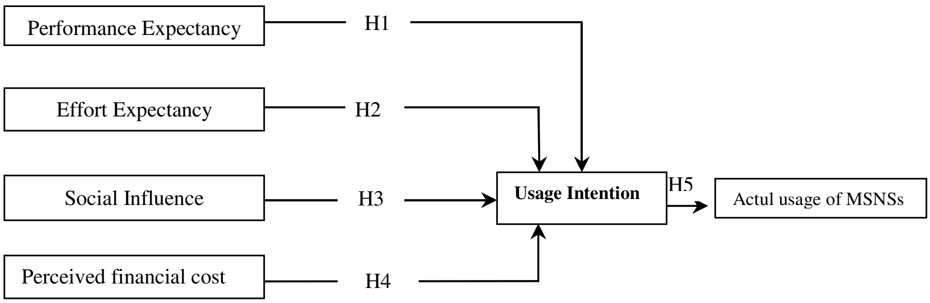

Fig. 1. Research model for MSNSs acceptance in KSA

4 Research Methodology

In order gather appropriate data, the decision was made to adopt a positivist approach through the research by applying a survey. This is acknowledged as being the most suitable technique in this context. Previous studies conducted in the same arena, such as those by [30-32], have utilised such an approach.

After the designing of the questionnaire, some minor testing was conducted with the help of five IT-specialised academics. This was considered essential when seeking to establish survey-related developments before the actual survey is to be carried out [33]. As a result, there was both the online and manual distribution of the survey to 50 individuals aged 18–45 years. Importantly, the sample participants are all citizens of the Kingdom of Saudi Arabia. With this taken into account, there was the option to utilise Cronbach's α (Alpha), which is regarded as being useful in terms of calculating and analysing the SPSS reliability. Notably, it is recognised that the alpha score exceed 0.7; if this is not the case, it must be rejected. The results were all found to be over 0.7.

Questionnaire distribution was carried out online and manually, with a large sample of 980 mobile device users within the KSA targeted. From this figure, a total of 420 were completed and returned, thus providing a response rate of 42.86%. Of the 420 returned, 363 could be utilised for the study; the remaining 57 had to be removed from the sample owing to missing important information.

Sample

The table below provides an overview of the subjects involved in the study on the basis of age, education and gender.

Of the 363 respondents, majority were female (63%, n=230) while 37% (n=133) were male. The majority were young in the age group of 18-25 years (50%, n=181), followed by 26-35 years (27%, n=99), 15-18 years (14%, n=52), 36-45 years (7%, n=24), while only 2% (n=7) were aged 45 years and over. As for education, the majority (50%, n=181) held undergraduate level degrees, 25% held high school certificates, 12% held postgraduate degrees, 6% (n=20) had less than high school qualifications, while 5% held a diploma.

Table 1. Demographic characteristics of the participants (N=363)

Demographic	Category	Frequency	%
Gender	Male	133	37
	Female	230	63
Age	15-18 years	52	14
	18-25 years	181	50
	26-35 years	99	27
	36-45 years	24	7
	+45 years	7	2
Education	Less than high school	20	6
	High school	90	25
	Diploma	17	5
	Bachelor	192	53
	Postgraduate	44	12

Reliability Test

As has been highlighted by [34], through the application of Likert-type scales, there is the ability to calculate Cronbach's alpha coefficient. This achieves insight into internal consistency reliability for any scales or subscales utilised. Data analysis should then involve such composite scales or subscales. Importantly, the closer Cronbach's alpha coefficient is to 1.0, the greater the internal consistency of scale items. Importantly, the threshold for suitable reliability is 0.7, as highlighted previously [34]; however, some believe 0.6 is also satisfactory [35,36] . [37] further recognise that the score achieved may be broken down into four categories: excellent (0.90 and above), high (0.70–0.90), high moderate (0.50–0.70), and low (0.50 and below). The table below provides an overview of the reliability for all constructs, in addition to their interpretation.

Table 2. Reliability of Measurements

Constructs	N	Number of Items	Cronbach's Alpha [α]	Type
Usage Intention	363	4	0.75	High Reliability
Performance Expectancy	363	5	0.89	High Reliability
Effort Expectancy	363	4	0.74	High Reliability
Perceived financial cost	363	3	0.75	High Reliability
Social Influence	363	3	0.79	High Reliability
N=Sample Size				

Factor-Loading Result

All items loaded on particular factors bring about constructs demonstrating high levels of validity, thus highlighting the well-known elements of MSNSs. Importantly, none of the items cross-loaded onto other factors in the rotated component matrix. Furthermore, all of the items loaded strongly on only one component, meaning that all of the elements were found to exceed 0.4, i.e. the minimum suggested value in the context of IS studies [38,39] .

Table 3. Factor Loadings

Constructs	Number of Items	Factor Loadings
Usage Intention	4	,731 - ,585
Performance Expectancy	5	,828 - ,783
Effort Expectancy	4	,756 - ,674
Costs	3	,866 - ,523
Social Influence	3	,885 - ,770

Regression Analysis

The four predictors' effects in regard to usage intention was examined through the use of the standard multiple regression (enter method). As a group, the four predictors explained 36.1% of the variation in usage intention, hence this is a reasonably good model, though 64.9% of the variation in usage intention scores is still unexplained, i.e., there are other unknown factors that may influence usage intention that are not accounted for in this model [40]. It was found that, as a whole, the framework was significant ($F = 48.939$, $MSE = .370$, $p<.001$). A positive and significant impact on usage intention scores at a level of 0.001 was seen amongst three of the predictors. Importantly, Performance Expectancy showed the highest impact ($\beta = .521$, $t = 11.454$, $p<.001$) owing to the fact that this element was seen to have the greatest standardised Beta (β) and t-values. Financial cost followed secondly ($\beta = .162$, $t = 3.574$, $p<.001$), and is therefore the second largest predictor of usage intention. Lastly, the lowest explanatory power was seen in regard to Effort Expectancy ($\beta = .111$, $t = 2.405$, $p<.05$). On the other hand, however, Social Influence was recognised as an insignificant predictor of utilisation intention.

Testing the Impact of Usage Intention on Actual Use: Linear Regression

A low value for R square (0.085) was found, thus suggesting that only 8.5% of the variation in actual use could be explained by usage intention. The framework was found to be highly significant ($F = 32.622$, $MSE = .277$, $p<.001$). Actual use can be significantly predicted through usage intention ($\beta = .292$, $t = 5.712$, $p<.001$), with a one standard deviation increase in Usage Intention scores, thus inducing an increase in actual use by .277 points (based on the standardised Beta coefficient value).

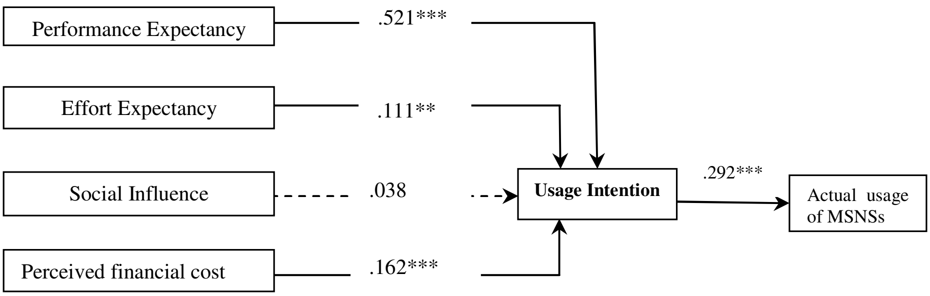

Fig. 2. Alternate model

*** Significant at P<0.001.

5 Discussion and Conclusion

The empirical data gathered provides further sustenance for the study framework structure. As can be seen through Figure 2, with the exception of H3 all hypotheses were supported. It was established that performance expectancy is significant in terms of estimating the usage intention of users in Saudi Arabia in regard to MSNSs. This finding was expected, and provides further support for works carried out previously [20,24,25,41] . Such researches have suggested that the PE has adopted a key role in terms of impacting the behavioural intention of users in relation to technology adoption. From this study we found that users are deterred more by performance expectancy than by effort expectancy. Effort expectancy aspect is also recognised as having a notable effect on the intention to use MSNSs, with this result also further supported through past researches [25,43,44] . From this standpoint, consumer usage intention is seen to increase by 0.111 points on average when MSNSs are not found to be compacted. This result suggest that MSNSs provides need to improve their camapility with various user requerments. In line with our finding, this research acknowledges that mobile social network service costs are quite costly—a view agreed upon by most Saudis—although MSNSs usage behaviour is not negatively impacted as a result. This is considered to be an unexpected result when taking into account the fact that this study has identified a positive relationship between usage behaviour and cost, whilst other studies have identified contrasting links [20,25,42] . Moreover, such a finding reinforces the link between actual usage and intention to use, which has been identified in other study [41]. Nevertheless, an insignificant impact on consumer UI in the context of m-commerce services was found in regard to Social Influence, which goes against the findings garnered through other researches [20,23,45].

Lastly, the results demonstrate very different findings when contrasted with other studies conducted in the same sector but in other locations. This point is recognised as valuable, and therefore necessitates further investigation as a way of drawing comparisons between countries, such as between Saudi Arabia and Malaysia. This could help to establish the presence of other differences to a greater degree.

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A Survey of Cloud Computing Migration Issues and Frameworks

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Abstract. The cloud computing paradigm is transforming the way IT services are provided and consumed. The moving of in-house IT services to the cloud-computing paradigm should be performed carefully lest cause high losses in the institution that is in the process of transition to cloud computing. So, in this paper, we presents a study of several frameworks developed to move IT services and applications to the cloud computing. The work ends with a summary description of the proposed solution, by the same authors, to the migration of services, applications, data and infrastructures to cloud computing. The solution encompasses a framework with a set of processes that are supported by the Information Technology Infrastructure Library (ITIL).

Keywords: Cloud computing, cloud computing adoption, ITIL.

1 Introduction

There is always a strong pressure on Information Technology (IT) to do more with fewer resources. Over the decades, this pressure to rationalize IT costs spurred a number of paradigms, technologies and buzzwords. While some of them failed to meet their promises others became successfully embed in IT practices and infrastructures, providing sizeable benefits. The paradigm of cloud computing is currently riding this wave, promising to be the next great revolution in IT. Cloud computing appears to have the right technological and market ingredients to become widely successful.

Cloud computing is a cost-effective and flexible platform that provides IT services to customers over the Internet. The term “cloud computing” was coined in the fourth quarter of 2007, in the context of a joint project between IBM and Google [1], [2]. However, as also happens with many other emerging trends – and despite being a subject on which much has been written – there is no consensual definition of what really means. As an example, in [3] there is a list of at least 22 distinct definitions of cloud computing proposed during the year of 2008.

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The National Institute of Standards and Technology (NIST) [4] presents one definition of cloud computing recognized by several authors [5–9], considered as being holistic [10] and adopting a broad scope. They define cloud computing as: "*a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction*." [11].

Cloud computing is classified in four deployment models: public, private, hybrid and community. Traditionally, each of these deployment models is divided into three layers (also known as service models), according to the services it provides to the users. These three layers include, on the first level, Infrastructure-as-a-Service (IaaS), where the user can afford, upon request, processor resources, storage and networking, among others. At this level, the user is required to have specialized technical knowledge and the provider delivers computing power/resources. On a second level, the Platform-as-a-Service (PaaS) layer allows users to implement their applications in the cloud, by using the programming languages and tools provided by the service provider. The third corresponds to Software-as-a-Service (SaaS), where the applications provided by the service provider run in the cloud infrastructure and are typically accessed using a Web browser. Nonetheless, in order to completely fulfill its promises, cloud computing still needs to win the trust of involved stakeholders.

With the large amount of resources provided for developing and deploying applications, the cloud-computing paradigm is a tool of major importance to the replacement and migration of many of the services hitherto available in data centers.

The main goal of this paper is to present the challenges and issues of cloud computing as well as the concerns of the migration to this paradigm. Additionally we present some solutions envisaged by several authors aimed at cloud computing migration. Nonetheless, few researches are dedicated to determine the drivers of adopting cloud computing thus the literature is limited on this topic [12].

The rest of the paper is organized as follows: Section 2 presents the overview of the cloud computing paradigm, its concerns and governance. In Section 3 are presented various frameworks developed by several researchers. Finally, the paper concludes in Section 4.

2 Moving to Cloud

In this section it is presented an overview of the cloud computing paradigm, its concerns and governance.

2.1 Concerns

In [13] the authors argue about the major challenges towards the migration of services to the cloud environment, considering both public and hybrid clouds. They start by identifying the problems faced by customers who want migrate services to cloud computing. The first issue found is the trust that customers must have on the cloud service providers, following with the known technical problems of availability of service, vendor lock-in, abuse of privileges (e.g. by system administrators), the possibility of an uncontrolled automatic increase or decrease in resources, information governance (encryption, location information), the risks of depending on Internet access and the undefined cloud performance. On the other side, they place the business problems, beginning with the reduced possibility that the customer has to manage the platforms provided via the cloud, difficulties of proper monitoring, security and virtualization security and confidence.

Additionally they point some existing solutions for problems such as the problem of monitoring (Hypernic's CloudStatus) and management (RightScale).

2.2 Governance

Governance, in cloud computing, is defined in [14] as the set of processes used to monitor and control the approval and implementation of a service based on cloud computing, in accordance with recognized policies, audit procedures and management policies. The same authors advocate the idea that can be used much of the knowledge acquired from Service-oriented architecture, SOA, for managing the cloud. Thereupon they present a draft of an overview of a governance model to be used on the adoption of cloud-based services and migration services to the cloud. This model is based on requirements that highlight the need for policies and management processes, management life-cycle services, visibility and contextualization. Hao et al. in [15] also advocates the importance of SOA to support the paradigm of cloud computing. They present a framework to facilitate service migration and design a cost analysis model to determine the advantages and disadvantages in selecting services migration.

Furthermore, [16] advocate the importance of the information obtained in the form of best practices and propose a framework with simplified modeling languages for alignment between business and IT.

3 Moving to Cloud, Frameworks

In this section, we discuss and analyze the frameworks available in the literature for cloud adoption. Besides the presentation of each of the frameworks are summarized the issues not covered by each one on the process of cloud adoption.

3.1 Strategic Perspective for Federal US Agencies

In February 2011, Vivek Kundra in [17], proposes a decision framework for cloud migration. The framework presents a strategic perspective, for federal US agencies, in terms of thinking about and planning for cloud migration.

The framework consists of three major migration steps: (i) Select, (ii) Provision and (iii) Manage. It outlines a methodology that can be used to determine the services that are ready for cloud computing today and what can be considered for later migration. The framework also shows how to choose, provision and then manage services in the cloud. Although this is a framework designed specifically for the migration of federal US agencies to the cloud-computing paradigm, its advices are applicable to all organizations.

This work presents a high level set of rules that the agencies should follow in order to migrate their IT services to cloud computing, but does not specifically point the actual steps to know the current institution IT state, in terms of IT infrastructure such as services, relationship between the various software applications and data, the hardware capacity needed, neither concretely the steps to migrate to cloud.

3.2 Six Steps Framework

In [18], the author, Adela Tušanová, argues that the migration to cloud computing is a complex process of decision-making, reason that motivated her to present a framework to facilitate the process of decision-making for cloud adoption.

The framework comprehends six steps:

1. Workload definition;
2. Workload suitability Analysis;
3. Definition of Alternatives;
4. TCO Calculation;
5. Definition of criteria;
6. Multi-criteria method application.

In the first step are defined the collections of IT components and the relationship among them. After that, they are classified in the three main types of cloud workload (SaaS, PaaS and IaaS). The purpose of the step "Workload suitability Analysis" is to ask IT manager a set of questions, which will help to evaluate suitability or unsuitability of particular workload for cloud computing. The "definition of alternatives" step is where the solutions of cloud computing where characterized by a set of criteria. The costs for each cloud service model are calculated on "TCO calculation" step.

In the fifth step, are defined the criteria that delineate which alternatives are to be considered. The last step, "Multi-criteria method application" is where the author suggests the application of the application of the Decision Matrix Method (DMM) for multi-criteria decision-making.

Despite grouping the IT components into the cloud categories, when moving to cloud the categories could not be the same, for instance if the institution replace an existing application with a SaaS solution. Moreover is not pointed any structured way to gather this information. The workload suitability analysis may be influenced by the definition of alternatives, a subsequent step; however there is no life-cycle notion between any of the steps of the framework.

As presented the solution cost is an important factor that affects the cloud computing adoption decision. Again there is a need to have a cycle since the cost can guide suitability analysis.

3.3 Cloud Adoption Toolkit

In [19] the authors, Ali Khajeh-Hosseini et al., describe the challenges that a decision maker face when assessing the feasibility of the adoption of cloud computing in their organizations, and presents a Cloud Adoption Toolkit, which has been developed to support this process.

The framework starts by support the decision makers in determining if cloud computing is the most appropriate technology to support the system proposed, continues with the step accountable by supporting the decision makers in obtaining accurate estimate costs and energy consumption. At the same time, assess the organizational fit to the cloud paradigm in terms of "practicalities, social factors and political factors". After these two steps in parallel follows the operational feasibility step by verifying the workable set of responsibilities and by determining the socio-political acceptability of strategic dependencies between organizations and departments. The framework ends with the requirements and implementation phase.

This toolkit is an attempt to establish a framework to organize thinking about the problems placed to the decision makers during the adoption of cloud computing in the enterprise. It provides a set of tools to address the concerns of decision makers, allowing them to focus on shaping the different attributes of the organization or IT systems. The toolkit covers Cost Modelling and Service pricing. However, this framework doesn’t cover risk analysis, responsibilities, availability, capacity and provider selection.

3.4 Ezzat et al., Work

In [20] Ezzat et al., propose a framework targeting to help decision makers in cloud computing adoption decision making depending on their own business case and predefined factors. They view the cloud adoption under three perspectives, the business, the technical and the economic. The Business perspective is studied in terms of business requirements description in order to describe the organization as a whole and the Technical perspective which aim is on the technical application itself. The Economical perspective deals with a precise cost analysis for the needed application/service to define whether it is better to adopt the cloud or remain with on premise capabilities.

The framework consists of three main layers. The first is the integration between business, technical and economical perspectives as all hold the same level of importance. In the second layer are the basic factors that are considered under each perspective. The third and final layer is a supplementary decomposition of sub-factors within each basic factor for assessment and evaluation.

Besides the work developed and the new ideas presented this framework does not seem to present a formal process to support customers on the task migrating to the cloud.

3.5 Hackystat

In [21] the author's, Muhammad Aufeef Chauhan and Muhammad Ali Babar summarize their practical experience reporting the information gathered when they have migrated an Open Source Software framework, Hackystat, to cloud computing. They assert that the following steps should be included as a process support for migrating software systems to cloud computing.

1. Evaluation of components for scalability
2. Evaluation for Orchestration
3. Identification of the components for refactoring
4. Evaluation of the solution against the target cloud environment

This work present a summary of a practical experience of migrating an open source software application to the cloud computing. Besides presenting various steps that have been taken to migrate the Hackystat application to the cloud computing it does not present a formal framework for migrating services to cloud.

3.6 Cloudstep

Patricia V. Beserra et al., in [22] present Cloudstep, a step-by-step decision process aimed at supporting legacy application migration to the cloud. The process was demonstrated with the migration of a commercial medical application to cloud computing.

The Cloudstep process is centered on the guided identification and analysis of relevant factors that might influence the cloud selection and migration task.

The framework comprehends the following steps:

1. Define organization profile;
2. Evaluate organizational constrains;
3. Define application profile & define cloud provider profile;
4. Evaluate technical, financial constrains;
5. Define migration strategy;
6. Perform migration.

In short, the Cloudstep starts by determine the key characteristics of the application that is to be moved to cloud computing and few potential cloud providers to make a profile. Afterwards, this profile is analyzed with the purpose of discover constraints that prevent the company to migrate to the cloud. After analyzing the profile, the discovered constraints can be solved if possible and the institution can adopt a cloud solution that suits the best company needs. There are nine activities that compose the whole Cloudstep decision process.

The decision process developed new ideas and takes care of the decision process for supporting the migration of legacy applications to cloud computing. However, we do not find any processes related to data and services, impact of this change on the institution, SLAs management, for example.

3.7 CloudMIG

The migration to cloud computing approach followed by Frey et al. [23], CloudMIG, aims at supporting SaaS providers in the comparison and planning phases to migrate enterprise software systems to PaaS or IaaS based clouds. This model encompasses six steps, namely: A1 – Extraction (this step comprehends the extraction of architectural and utilization models of the legacy software systems); A2 – Selection (In this step (that can be performed in parallel with step 1), an appropriate cloud profile candidate is chosen. The criteria for the decision can be the preference of renowned cloud provider, defined cost structure or a feature that has to be supported.); A3 – Generation (The generation activity produces the target architecture and a mapping model. In addition, are detected the constraint violations (a violation describes the breaking of a limitation of a specific cloud provider, for instance)); A4 – Adaptation (In this step, a reengineer could manually adjust some aspects of the generated target architecture.); A5 – Evaluation (The evaluation activity involves static analyses and a runtime simulation of the target architecture.); and A6 – Transformation (The actual manual migration toward the target architecture.).

Besides the work developed and the interesting concepts and the new ideas presented this framework does not seem to present profiling and a categorization of the applications.

3.8 Banerjee Work

Banerjee in [24] addresses the migration to cloud computing of enterprise level workloads without re-architecting or re-engineering the existing applications. To achieve this goal, the author presents the five themes in the context of the five steps of moving workload to cloud computing.

In the Initial screening and analysis step the aim is to gather key data on existing workloads, applications and their dependencies, analyzing these data and determining probable migration candidates. The next step, Planning and design, takes care of the logical design of the applications in cloud.

The Implementing the Migration step follows. It is in this step that the workloads are moved to the cloud platform using the most appropriate technique. Once in the cloud, the instances have to go through an adjustment stage, which is done in the Tuning the target step. A final step, Final testing and go-live, is where is confirmed that the migrated workloads are performing as expected and the cloud become the production environment.

Besides the work developed and the new ideas presented this framework does not seem to emphasize the importance and the role of business in migrating to cloud computing. Also it starts an information collection process without first being prepared a strategic plan. The framework is a high level framework, however has little details about the tasks to be performed.

3.9 IVI Cloud Computing Life Cycle

The Innovation Value Institute (IVI) National University of Ireland Maynooth consortium (a consortium of leading organizations from industry, the not-for-profit sector, and academia), to address the issues involved in cloud computing migration developed and tested a life cycle for systematically managing cloud migration projects, the IVI Cloud Computing Life Cycle [25]. The cloud life cycle comprises four phases, further divided into nine steps.

The first phase "Architect" is further divided into the steps “Investigate”, “Identify”,” Implementation strategy” and “Business Design”. In this phase it is started the investigation and the planning of the cloud project.

The second phase, engage, encompasses the select and negotiates steps. It is in this phase that the cloud provider is selected. Hereafter is phase 3, operate. This phase is divided into the operational roll-out and in the Manage the supply chain steps. In this phase the services are implemented and managed the day-to-day of the cloud services. The last phase, Refresh, comprehends the Review step; it is where an ongoing review of cloud services takes place.

Besides the very good work developed and the new ideas presented this framework does not seem to present the view from the cloud provider.

3.10 Cloud Decision Support System

Mithani et al. [26] identify the need to validate the business applications and workloads in terms of technical portability and business requirements/compliance so that they can be deployed into a public cloud without considerable customization.

In this work, the authors present an approach, Cloud Decision Support System (CDSS), that helps the stakeholders in the process of moving to the cloud computing namely to automate the process of identifying business workloads that that should be moved to a public cloud without re-architecting the applications or changing their business logic as understanding its cost benefits.

3.11 Windows Application to the Windows Azure

Paulo Jorge and António Miguel in their paper [27] presents the steps to migrate a traditional windows application to the Windows Azure world. With their study and through a small case study they have concluded that the application performance does not deteriorate when migrating to the cloud. However, they finish by stating that the migration to cloud computing will be primarily accomplished for non-critical business applications, protecting in this way the core applications of the institution from errors and security faults while the organization gains experience with cloud usage.

4 Conclusions and Future Work

One of the main challenges facing the adoption of cloud computing is the migration of existing or new IT infrastructures and services to the cloud. The migration of services to cloud computing includes several activities and issues that must be resolved. In the previous sections of this work we presented a study of various frameworks for cloud computing adoption found in the academic literature.

Notwithstanding each of the studied frameworks purpose a solution to migrate IT to cloud computing, none of them points a way to enforce that the actions developed to complete each process (that make up the framework) are managed, done appropriately and in an organized way. On the other side and since each institution have its own details, is not suitable define a model of actions and apply the same to all.

The ITIL could support this issues and the moving to cloud computing. Indeed ITIL is not being prescriptive, meaning that its recommendations could be adapted to each institution. Additionally ITIL is a de-facto standard and is the most widely adopted approach for IT Service Management in the world with an acceptance of 28% [28]. Furthermore, facilitates the communication between service providers and customers, the two main actors of the migration to the cloud computing process, been useful to facilitate the understanding of customer needs from the service provider and allows him to provide the most appropriate services according to the needs identified by the customer. So it make sense to ponder the use of ITIL as a support for the moving of IT services, applications and data to the cloud computing.

To this end, the authors are already working in the development of a framework to move IT services, applications, data and infrastructures to cloud computing with the support of ITIL.

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Systematic Review Tool to Support the Establishment of a Literature Review

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Abstract. Systematic Reviews provide to researchers a protocol in order to obtain scientific knowledge through the identification of relevant scientific papers, which contain research tendencies and experimentation about a specific topic. There are several studies about how to implement a systematic review, however these studies only indicate the systematic review protocol and do not provide some software tool or application to support the automation of this protocol, giving as a result that the researchers expend large amounts of time to search and identify relevant scientific articles in a manual way. Therefore, in this article is proposed a tool for systematic reviews protocol automation.

Keywords: Systematic Review, Protocol, Tools.

1 Introduction

The first step to obtain scientific knowledge in order to delimitate a scientific research topic is to establish a literature review. In this context the systematic review in software engineering provides an effective means to identify and evaluate existing literature and investigations of a specific domain [1]. Several studies about systematic reviews and its application on Software Engineering have been made [1, 2, 5, 6]. These studies analyze the activities that are performed on a systematic review protocol and propose new steps or activities to implement it. However, although there are several studies for the establishment of the systematic review protocol, these only indicate the steps or activities in the systematic review protocol and do not provide some software tool or application to support the automation of this protocol. So far, only few tools have been identified such as: Mendeley [7], RefWorks [8], JabRef [9], EndNote [10]. These tools give support to the researcher mainly on making bibliographic citations, managing found studies and interaction with some digital libraries.

Therefore, the main objective of this paper is to present a software tool or application to allow the automation of the systematic review protocol. In order to decrease the time that the researchers expend in a manual way to search and identify

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relevant scientific articles. This paper is structured as follows: Section 2, presents phases and activities of systematic review protocol; Section 3, analyses tools in order to establish a comparative and to identify improvements to be included on the proposed tool; Section 4, presents the proposed tool for systematic reviews; Section 5 presents the case study in which the tool is applied, and finally; Section 6 presents conclusions and future work.

2 Systematic Review Protocol

According to Kitchenham's definition [2], the systematic review is a protocol that allows researcher to obtain relevant and quantifiable results, this support them to the identification, selection of evidences based on the research of a particular topic [1, 5].

There are many reasons to carry out a systematic review. The most common reasons are [2]:

- To identify any gaps in current research in order to suggest areas for further investigation.
- To provide a framework/background in order to appropriately position new research activities.

In order to establish the phases and its steps that the proposed tool should contain, it was necessary to perform an analysis from several authors about how to implement a systematic review. Pino [4] marks the activities that must be realized in order to carry out a systematic review. Kitchenham, Dyba [5] and Jorgensen [6] show the importance that acquires the practice of systematic reviews on software engineering and generally explain how to implement a systematic review, from where can be extracted the method to implement in the tool. An example of primary studies selection, and the importance of statistics is shown on the works realized by Jorgensen and Shepperd [6]. An approach of systematic reviews application and the steps to follow on Software Engineering is presented by Mian, Conte, Natali, Biolchini and Travassos [1], in where they establish the process of systematic reviews tailored for software engineering.

The performed research gives the main phases and the steps that these must integrate for a systematic review, which are:

- Review Planning: the first phase, in this stage the investigation is identified, objectives are established and the following activities performed:
  - Investigation name selection.
  - Search strings formulation.
  - Studies search sources selection and establishment of primary and secondary studies selection criteria.

- Perform the systematic review: in the second phase, these activities are executed:
  - Search execution.
  - Evaluate studies quality.
  - Review selected studies.
  - Extract information.
  - Document data extraction.
  - Extraction execution.
- Review Report: third and last phase that resumes and analyses the results using statistical methods, contemplated activities:
  - Statistical calculus.
  - Result presentation.

3 Tools Review

Once the protocol's phases and its activities are identified, a review about available tools on the Internet was performed. It was found that while there are tools that offer some kind of support, but these do not cover completely the systematic review protocol. The main tools found are:

- Mendeley [7]: It is a tool to develop bibliographic citations, manually added studies control and features a plug-in named web importer, which is used to add the functionality of the application's downloads to the distinct web navigators. However, searches are still made manually, resulting in large time consumption to researchers in the search of scientific papers.
- RefWorks [8]: It is an online pay application; it allows a test period of 30 free days. The tool works online as a manager of papers and reference, but manually, namely, the researcher must have the papers on their computer and import them to the application that works on a web platform. In others words, RefWorks serves to create bibliographic citations and to manage papers.
- JabRef [9]: It is an open source application that allows among other features, as the two previous tools, management of papers and bibliographic citations.
- EndNote [10]: It is a tool for managing of citations and publication, the interesting of the tool is that it allows over 5000 bibliographic citation styles.

After of tool review, it should be noted that the four applications allow the creation of a database of papers saved on the researchers' computer, also, support the search of an paper's data on Internet, but solely with in order to create bibliographic citations, and although they are of great utility, do not give the necessary support to realize a systematic review's protocol.

As a result of the tools review, Table 1 shows that the protocol of the systematic review identified steps are not included on the analyzed tools.

Table 1. Similar tools functions comparison

Tool / Elements	Mendeley	RefWorks	JabRef	EndNote
Bibliographic Citations	Yes	Yes	Yes	Yes
Internet Searches	Yes	Yes	Yes	Yes
Studies Management	Yes	Yes	Yes	Yes
Priority Assignation	No	No	No	No
Digital Libraries Search	Yes	Yes	No	Yes
Automatic Data Extraction	Yes	Yes	Yes	Yes
Template Elaboration	No	No	No	No
Analysis Charts Elaboration	No	No	No	No
Primary Studies Selection	**No**	**No**	**No**	**No**

As a result, it can be seen there is not any tool available that covers and automates the identified activities for the systematic review protocol. Therefore, these activities must be established as the main functionalities in the proposed tool.

4 Proposal of a Tool for Systematic Reviews

In this section are described the modules developed in the proposed tool. The tool is structured in modules of easy access to bring the researchers a friendly interface. The software's modules are shown on Figures 1 and 2, which are based on the phase and activities identified on section 2. The textbox in the Figures are describing in the next sections, for example the textbox 4.1.1 in Figure 1, is describing in the section 4.1.1 and so on.

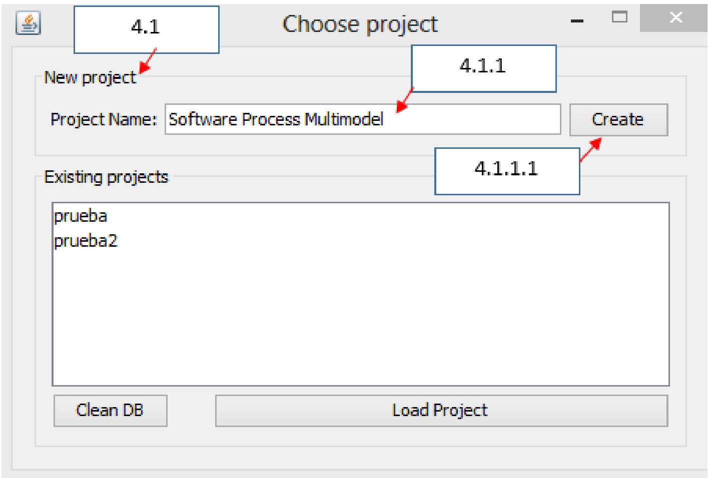

Fig. 1. Module of Review Planning Support

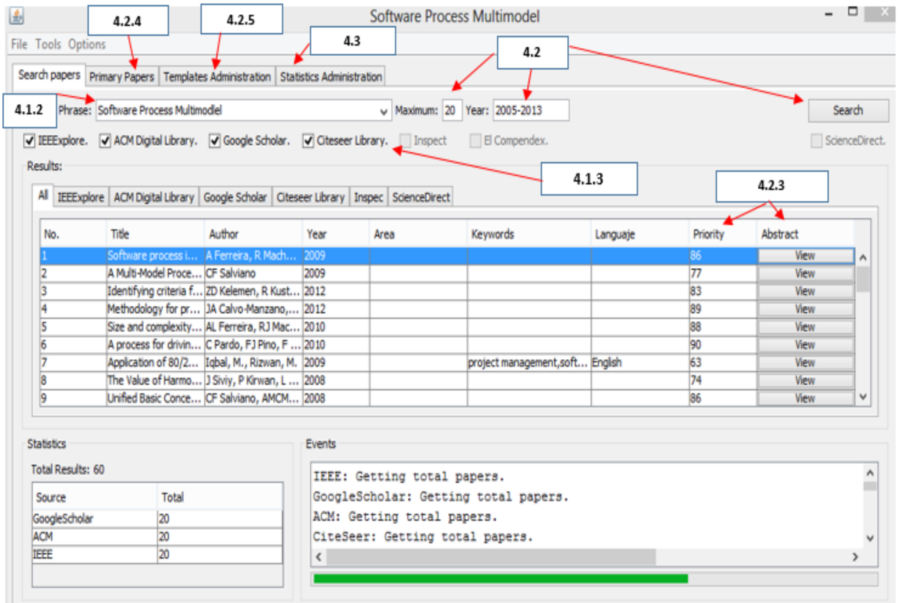

Fig. 2. Main Modules for Systematic Review Protocol Automation

4.1 Review Planning

The proposed tool covers this protocol's phase through the following modules (see Figure 1):

4.1.1 Research Name Selection

It establishes the environment to perform this **function through** the *new project* window, it allows creating a research project, and this activity is performed through the following module.

4.1.1.1 Project Creation

To create a new project it is assigned a name according to the topic of the research to be performed, this project is automatically added to the database. All the searches, studies, files, templates, statistics and downloads are stored in the database for its posterior use.

The main function of this module is to provide an efficient management on reviews and studies. This module allows creating to a folder structure to have papers, templates and statistics of each study, in order to enable an efficient control about the location of each element of the research.

4.1.2 Search Strings Formulation

The search motor implemented in the tool is based on criteria used by the main digital libraries; this activity is performed through the following module (see Figure 2).

4.1.2.1 Paper Search Module

It allows the researchers to type search strings made by them. The search strings can be established of the main topics of the research. Once the search strings is typed, the system converts them to the format of each search motor in the digital libraries to perform the extraction of studies for each source. The data by which papers can be searched are: a) Title, b) Research topic keywords, c) Topics linked with boolean operators AND, OR and NOT, d) Author, e) Synonyms and abbreviations.

4.1.3 Selection of Study Search Sources and Establishment of Criteria

The tool features a study search module which allows us to select digital libraries, this module is the following:

4.1.3.1 Digital Libraries

This module embedded on the search window allows selecting extraction from the following sources:

1) IEEEXplore, 2) ACM Digital Library, 3) Citeseer Library, 4) Inspect, 5) EICompendex, 6) ScienceDirect, 7) Scholar Google.

4.1.3.2 Study Selection Criteria and Study Selection Process

The system supports the study selection considering the following factors: a) Year of Publication, b) Authors experiences on the research topic c) Keywords incidence in article abstract.

4.2 Perform the Systematic Review

The tool allows automation of this second phase through a set of modules that perform the required functions (see Figure 2). These functions are described next:

4.2.1 Max Number of Studies to Search in Each Library

This option allows establishing a maximum number of studies that should be obtained in each library.

4.2.2 Search Execution

When the search string has been set, the tool has a button which starts the search in the selected sources. This button also allows stopping the search and initiates a new one with different parameters.

4.2.3 Quality and Review of Selected Studies

Studies evaluation is performed based on the priorization of primary studies. The modules that perform the activity related to study quality are:

4.2.3.1 Results

In this screen, the tool allows us to observe the results given from a search, the results are displayed:

- All: Shows all the results found.
- By Digital Library: Using tabs that show the results found in an specific library.

The fields for each paper that are showed in the libraries are: a) Title, b) Author, c) Year, d) Area, e) Keywords, f) Language, g) Priority, h) Abstract.

4.2.3.2 Studies Quality Evaluation

The system allows displaying the abstract of each document through the See Abstract button. The system also shows the paper priority. In this option the paper can be considered as primary or secondary in case it does not satisfy the review project expectations.

4.2.4 Information Extraction

The base module that performs the data extraction and synthesis functions is the primary articles management. This module is described next.

4.2.4.1 Primary Articles Management Module

The tool allows sorting and maintaining a registry of the project primary articles, the sorting can be done using the following criteria by: **a) assigned file, b) not assigned file and, c) template.**

Identifying an article as primary, this functionality allows two options: 1) Download the article automatically and, 2) Add the file manually.

4.2.5 Data Extraction Documents and Extraction Execution

The tool offers a template creation and management system; the templates are standardized to report the studies information. The following aspects are used to make a template:

- A template can contain the information of one or more documents.
- The template fields are tailored, i.e., the researcher can define their own fields.
- The template management system allows the researcher to create, modify and delete templates.
- The template management system allows the visualization, modification, deletion and exporting of the articles that conform a template.

4.3 Review Reporting

For this third phase, the tool allows the elaboration of reports based on the templates together with the analysis module that enables to generate statistic charts (see Figure 2). The objective is to provide researchers a system that enable them the analysis of the studies they selected and to obtain results based on the templates they created. To add a chart, the first step is to select the template from which the criteria is going to be evaluated, by default the general option is selected and all the existing templates are converted to charts. It is also possible to select only one template, automatically the general template fields are shown, although it is also possible to select manually the custom criteria of the template. The chart visualization is done on the same module through the See option. For documentation control it can be also exported to a docx document, as the same as with the template reports.

4.3.1 Bibliographic Reference System

The system counts with a bibliographic citation add module. The citations are included in the report templates or if it is required the citations can be exported from the Tools menu to export them in several formats, among others:

- IEEE
- AMERICAN MEDICAL ASOCIATION (AMA).
- Harvard Reference format 1 (author-date).
- Nature.
- American Sociological Association.

5 Case Study

Currently the tool is applied to perform systematic reviews in the research of the literature review of four thesis master degree at the Centro de Investigación en Matemáticas CIMAT Unidad Zacatecas. It is expected to obtain a vision of the system behavior. Until the now, search strings are being introduced into the tool to obtain files from the diverse sources. With this proposed tool, a number of studies, studies' data and files, and an assigned priority according the tool criteria are obtained.

In contrast to check its effectiveness, the same string is searched on every one of the digital libraries in which the studies are found, on the Internet, and it has been noted the tool effectiveness since the same studies are identified and with similar priority indicating that the applied criteria are correct in a high percentage. The Figure 3 shows the papers obtained with search string "Software Process Improvement".

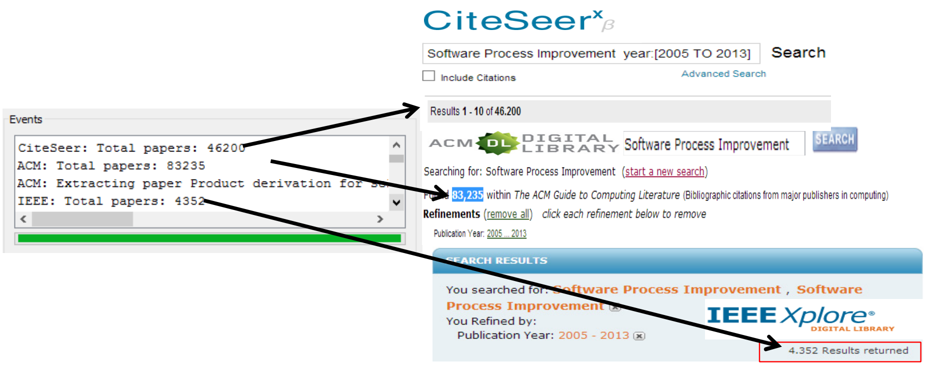

Fig. 3. Comparative among Systematic Review Tool and web library (CiteSeer, ACM, IEEE)

As can be seen in Figure 3, the papers obtained in each library (CiteSeer, ACM, IEEE) are similar to the papers obtained in the Systematic Review Tool.

Moreover, the proposed model allows us to identify which studies has priority high or are relevant to the researcher's interest and must be identified as primary studies in their research (See Figure 4).

This priority is calculated on three criteria: publication date, authors' experience on the area (number of publications within the same area), and the frequency of search string keywords on the paper abstract:

Publication Date: The tool allows you to set the date range in search of papers. Once the date is established, the proposed tool gives higher priority to papers published in recent years. If the paper is more recent a higher priority is given (values from 50 to 100), value of 50 when the paper is 10 or more years old its publication and when the paper is published in the actual year is assigned a value of 100.

$$\boldsymbol{pubDateCriteria} = \left(\frac{cDate - aDate}{maxYears}\right)$$

where:
pubDateCriteria: is the calculated value of the date criteria for the paper
cDate: is the current year
aDate: is the study year of publication
maxYears: is a customizable parameter used to give more or less weigh to papers antiquity

Authors' Experience: Once the date range is established for the search in the proposed tool, the tool analyzes the number of published papers by the author. This analysis is performed within the list obtained from the search in the tool. For each author a rating from 0 to 100 is calculated. The rating 0 is assigned to the author when the author has no more than one paper and when the author appears on 3 papers or more is given a rating of 100. Then, the final rating for each author is assigned, taking into consideration the average among the ratings assigned.

$$pubAuthorCriteria = \frac{\frac{\sum_{n=1}^{nA} numberOfPublications(Author_n)}{nA}}{requiredPublications}$$

where:
pubAutorCriteria: is the calculated value of the authors criteria for the paper
Author: is the set of authors of the paper
nA: is the number of authors of the paper
numberOfPublications: is the number of papers that a certain author has published
requiredPublications: is a customizable parameter used to give more or less weight to papers with experienced authors

Frequency of Search String Keywords on the Paper Abstract: The proposed tool automatically counts how many times the keywords that makes up the search string appear in the abstract. A score for keyword is calculated from 0 to 100. 0 is assigned if the keywords not appear in the abstract, and 100 when keywords appear equal to or greater than 5% in the abstract. Then, each assigned scores are averaged in order to obtain the final rating.

$$\boldsymbol{pubKeywordCriteria} = \frac{max\left(\frac{\sum_{n=1}^{nKW} frequency(Keyword_n,\ abstract)}{requiredFrequency}, 1\right)}{nKW}$$

where:

pubKeywordCriteria: is the calculated value of the keywords and abstract criteria for the paper.

Keyword: is the set of keywords used in the search string.

Abstract: is the abstract of the paper.

nKW: is the number of keywords contained in the search string.

frequency(word, text): is a function that counts how many times *word* appears on *text.*

requiredFrequency: is customizable parameter used to give more or less weight to articles' abstract/keyword relationship.

Max: is a function that returns the greatest value of the parameters it receives

Finally: Once the three formulas are calculated, the overall rating of the three formulas divided by 3 (number of obtained rating) is performed. As a result, the overall priority of each paper is obtained.

$$priority = \frac{pubDateCriteria + pubAuthorCriteria + pubKeyWordCriteria}{3}$$

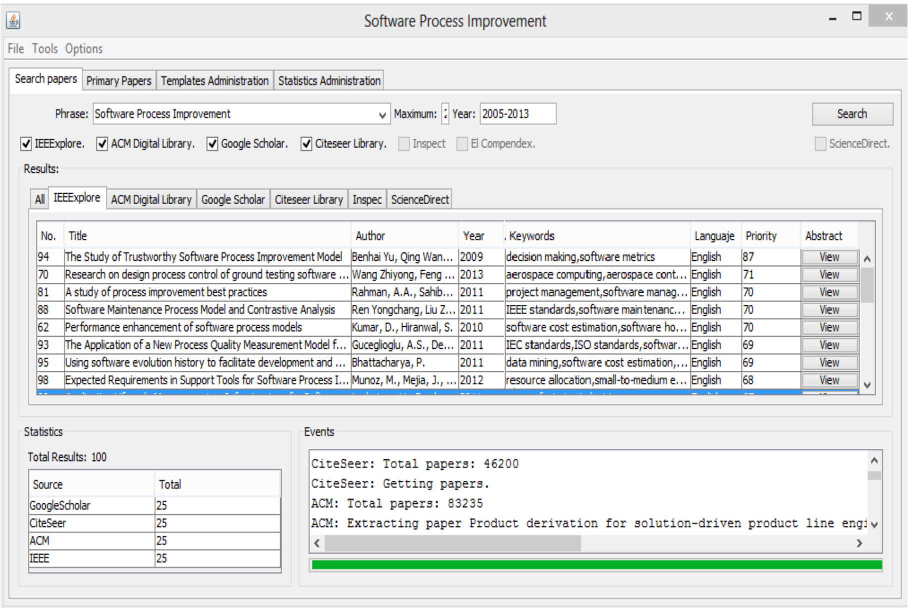

Fig. 4. Systematic Review Tool

Figure 4 shows an overall view of the Systematic Review tool. It can be seen in the Priority column (see Figure 4), the priority value assigned according to the formulas set forth above. This value shows the degree of relevance for each paper identified in the search through the proposed tool.

6 Conclusions and Future Works

Until now with the tests that have been performed, the use of the tool speeds up the realization of the systematic review protocol. The searches with the tool provide feasible results and accurate compared with the manual searches. The times that a systematic review consumes and the protocol application have been reduced over 70% compared to when it is done manually due to investigation search, downloads and monitoring automation. The tool offers an ideal support for the elaboration of reports. Some tools have been analyzed but none of them performs the functions of the proposed tool. Besides, the proposed tool allows identifying which studies has priority high or are relevant to the researcher.

The future work implies to test the proposed tool in more case studies to prove its effectiveness and to have a broader range of results of the tool's performance. Besides, it is now being developed a plug-in that allows integrating the tool to word processors to extend the use and functionality of the tool. Moreover, the option to enable the researcher to define their own criteria to indicate the priority of each selected papers is being studied.

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Descriptive Lightweight Learning Organization Ontology

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Abstract. The learning organization provides a clear competitive advantage. However, the concept has conceptual and operational imprecision. This paper presents descriptive lightweight learning organization ontology in an attempt to create a shared understanding about the learning organization. The ontology identifies the core concepts and relations. Each concept and relation definitions are given and explained. The classes Entity and Level and the relations embeds_in and transcend_and_include are identified as central for the learning organization ontology.

Keywords: learning organization, lightweight ontology, descriptive ontology.

1 Introduction

Ontology is an explicit specification of a shared conceptualization [1]. Through ontology, explicit terms and definitions are given to the concepts and relationships of the abstract model [2]. Ontologies are useful because they explicate components that define a phenomenon and, thus, can help in systematically understanding or modeling that phenomenon [3]. This paper presents a general purpose lightweight learning organization ontology that can be used by practitioners and researchers.

According to The Boston Consulting Group [4,5], in this world, becoming a learning organization from top to bottom provides a clear competitive advantage and will become more important in the future. A learning organization is an organization that facilitates the learning of all its members and consciously transforms itself and its context [6]. It is an organization skilled at creating, acquiring, interpreting, transferring, and retaining knowledge, and at purposefully modifying its behavior to reflect new knowledge and insights [7].

Despite the extensive debate about the value of learning organizations (LO) in order to be competitive and about the presentation of its positive sides, the issue of lack of quality concept for the LO has also been raised [7–10]. The presence of conceptual and operational imprecision contributes to the way a learning organization is perceived [10]. Furthermore, ill-defined concepts can have a negative impact on certain propositions and misguide the efforts of researchers and practitioners using them [11].

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This undermines the opportunity for development of learning organization models, tools, and information systems that will support learning in the organizations.

This paper presents an attempt to respond to critics by constructing and outlining a lightweight ontology of the learning organization based on extensive literature review. This ontology is an additional step in the process of clarifying the concept of learning organization. In addition, it should enable a solid base for a discussion between businessmen and information systems developers in their pursuit of development of frameworks, tools, and systems that will support learning in the organization. In the first part of the paper, the lightweight ontology theory and the reasons for using it for developing learning organization ontology are presented. Then the literature review process applied for creating the context for ontology development is given. The next section presents the lightweight learning organization ontology. Implications of the ontology for research and practice are subsequently discussed.

2 Lightweight Ontology

The purpose of the learning organization ontology is to facilitate the communication between the people that work on development of the learning organization models, frameworks, tools, and systems by creating a shared understanding, The idea is to provide one set of defined terms and relations that will accurately cover the concept of the learning organization. Thus, our current goal is to create a so-called lightweight ontology [12]. Lightweight ontologies typically consist of a hierarchy of concepts and a set of relations holding between those concepts [13]. However, based on their usage, there are two main types of lightweight ontologies: descriptive and classification lightweight ontologies [14]. Descriptive lightweight ontologies are primarily used for defining the meaning of terms as well as the nature and structure of a domain [15] to capture the more commonsensical and social notions based on natural language usage and human cognition [16]. Thus, in descriptive ontologies, concepts represent real world entities (e.g., the extension of the concept animal is the set of real world animals) [17]. The focus of this paper is the development of descriptive lightweight ontology for the learning organization concept.

Based on the proposal of [18], the learning organization lightweight ontology should minimize the difficulty for users of adapting to the ontology. Furthermore, it can be used as a base on which later on, a classification lightweight ontology can be created [14] and be used for the development of heavyweight ontology [13]. In this way several points where the ontology can be evaluated and improved are introduced. As a result the ontology on the next level of complexity is based on ontologies with better quality.

3 Research Methodology

The ontologies are inseparable from the context of the community in which they are created and used. Developing the ontology from its context can have only benefits to bring in terms of more meaningful and easily maintainable conceptual structures [18]. In this paper, the context is identified through in-depth literature review.

The literature used in this paper was identified and selected through a two-level process. First, a pool of articles was created through a broad search in several online databases (ProQuest, Sage, Springer link, Jstor and Science Direct) by using the keywords: Learning organization concept, Learning organization definition, and Learning organization characteristics. The results in each database were sorted by relevance and a sample size of 1037 items was identified. All the duplicates, book reviews, editorials, posters, and non-English papers were eliminated. As a result, a population of 623 articles was created. By using a confidence level of 95% and confidence interval of 10, a sample size of 83 articles was sufficient. By using random numbers, the 83 articles were identified. Through the same procedure, from the journal "The Learning Organisation" devoted to LO issues, additional 54 papers were identified. All the articles in both samples were reviewed; definitions, characteristics, models, methods, and methodologies were identified. Then through second-level analysis, the original articles and books in which the identified definitions, characteristics, models, methods, and methodologies are mentioned for the first time were reviewed, and the original text was extracted and analyzed.

The literature survey resulted in identification of twenty nine definitions and large number of characteristics of the LO. The identified characteristics were grouped in eleven facets of the learning organization: learning, strategy, vision, culture, power, politics, structure, technology, processes, leadership, and change.

Then a pattern oriented modeling was applied [19]. POM aims to "decode" the internal information about the system that the patterns contain [20]. The patterns provide the defining characteristics of the concept and indicators of the essential underlying processes and structures. In total more than twenty patterns were identified and graphically presented through UML diagrams. These patterns were then used to develop the descriptive lightweight learning organization ontology.

4 Descriptive Lightweight Learning Organization Ontology

The descriptive lightweight learning organization ontology contains classes and relations between these classes. They are presented in terms of definitions. Definitions form the ontology's backbone, defining its conceptual structure. The following convention is applied: The name starts with D and then letter C for classes or R for relations is added, followed by a number. The definitions are numbered as they appear. In the definitions, the relations are displayed in bold face and not capitalized ("**embeds_in**"). The classes are capitalized and italicized ("*Entity*"). After the definitions, examples are presented.

We begin our ontology by taking the **part_of** relation as a primitive relation and use it to define the **embeds_in** relation.

DR1: *Entity X* **embeds_in** *Entity Z* if *Entity X* is **part_of** *Entity Z.*

DC1: *Entity* is a particular autonomous unit.

In the learning organization, three main entities are identified: individual, team, and organization [21]. They are subclasses of the class *Entity*.

DC1-1: *Individual* is a human being.

DC1-2: *Team* is a form of collection of individuals who work on a common issue.

DC1-3: *Organization* is an organized form of individuals with a particular purpose.

Other entities in the learning organization can also be identified such as dyads, departments, and strategic business units. The learning organization should also be aware of its external environment [22]. Thus, the environment is also an *Entity*.

DR2: *Entity Z* **embeds_in_sum** if *Entity X* **embeds_in** *Entity Z* and *Entity Z* **embeds_in** *Entity Y* then *Entity Z* **embeds_in** *Entity Y*.

Through the **embeds_in_sum**, the *Level* is introduced.

DC2: *Level* is a position on an artificially determined hierarchy.

The *Level* can be *Ecological* or *Developmental*.

DC2-1: *Ecological level* is a position on an artificially determined hierarchy of entities.

For *Entity*, the *Ecological levels* are individual, team, organization, direct environment (competitors, suppliers, governmental institutions), and general environment (culture, politics, social aspects).

DC2-2: *Developmental level* is a position on an artificially determined hierarchy of states.

For example, Argyrils [23] identifies three types of learning: single-loop, double-loop, and deutero-learning. Senge [24], on the other hand, identifies two levels of learning: adaptive and generative.

DC3: *State* is a particular condition that someone or something is at a specific time. The *State* can be *Actual* or *Potential*.

DC3-1: *Actual state* is a state that exists in the moment.

DC3-2: *Potential state* is a state that could exist in the future.

For example, in a learning organization, the individuals and teams should be empowered [20], that is, to be in an empowered state. In addition, the structure should be organic, that is, to be in an organic state [25].

The *Level* of the *Entity* is determined by the relation **positioned_at**.

DR3-1: *Entity X* is **positioned_at** *Ecological level X* if *Entity X* has the characteristics determined for *Ecological level X*.

DR3-2: *Entity X* is **positioned_at** *Developmental level X* if *Entity X* has the characteristics determined for *Developmental level X*.

DR4-1: *Entity Z* **transcend_and_include** *Entity X* if *Entity X* **embeds_in** *Entity Z*; and if *Entity Z* is **positioned_at** the next level of defined ecological hierarchy; and if *Entity Z* has the characteristics of *Entity X* and it also has its own characteristics.

This means that each individual brings its own characteristics in the organization; however, the organization adds its own characteristics. This requires having a multi-level integral look on the entities.

DR4-2: *Level Z* **transcend_and_include** *Level X* if *Level X* **embeds_in** *Level Z*; and if *Level Z* is **positioned_at** the next level of defined developmental hierarchy; and if *Level Z* has the characteristics of *Level X* and it also has its own characteristics.

This means that in order to practice double-loop learning, one also needs to practice single-loop learning.

DR5-1: *Entity Z* **transcend_and_include_sum** *Entity X* and *Entity Y* if *Entity Y* **transcend_and_include** *Entity X* and *Entity Z* **transcend_and_include** *Entity Y.*

DR5-2: *Level Z* **transcend_and_include_sum** *Level X* and *Level Y* if *Level Y* **transcend_and_include** *Level X* and *Level Z* **transcend_and_include** *Level Y.*

Through this relation, we deduce that each entity or level on subsequent level is more complex. As a result, due to this complexity, it is harder to achieve higher levels.

DR6: *Entity X* is **aligned_to** *Entity Y* if *Entity X* is **positioned_at** *Developmental level* as *Entity Y* and if both, *Entity X* and *Entity Y*, are **positioned_at** the same developmental hierarchy.

DR7: *Entity X* can be a **player_of** multiple *Roles* at the same time. *Entity X* can be a **player_of** *Role X* if it is **positioned_at** *Developmental level X* or higher and if it has a group of *Assets X* **positioned_at** *Developmental level X* or higher.

DC4: *Role* is the way an entity participates in an activity [26]. The entity can take different roles like learning role, teacher role, leadership role, follower role, power role, information management role, etc.

DC5: *Asset* is a resource that can create value. Two subclasses of assets are identified.

DC5-1: *Physical asset* is a tangible physical thing. The computers, buildings, cars that the entities have are examples of physical assets.

DC5-2: *Abstract asset* is a thought, an idea that does not have physical existence. In the ontology, we introduce the abstract assets to acknowledge the existence of individual mental ideas, concepts, and models; and the existence of mental ideas, concepts, and models that are the results of interactions between individuals.

DR8: *Entity X* **manages_an** *Activity X* by being a **player_of** a *Role X*. *Entity X* should **manage_an** *Activity X* by being a **player_of** a *Role X* if *Activity X* is **positioned_at** the same or lower *Developmental level* of *Role X* and *Entity X*, and where *Role X* is **positioned_at** the same or lower *Developmental level* from *Entity X*.

DC6: *Activity* is a state of being active. The activities can be *Formal (visible) activity* and *Tacit activity*.

DC6-1: *Formal (visible) activity* is anything that involves actual doing, in particular, including action [26]. On the other hand the

DC6-2: *Tacit activity* is anything that involves mental doing that actually or potentially precedes or follows the formal activity.

This division of formal and tacit activities is important because it acknowledges the presence of mental activities that are not always clear and visible, but do exist. They are the base for the tacit knowledge [27].

DR9: An Activity **can_result_in** a *State* **positioned_at** the same lower or higher *Developmental level*. *Activity X* **can_result_in** the same *State X* if *Activity X* and *State X* are **positioned_at** the same *Developmental level X*. *Activity X* **can_result**_in higher *State Y* if *Activity X* is **positioned_at** *Developmental level Y*. *Activity X* **can_result_in** a lower *State W* if *Activity X* is **positioned_at** *Developmental level W*.

DR10: Each *Activity* is **triggered_by** an *Event*. An *Activity* is **triggered_by** an *Event* if the *Activity* start is related to the *Event*.

DC7: *Event* is an actual or potential occurrence.

DC7-1: *Internal event* is an event occurring within an *Entity*.

DC7-2: *External event* is an event occurring outside the *Entity*.

For example, an external event can be the introduction of a new product by the competition.

5 Discussion and Conclusion

In this paper, descriptive lightweight learning organization ontology is proposed. The ontology includes classes and relations through which the concept of the learning organization can be clarified. For each class and relation, a definition is given.

Although the ontology is descriptive lightweight, it fulfills the following:

- It provides the basic concepts through which a learning organization model can be developed.
- It identifies the *Entity* and the *Levels* as central classes because they are related to all the other classes. In addition, the values that these classes have influence the starting positions for the development of the learning organization.
- It identifies the relations **embeds_in** and **transcend_and_include** as important relations through which the learning organization is unique as a concept. These relations ensure that the systems approach is present in the development of the learning organization.
- It helps everybody involved in the development of a learning organization so as to be aware how the different classes of an organization are aligned through the relation **aligned_to**.

The next steps are first, the ontology to be evaluated by other experts, then the ontology to be implemented, and finally, to proceed to the development of heavyweight ontology.

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An Approach to Stigmergy Issues Based on the Recursive Application of Binary Neighbouring Rules

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Abstract. In this paper we define a set of binary neighbouring rules that can model the elementary action performed by an agent on its environment. The recursive application of the rules provide time sequences (behavioural patterns) which have the capability to model cues since they mimic both the interpretation of the message by an agent and its following behaviour triggered by the interpreted message. The structural analysis of the cues provides the key for the generation of social communication and provides a means to mimic a stigmergy structure.

Keywords: binary neighbouring rules, recursive application, behavioural patterns, cues, stigmergy, social communication.

1 Introduction

The study of complex systems represents a new approach to science that investigates how relationships between parts give rise to the collective behaviours of a system and how the system interacts and forms relationships with its environment [1]. Such systems are used to model processes in computer science [2], biology [3] economics, physics [4], chemistry and many other fields. In complex systems the communication between the entities can be indirect and distributed as referred by well-known works that provide interesting results [5-7]. The individual parts of a system, such as living cells in multicellular body, social insects in a colony, people in societies, or computers in the Internet, communicate with one another indirectly by modifying their shared local environment. These agents deposit cues in external structures (pheromones, connective tissue, termite mounds, or databases) that are used by other agents to modify the local environment [8]. The principle, called stigmergy [9] is that the trace left in the environment by an action triggers the performance of a next action, by the same or a different agent. In that way, subsequent actions tend to reinforce and build on each other, leading to the spontaneous emergence of coherent, apparently intelligent patterns without need for any control or direct communication between agents. Stigmergy supports efficient collaboration between extremely simple agents, who lack any memory or intelligence [10]. The communication with cues provides information embedded in the stigmergy structure that can be read and

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written again many times. In addition to the intrinsic information cues also provide information inherent to their location in the stigmergy structure. So, cues have both message and location meaning. Under the scope of computational modelling Wolfram [11-14] presents an empirical study of very simple computational systems and argues that these types of systems, rather than traditional mathematics, are needed to model and understand complexity in nature. Concretely the behaviour of the systems is depicted in a visual way by a lattice where a black cell interacts with its neighbouring white cells. The rules of interaction are very simple and apply step by step on a growing cell neighbourhood. The results are different patterns, some of them are famous namely Pascal's triangle. Wolfram's conclusion is that the universe is digital in its nature, and runs on fundamental laws which can be described as simple programs.

In this paper we define a set of neighbouring binary rules that can model the elementary action performed by an agent on its environment. The recursive application of the rule provides time sequences (behavioural patterns) which have the capability to model cues since they mimic both the interpretation of the message by an agent and its following behaviour triggered by the interpreted message. The analysis of the cues provides the key for the generation of social communication and so is able to mimic a stigmergy structure.

Following the introduction, Section 2 defines a set of neighbouring binary rules and then applies them recursively in order to generate behavioural patterns. Section 3 is devoted to explain why this process is a suitable model for the cues in a stigmergy structure. The stigmergy structure is presented by a lattice filled by an input sequence which means the information provided by the environment that is read and interpreted. The output sequence (pattern) is the interpretation of the environment by a particular agent. The patterns are outlined and characterized since they suggest a social communication framework. Section 4 summarizes and presents some concluding remarks.

2 Neighbouring Rules and Recursive Application

Equation (1) defines neighbouring binary rules $\otimes$ as follows:

$$\begin{aligned} &\otimes : (0,1) \to (0,1) \\ &(a,b) \to c = \otimes(a,b) = a \otimes b \end{aligned} \tag{1}$$

The rule is particularized by a two input table so, 16= 2^4 different rules (tables) can be defined, see Fig.1: m stands for the index of the table which is the four bit value stored in the cells, m = $a_3\, a_2\, a_1\, a_0$, $i \in [0, 3]$ and $a_i \in (0, 1)$; $m \in [0, 2^4\text{-}1]$,

$\otimes$	**0**	**1**
0	a_3	a_2
1	a_1	a_0

Fig. 1. Generic neighbouring rule represented by a table

Without loss of generality we set the row operand is the left one and the column operand is the right one in a one dimensional space. For example: $\otimes$ (0, 1) = 0 $\otimes$ 1 = a_2 (0 "acts" on 1).

The recursive application of rule $\otimes$ generates a pattern f_m as shown in equation (2), p stands for the sequence length (in bits).

$$\begin{aligned} &\otimes (0,1)^p \to (0,1)^p \\ &(x_{p-1}......x_1x_0) \to f_m(x_{p-1}......x_1x_0) = ((x_{p-1} \otimes x_{p-2})........(x_2 \otimes x_1)(x_1 \otimes x_0)x_0) \end{aligned} \tag{2}$$

As an example:
for $m = 7$, f_7 is defined by a table where: $a_3 = 0$, $a_2 = 1$, $a_1 = 1$, $a_0 = 1$,
so, for p = 4, if $(x_3\, x_2\, x_1\, x_0) = (1101)$, we have $f_7\,(x_3\, x_2\, x_1\, x_0) = f_7\,(1101) = 1111$.

We now explore the pattern f_m when p varies by mapping a set of input sequences. The left lattices represent the input sequences. For p=2, we have four possible input sequences of two elements: 00, 01, 10 and 11 (four initial rows). For p=3, we have eight possible input sequences of three elements: 000, 001, 010, 011, 100, 101, 110 and 111 (eight initial sequences) and so on (it becomes quite easier to organize all the possible input sequences as if they were decimal values 0, 1, 2, 3 etc…). The right lattices represent the output sequences f_m after applying recursively the rule $\otimes$ on the input sequences. The corresponding input-output pair is on the same row.

As an example, *f0* is shown in Fig.2. for p=2, 3 and 4.

The same can be done for the rest of the patterns. The instructions to interpret the patterns are:

1. The recursive application of rule $\otimes$ preserves the sequence length. The dotted underlined values outline the changes that occur after applying $\otimes$. The cursive values stand for the changes that occur after applying $\otimes$ when the length of the input sequence is doubled because p increments one unit.
2. The seed value (LSB) never changes
3. "Set" means put to "1"
4. "Reset" means put to "0"
5. "Swing" means change from "0" to "1", or from "1" to "0"
6. The last value is the (MSB)
7. The complemented last value is (MSB)'

Input sequence **Output sequence**

f0

						0	**0**
						0	**1**
						1	**0**
						1	**1**
					1	0	**0**
					1	0	**1**
					1	1	**0**
					1	1	**1**
				1	0	0	**0**
				1	0	0	**1**
				1	0	1	**0**
				1	0	1	**1**
				1	1	0	**0**
				1	1	0	**1**
				1	1	1	**0**
				1	1	1	**1**

				0	*0*	0	**0**	**p=2**	**p=3**	**p=4**
				0	*0*	0	**1**			
				0	*0*	$\underline{\mathbf{0}}$	**0**			
				0	*0*	$\underline{\mathbf{0}}$	**1**			
				0	$\underline{\mathbf{0}}$	0	**0**			
				0	$\underline{\mathbf{0}}$	0	**1**			
				0	$\underline{\mathbf{0}}$	$\underline{\mathbf{0}}$	**0**			
				0	$\underline{\mathbf{0}}$	$\underline{\mathbf{0}}$	**1**			
				$\underline{\mathbf{0}}$	0	0	**0**			
				$\underline{\mathbf{0}}$	0	0	**1**			
				$\underline{\mathbf{0}}$	0	0	**0**			
				$\underline{\mathbf{0}}$	0	0	**1**			
				$\underline{\mathbf{0}}$	$\underline{\mathbf{0}}$	0	**0**			
				$\underline{\mathbf{0}}$	$\underline{\mathbf{0}}$	0	**1**			
				$\underline{\mathbf{0}}$	$\underline{\mathbf{0}}$	$\underline{\mathbf{0}}$	**0**			
				$\underline{\mathbf{0}}$	$\underline{\mathbf{0}}$	$\underline{\mathbf{0}}$	**1**			

Fig. 2. The pattern *f0* for p=2, 3 and 4

Following the instructions, the behavioral pattern are interpreted as follows

f0: general reset.

f3: forward reset.

f15: general set.

f1: general reset, except when the input sequence is all composed of "1s" so, only forward reset is performed.

f5: forward set to the value of the LSB.

f2: when there are two consecutive "1" in the input sequence, the second is reset and then forward reset is performed.

f11: when there are two consecutive "0" in the input sequence, the second is set and then forward set to the (MSB)' is performed

f10: when there are two consecutive "1" (or "0") in the input sequence, the second is reset (or set) and then forward set to the (MSB)' is performed

f4: "0" resets the next bit and "1" swings the next bit.

f13: "0" swings the next bit and "1" sets the next bit

f8: "1" resets the next bit and "0" swings the next bit.
f14: "0" sets the next bit and "1" swings the next bit.

f6: "1" swings the next bit and "0" maintains unchanged the next bit.
f9: "0" swings the next bit and "1" maintains unchanged the next bit.
f7: "1" sets the next bit and "0" maintains unchanged the next bit.
f12: "0" sets the next bit and "1" resets the next bit.

3 Cues Modeling

The capability of the patterns to model cues is related to the emerging effects of the elementary actions previously depicted, since they mimic both the interpretation of the message by the agent as well as its following behavior triggered by the interpreted message. The input sequence stands for the information provided by the environment that means different things to different agents that read and interpret it. The output sequence is the interpretation of the environment by a particular agent, out of 16 (pattern *f*) (cue). When p= p+1, the environment information is read again and updated (this information can even have one more bit) and so, extended. So memory modifies behaviour and behaviour in turn modifies memory; that is a suitable approach for stigmergy. In addition to the intrinsic information embedded in the cues, which is read and updated many times, the model provides also information inherent in their location in the stigmergy structure. In algebraic terms, the elements "0" or "1" are just bit values but the important information comes from which position in the sequence they occupy. Our model for cues has both message content and location, so it seems to be suitable to model more complex social organizations.

We depict the different patterns (cues) in terms of social communication and summarize them in Table 1.

f0: any message is turned to "0".

f1: any message is turned to"0", except when the message is all composed of "1" so, only forward propagation of "0" is performed.

f3: forward propagation of "0".

f5: any message is turned to the value of the first elementary information (seed value).

f4: changes the messages "10" to "00"; "11" to "01"and "01" to "11" and then propagates forward the last elementary information (last bit in the sequence).

f6: changes the messages "01" to "11"; "11" to "01" and then propagates forward the last elementary information (last bit in the sequence).

f8: changes the messages "00" to "10"; "10" to "00" and "11" to "01"and then propagates forward the complement of the last elementary information (last bit in the sequence).

f9: changes the messages "00" to "10"; "10" to "00" and then propagates forward the complement of the last elementary information (last bit in the sequence).

f11: changes the message “00” to “10”; and then propagates forward the complement of the last elementary information (last bit in the sequence).

f10: changes the messages “11” to “01”; and “00” to “10” and then propagates forward the complement of the last elementary information (last bit in the sequence).

f2: changes the message “11” to “01”; and then propagates “0” forward.

f7: changes the message “01” to “11” and then propagates “1” forward.

f12: changes the messages “00” to “10”; “10” to “00”,“11” to “01”and “01” to “11”then propagates “1” forward.

f13: changes the messages “00” to “10”; “10” to “00” and “01” to “11” then propagates “1” forward.

f14: changes the messages “00” to “10”; “01” to “11” and “11” to “01” then propagates “1” forward.

f15: changes the messages “00” to “10”, “01” to “11”and then propagates “1” forward.

Table 1. Characterization of the different cues in terms of social communication

	Message modification				Elementary message propagation									
					General					Forward				
	“00” to “10”	“10” to “00”	“11” to “ 01”	“01” to “11”	“1”	“0”	M	M’	S	“1”	“0”	M	M’	S
f0						X								
f1					When input sequence is “111……1”						X			
						X	For any other input sequence							
f2			X								X			
f3											X			
f4		X	X	X								X		
f5									X					
f6			X	X								X		
f7				X						X				
f8	X	X	X										X	
f9	X	X											X	
f10	X		X										X	
f11	X												X	
f12	X	X	X	X						X				
f13	X	X		X						X				
f14	X		X	X						X				
f15	X			X						X				

As observed, the cues encompass both message modification (00, 01, 11, 10) and general or forward propagation of elementary messages (0, 1, M, M’ and S). M and M’ mean “Last elementary information” and “Complemented last elementary information”, respectively; S stands for the seed value.

The combinations of these two actions are the keys for the generation of social communication. A deeper analysis of the communication structure falls out of the scope of this paper and remains as future work as well as the application and validation in realistic scenarios.

4 Conclusions

In this paper we have presented a set of neighbouring binary rules that can generate behavioural patterns when they apply recursively. At higher level, the sequences provide a suitable approach to the cues since they have the capability to model the initial environmental information (input sequences) as well as the updating and extending process of the information performed by an agent (characterized by its behavioural pattern). As in the stigmergy structure our approach allows the information is updated many times, by increasing the value of p. In terms of social communication, 16 different modes have been generated. All they encompass both message modification and elementary message propagation. This initial work will be improved by a deeper analysis of the communication structure and the application and validation in realistic scenarios.

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Envisioning a New Future for the Enterprise with a Big Data Experience Framework

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Abstract. The enterprise experience is often a fragmented one that spans multiple vendors, devices, and products. Big data has garnered attention as companies attempt to transform it into a competitive advantage. In the enterprise where users generate mountains of data, it is often under-utilized for managing the user experience (UX), or at best used in a limited way to improve an individual product. Those wanting to do more with big data often struggle to derive meaningful insights or relate it to outputs of more traditional UX methods. We present a hybrid analysis approach to bridge the chasm between big data and outputs of UX methods; it allowed us to define an over-arching experience framework that provided actionable insights across the enterprise. We will discuss the underlying methodology and how the work is transforming experience decision making. We will highlight how different roles use the framework and provide key learnings from its use.

Keywords: enterprise transformation, IT strategy, user experience, big data, service design, agile teams, user research, organizational transformation.

1 Introduction

As systems required to keep companies running smoothly grow larger and more complex, enterprise users are faced with increasingly convoluted and fragmented experiences that span multiple platforms, products, and devices. In the course of a normal day, enterprise users typically must jump between disconnected tools, deal with vastly different interfaces, and enter already known data about themselves just to complete their work. Users are left to manually bridge the chasms between tools and make sense of contradictory interfaces. Their experience is seldom satisfying and often bewildering, leaving them frustrated and less effective.

Consumerization is also increasingly impacting user expectations of the enterprise. Once these users leave the confines of the enterprise, they encounter consumer devices and applications that allow them to seamlessly and much more easily accomplish a wide variety of tasks, including some of the very same ones they do with more difficulty within the enterprise. As a result, never in the history of the enterprise has the gap between user expectations and enterprise reality been larger.

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Traditional, well-established methods of managing the enterprise abound, but they typically focus on the functioning of the underlying systems and processes. Users are often treated as a system component and expected to comply with enterprise mandates much to their frustration. In response to user dissatisfaction, IT shops are increasingly turning to user-centered approaches as a means of improving user productivity, increasing business velocity, and in general increasing the appeal of enterprise solutions with their target users. However, enterprise UX professionals, like their more traditional IT counterparts, often focus on a specific system. UX success, when it happens, is often siloed within a particular interface or system.

In 2011, after years of siloed UX engagements that failed to significantly improve the overall experience, our large corporate IT shop took an audacious goal to define a One IT enterprise experience that spanned the multitude of products offered by our IT shop. The aim was to develop a holistic understanding of the enterprise experience and provide an experience vision that individual IT teams align their product with. This approach is a fundamental shift in the management of the enterprise experience from the perspective of both IT and UX. Success required UX professionals as well as their IT counterparts to transform their work practices and use the framework as a shared language for discussing the enterprise experience. To make this information easily re-usable, a set of core artifacts and processes were developed along with workshop and training materials to help teams across IT use this experience vision to set their product strategy and identify design opportunities.

In this paper, we will discuss the details of the hybrid analysis approach used to create the framework and bridge the chasm between big data and more traditional UX methods. We will decompose the framework and provide examples of how it is being used within the enterprise. Lastly, we will map the evolution of this effort over the course of the last two years, share learnings from our journey, and discuss the benefits of having a re-usable, over-arching experience vision in guiding IT decision-making.

2 Architecting a Unifying Experience Framework

Like most enterprises, our large corporate IT shop had a wealth of data that could be leveraged to understand the over-arching IT experience. Stored in siloes across the enterprise, the available data included both “big data” by-products of operations (e.g., transactions, support tickets, social data) and outputs of traditional UX methods (e.g. interviews, participatory designs, surveys). Enterprise data provides details about user behavior, but does not help enterprises understand what motivates behavior or its larger context. While UX methods provide rich contextual insights, they rely on small numbers of users and sample sizes that are seldom statistically significant at the enterprise level, which puts their generalizability into question. Taking a hybrid approach that utilizes both data types, however, had the potential to mitigate these inherent risks and would enable us to study both the actual behavior of users along with their attitudes towards their IT experience.

Unfortunately, the nature of these diverse datasets does not lend itself to easy connecting. Enterprises often manage operational data in silos around infrastructure or applications; this data is often incompatible, incomprehensible, and messy to tie together. The narratives that are the by-product of many UX methods are seldom analyzed to the point where shared, underlying structures are visible which is a significant obstacle to connecting insights from different UX studies [1, 2]. However, by far the most daunting challenge to leveraging the combined intelligence of these datasets was the lack of connections—that is, a way to link these disparate datasets and to connect specific aspects of the experience to the stored mountains of data.

2.1 Connecting the Data

Before we could uncover the underlying patterns that would transform this data into actionable insights, we had to grow connections in the data, which included both operational data and primary UX research. The many gigabyte data set spanned over 100K employees around the world; it included over 700 hours of user narratives, 20K surveys, and 18 million transactions. We put users at the center of our strategy for connecting the data. Each piece of data was linked to a specific user, and all data for an individual user linked together. As our foremost concern was protecting the privacy of employees, prior to making any attempt to integrate the data sets, the raw data was anonymized by replacing all employee identifiers with an encrypted identifier. By organizing the data in terms of individuals, we could more easily discern user patterns and connect new data as it is discovered.

Enterprise Big Data. The operational data set included employee demographics (e.g. role) and by-products of their transactions (e.g., search history). Connecting the vast amounts of data required different technologies and skill-sets outside of traditional UX. Architecting a UX repository that could house the combined data required technical knowledge (e.g. what platforms to use) as well as developing robust data models. Identifying what transactional systems and data entities were important required knowledge of underlying processes. Given the size and degree of decentralization of our IT organization, identifying data owners across the various organizational silos and negotiating access took large amounts of time.

Integrating structured data from the various systems was challenging, due to the wide variety of file formats and capacity limitations of our repository. Sometimes we could use ETL (Extract-Transform-Load) to bring the data into our repository. In other cases, data would be provided in “flat files”. When the magnitude of the incoming data exceeded the repository capacity, we would develop summary usage metrics for individual users and connect those measures in lieu of the raw data.

Unstructured data (e.g., contents of social media platforms, web logs, and other unstructured textual information) was rich in insights, but difficult to make sense of. Approaches using Apache Hadoop architectures helped in the management of unstructured data. Using these “big data” tools meant that we had to acquire new skillsets (Unix/Linux, Java coding, data management tools) which we did by training team members and by building partnerships with data architects and developers in the larger IT organization. Using Apache Hadoop has opened the door to text analytics for: pattern recognition, clustering, sentiment analysis, and visualization. It also allows for predictive analytics which benefit our support organizations and user determined taxonomies which describe issues or increase search relevance.

UX Narratives. The UX narrative data was the result of large-scale user research focused on identifying the real problems and needs of users across the corporation, this included over 250 hours of interviews and observations, 300 participatory design sessions, and 100K support requests. The narratives provided rich, near verbatim accounts of users' enterprise interactions and were treated as a direct representation of experience or a critical part of a user's underlying mental model [1].

We manually coded the narratives using a mix of exploratory and structured coding. Structured coding was limited to the support tickets, with each categorized in terms of the underlying usability issue (e.g., unclear language). For the more free-form narratives, we started with the smallest actionable narrative chunks (e.g. low-level statements) and built the coding structure from the bottom up. While we let the user narrative guide the structure, we made sure to code certain attributes including workflow (e.g., steps, triggers, decision points), critical incidents, environmental factors (e.g., location), social connections, underlying technology (e.g., tools, a process, or device), and individual characteristics (e.g., attitudes, motivators). The resulting coding structure represented the users' over-arching mental model of the enterprise experience [3] and defined the experience that users wanted IT to deliver. Summary measures were defined based on the emergent coding structure and the number of references for each high-level node in the top levels of the structure. Rather than merge the whole narratives into the repository as unstructured data, we used the summary measures to connect the narratives to the operational data.

2.2 Discovering an Underlying Conceptual Architecture

By connecting the outputs of UX methods, with the structured data of transactional systems, along with unstructured data available in logs, discussion forums, and other sources, we had a vast amount of information from which to develop insights about enterprise users. Our search for underlying meta-patterns from which a conceptual experience framework could be defined began with the emergent coding structure derived from the UX narratives. The coding structure mapped meta-patterns of user needs, while served as a concept map of the desired enterprise experience, that included rich levels of detail that allowed the experience to be decomposed to the level of user requirements.

The connected operational data sets in the UX repository were invaluable when it came to refining and testing coding meta-patterns. By looking at the data connected with a specific individual, we could view the user's "footprint" within the enterprise for the previous year. We tested the generalizability of each meta-pattern using these enterprise footprints. For instance, our UX narratives suggested people in certain roles had much broader information interests than other employees. We initially verified this pattern using the footprints of users who had provided related narratives; then fine-tuned the pattern using data from the entire enterprise.

Using a variety of statistical pattern-finding methods including clustering and social network analysis, we could refine our initial set of meta-patterns and increase the granularity of our underlying model. We would also mine the UX narratives to help us explain operational trends that our pattern-finding methods discovered. At times, we had to add additional data to aid our sense-making. Over a period of months, the final meta-patterns emerged and became the building blocks of the experience framework. These patterns are discussed further in the following section.

2.3 Bringing the Framework to Life

We wanted the experience framework to serve as a conceptual architecture that would help IT teams envision a new future for the enterprise and make a structural shift towards the desired experience. While the data patterns were potentially powerful, they did not lend themselves to easy re-use in different contexts. We needed teams to be able to zoom in and understand, at a detailed level, how the framework could help them reframe the experience of a specific product or service. At the same time, we needed teams to be able to zoom out and assess how well their product fit the larger experience. Both required a visible and actionable hierarchy of experience attributes that would facilitate reuse and help us measure to what extent IT products and services were aligning with the envisioned experience.

We introduced large-scale, layered storytelling and a structured vocabulary as a means of bringing the underlying richness of the data to life and making the envisioned enterprise experience sticky to larger IT. Each of the underlying stories focuses on particular piece of the framework and ignores the rest. Strung together they map the desired experience, but individually only tell a piece. Users of the experience framework then take these stories and underlying data to craft their own stories that are grounded in the context of what they are trying to do; many stories are possible from the same data. The stories associated with different pieces provide different insights and follow different models; they are discussed in more detail below.

Themes. They are the core experiences that enterprise users want from IT and define an experience vision that spans the many IT products and services. They help IT teams understand the shared expectations that users have of both the enterprise environment as well as their individual product interactions. To increase the ease of applying an experience theme to a specific product or service, each theme was decomposed into layered components that provide additional levels of granularity around user needs as described here.

- *Qualities* define the essential experience principles needed to bring a specific theme to life include key usage elements and desired functionality. They were packaged as quality “trading cards” and provide tangible artifacts for teams to utilize while setting UX strategy and defining product roadmaps.

- *Elements* specify the key usages that make up a quality, including user scenarios, user requirements, relative importance, illustrative examples, and any user differences. They were packaged in theme vision books and as 8x10 cards to facilitate use in face-to-face design sessions.

Three themes, 12 qualities, 59 elements, and many hundreds of user requirements detail the envisioned experience. Table 1 provides an overview. To aid decision-making, each component had experience objectives defined in terms of user minimum, target, and outstanding expectations of that specific component.

Table 1. The themes and qualities that framed the envisioned enterprise experience

Theme	Qualities
Feed Me I quickly and easily find the information I need to speed my work and my life.	• *Seamless* - Transparent. Integrated but flexible. • *Simple* - Quick and easy. Language I can understand. • *Meaningful* - Points me the right direction, aids me in sense-making of information, and helps me work smarter. • *Proactive* – Push me relevant information, make me aware of changes before they happen, and help me not be surprised.
Connect Me Connect me with the people, resources, and expertise I need to be successful.	• *Purposeful* - Together we do work. • *Easy* - Easy to work together and connect. • *Cooperative* – Larger environment is supportive of me. • *Presence* - Always present or at least I feel like you are near.
Know Me My information is known, protected and used to improve provided services.	• *Recognized* - Know who I am. • *Personalized* - Implicitly know what I need... • *Customized* - Give me choices. • *Private* - My information is under my control. Always protected and secure.

Segments. They are groups of users, with similar usage of enterprise systems, attitudes towards IT, and user needs. Although themes are based on data from thousands of enterprise users and apply to all enterprise products offered by our corporate IT shop, how they apply to individual segments may vary. Some segments were further decomposed into sub-segments based on within segment differences. Table 2 summarizes the major groupings of enterprise users.

Personas put a "face" to enterprise users, with each segment having a persona family that represents it. They provide a common cast of characters for IT teams creating enterprise experiences. They provide summary information on user characteristics, goals and needs, key tasks and behaviors, pain points, use of IT products, and relative priority of different experience qualities. The collateral ranges from persona family posters, individual personas, day-in-the-lifes, and trading cards.

Table 2. Major groupings of enterprise users within our large corporation

Segment	Shared Focus	Sub-segments
Hardware Technologists (36%)	Hardware but at different stages of the product lifecycle	(1) Factory Engineer, (2) Product Engineer, (3) Sales Engineer, (4) IT Engineer
New Employees (19%)	Doing the job while figuring out the corporation (< 18 months)	n/a
Manufacturing Operations (18%)	Meeting production schedules but not always shared language	n/a
Versatile Experts (16%)	Applying their skill sets across the corporation in any organization	(1) Leads, (2) Analysts, (3) Sellers, (4) Corporate Curators
Software Developers (10%)	Software but targeting different audiences	(1) Product Developers, (2) IT Developers
Adminstrators (1%)	Helping others succeed by removing roadblocks and acting on their behalf.	n/a

Influencers. They are core elements of the enterprise environment, whose characteristics impact the user's ability to accomplish work (namely, IT, HR, people, workspaces, and culture). They help assess the relative contribution of core components of the larger enterprise on the use experience. They detail key pain points related to the component and how they interact with other framework pieces,

Activities. They provide IT teams with specifics of how employees use and interact with enterprise products to accomplish shared tasks common to all employees (namely, get information, collaborate, learn, get help, and do), including high-level journey maps, summary transactions related to the activity, and key segment differences relative to the activity. They provide a jumping off point for more specific investigation relative to a particular product or service.

3 Envisioning a New Future for the Enterprise

The experience framework is a representation of the desired future of the enterprise from the user perspective. It provides a thinking model for those who make the day-to-day decisions that define the enterprise. It encourages them to look beyond their immediate challenges, past the boundaries of what they are responsible, and consider the holistic experience from the perspective of enterprise users. It challenges IT professionals to balance the technological and business needs of the enterprise against the needs of its users. Success requires IT adopt not only a shared vision of the future enterprise, but also a shared vocabulary and methods for creating a new future.

3.1 Shifting the IT Mindset

The success of any transformation depends largely on the mindset and commitment of the people who must implement it on a daily basis. Within our IT shop, UX professionals comprise less than 1% of the workforce. While our IT shop has embraced the idea of leading with UX, we retain a legacy staffing model of traditional IT roles. Many already have a general understanding of UX tools and techniques from long-standing efforts to weave UX into the DNA of the organization, but very limited experience with them. Our challenge is to create an environment where the value of the framework is agreed upon and it is regularly integrated into working behavior.

Growing Awareness of Value. In our large IT shop, where we've been given the mandate to Be Bold, and Act Fast, the biggest win offered by the framework was increased velocity. It provided re-usable insights and templates that teams could quickly adapt and insert into existing processes. By working from a shared understanding of users and design needs, teams could save time across the product lifecycle. Further by providing common target experiences and shared priorities, it helps create efficiencies across enterprise services and portfolios.

Our approach has been to create broad awareness of the benefits of the enterprise framework and to socialize it thru social media, workshops and training to the target groups shown Table 3. We also encourage use by providing easy-to-use tools. In doing so, we ensure that over 60% of our IT shop – those with the biggest opportunity to influence the experience – are able to take advantage of the framework.

Table 3. Key framework touch points for targeted IT roles

Role	Desired Behaviors
IT Staff	• Adopt a shared vocabulary and strategy for the experience
Service/Product Managers, Enterprise Architects	• Know their role in making the envisioned experience reality • Understand the intersection with their service/products and use that information to drive strategy, roadmaps, and plans • Can evaluate extent to which experience satisfies framework
Business / System Analysts, Solution Architects	• Understand the intersection with their project scope • Utilize framework personas, requirements, and scenarios as the starting point for their work • Can evaluate extent to which experience satisfies framework
Software Developers (de facto designers)	• Utilize design patterns related to the framework • Can evaluate extent to which experience satisfies framework
Quality Assurance	• Can evaluate extent to which experience satisfies framework
UX Professionals	• Think more holistically about the enterprise experience • Leverage insights and share their own UX artifacts

Putting Users at the Center. Segments and personas help offset the technology-centric mindset pervasive in most IT shops by providing an over-arching, landscape of users that spans IT products and services. Of all the framework building blocks, the adoption curve for segments was the shortest, with teams readily seeing the value of knowing the pain points and IT usage patterns of their target audiences. Their use has also spawned multi-year IT programs aimed at improving the overall experience of dissatisfied, business critical segments or sub-segments (e.g. software developers).

3.2 Turning Understanding into Transformation

The framework was intended to seed the envisioned experience into existing processes by providing both a shared vocabulary and shared ways of examining the enterprise. We encouraged teams to selectively apply different pieces of the framework depending on where they were in their existing processes. To help guide IT professionals in incorporating the framework into their processes, we proposed the following iterative approach, with the outputs of the last step feed back into the first.

1. *Evaluate what is.* Use segments to better understand users and theme components to determine how well current reality is meeting user needs.
2. *Ask what if.* Use relevant theme components start the conversation with your users, stakeholders and team and to envision possible new futures.
3. *Prioritize what is most needed.* Uses the experience objectives and the outputs of previous steps to set UX strategy, define roadmaps, and identify gaps.
4. *Define the detail.* Use framework personas, requirements, scenarios, and related design patterns to define what a product or service would do.

We stressed that framework insights were not a replacement for what was already known but instead were additive. We set the expectation that the framework would not answer all their questions, and any gaps in understanding would need to be filled using traditional UX methods. The rest of this section briefly discusses some of the common uses of the framework and its impact on how IT functions.

Shifting IT Strategy. The introduction of themes is shifting how the larger IT shop thinks about UX. IT's multi-year plans now includes horizontal experience services to more efficiently enable the integrated experience that users want. Product owners envision future products based on the most relevant qualities; product roadmaps track alignment to the themes with user functionality prioritization driving roadmap timing. One of the key themes (Know Me) is the focus of an IT pathfinding group that is building out a strategy for enterprise personalization including multiple proof-of-concepts across IT's solutions (e.g., Unified Profile, Recommender Systems) in the hopes of streamlining of tasks and increased filtering of irrelevant information.

Seeding Agility with Presumptive Design. Early project adopters of the framework evolved our original approach by combining use of the framework with elements of presumptive design [4] to speed up agile teams. The framework along with what was already known about a particular space formulated the starting "presumptions" on which designs were based. Agile teams found segments and an underlying component of experience qualities, namely experience elements, provided the most utility for generating starting presumptions.

On agile projects, the rich detail provided by the framework helps bring focus to team efforts and allows teams to more rapidly move from concept discussions to prototypes. In multiple projects, this information has seeded agile Vision Quest activities and served as a catalyst for creating design hypotheses around core presumptions of what features and capabilities should be included in the solution. From the created design hypotheses, a series of contextual scenarios are written that re-framed element usage scenarios in light of the current project and then were used to storyboard the product vision. Framework examples often inspire many of the designs reflected in the proof-of-concept (POC) prototypes, and the storyboard typically contains a swim lane that the team used to map the themes to the relevant portion of the story.

Providing Evaluation Guardrails. With adoption of the framework, IT needed a way of evaluating how well existing experiences aligned with the experience envisioned by our users. An experience evaluation spreadsheet was developed and by checking off the high-level requirements relative to today's experience, teams can quickly see how well their current solution aligned with the themes. The end-result is a score and color-coded heat map which allows teams to visualize where they should focus more attention in order to improve user experience. It serves as an evaluation tool for vendor selection and as a design foundation for new products and the evolution of existing ones.

4 Conclusions

By aggregating big data and the outputs from more traditional UX together, enterprise UX shops can speed UX within the enterprise. The detailed information within the framework defined interaction norms across enterprise tools and served as design guard rails to help developers create better interfaces. In a world where enterprise IT shops are constantly expected to move faster and do more, an experience framework can help speed up enterprise organizations and become a force for UX transformation.

However, transformation using the framework is possible only when the findings are communicated in way that resonates with the broad base of people who work together to define and develop the enterprise experience. An architect will look at the framework collateral through a different lens than a systems analyst or service owner. Further, transformation is a participatory process—it is not something that can be done by merely throwing the framework over the fence at those outside of UX. For change to happen, all levels of the organization must participate in the conversation and take ownership of how their own role impacts the enterprise experience.

As enterprise IT organizations are increasingly under pressure to blur the lines between internal and consumer experiences, such transformations become critical.

Programs like bring your own device increase the number of platforms to be supported. The need for mobility requires a consistent experience across form factors. Usage of SaaS solutions with native enterprise apps requires deep integration and consistent experiences across tools. Users are more sophisticated, their demands on technology are greater, and the imperatives to deliver solutions quickly have never been greater. Using an approach such as the discussed here can facilitate, and greatly assist, an enterprise IT shop in meeting all the demands placed on them.

The road to transformation that is carved by an enterprise framework isn't necessarily easy, or straight, and is often fraught with ambiguity, but for those who persevere on this journey (and it is most certainly a journey) a framework can help seed a shared experience vision and focus actions to help bring the vision to life.

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Reengineering Requirements Specification Based on IEEE 830 Standard and Traceability

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Abstract. In the recent years, we have seen the emergence and the growing of the software requirements engineering. Software requirements should be managed by using traceability. This will allow to better solve their conflicts and to eliminate faked or frivolous requirements that lack any justification. Meanwhile, writing the software requirements specification (SRS) must include traceability to allow a more efficient reading. Many standards have been proposed to provide efficient SRS templates such as the IEEE 830 standard. These standards present the content of the specification in a linear way, which often limits its use possibilities to a sequential reading. The proposed model of SRS uses a semi-structured data approach aiming at transforming the SRS into a hypermedia and is based on: (1) the IEEE 830 standard offering the SRS a tree's structure; and (2) the requirements traceability links offering the SRS a network structure. Such links could connect each requirement backward from its source and forward to its corresponding design artefacts. The main contributions of this paper are: (1) building an XML schema for the proposed SRS model; and (2) building a prototype of a web-based system named SRSM (SRS Manager), based on the previous SRS model.

Keywords: Software requirements specification, IEEE 830 standard, Requirements traceability.

1 Introduction

Software requirements engineering (SRE) is an emerging field of engineering that extends the analysis phase in the software development life cycle (SDLC).

SRE is composed of two major phases: requirements definition and requirements management. The first phase is an iterative process which includes eliciting, analysing, specifying and validating requirements. The second phase of SDLC involves all the activities of changes requests of requirements, impact analysis for the changes, agreement or disagreement of them, implementing the agreed changes and ensuring the consistency between artefacts and software plans [16].

Traceability has become more important over past years and subject to research in many areas of software development. The lack of the traceability information may

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lead to higher costs, waste of time, wrong or unnecessary modification, difficulty in reusability, and many other problems during the SDLC [6].

A software requirements specification (SRS) is often considered as a complex and knowledge intensive documentation. Accordingly, a linear structure of an SRS doesn't allow an efficient reading. Moreover, requirements recorded in the SRS have numerous complex and non-trivial dependencies. They often conflict with each other when they make contradictory statements about system's properties. A practical approach for representing the dependencies between requirements in one side and between requirements and other design artefacts in other side is to incorporate traceability within the SRS. We should then have a good idea of where requirements came from and how they moved further toward the design.

The proposed model of SRS uses a semi-structured data approach aiming at transforming the SRS into a hypermedia and is based on: (1) the IEEE 830 standard offering the SRS a tree's structure; and (2) the requirements traceability links offering the SRS a network structure. Such links could connect each requirement backward from its source and forward to its corresponding design artefacts. The main contributions of this paper are: (1) building an XML schema for the proposed SRS model; and (2) building a prototype of a web-based system named SRSM (SRS Manager), based on the previous SRS model.

The rest of this paper is organized as follows: Section 2 presents the problem statement. Section 3 shows the background related to software requirements specification and requirements traceability. Section 4 summarizes related works on requirements traceability. We show in section 5 the new traceability based SRS model and we illustrate how it works through a prototype in section 6. Finally, Section 7 concludes the paper and points out the future work.

2 Problem Statement

Eliciting, analysing, and writing good requirements are the most difficult parts of SRE. If developers do not follow the requirements very carefully during the SDLC, then it does not matter how they will do anything. This can lead to many issues with negative effect on software being developed. These issues include incomplete requirements, lack of user involvement, wasted resources and gold plating [16].

Consequently, previous issues show the importance role of the requirements traceability which help in reducing time, money, and effort required to determine the impact of changes if needed. Software requirements traceability can be viewed as a measure of system quality in a software development. It helps ensuring many aspects of system quality such as adequacy, understandability and maintainability to come over inconsistencies or omissions in the system. Also, it helps ensuring validation and verification between pairs of relating artefacts. It is required in many software development standards [17].

Traceability is most frequently found between software documents representations and source code for automated analysis [9]. Although requirements specification is the most important part of the SDLC, there is little or no support for tracing requirements to their sources or design artefacts.

An SRS should identify what the new software should do to support the domains tasks and user needs. It is important to relate the users' needs to the developers' artefacts. Accordingly there is a need to document more than only the requirements. It should be possible to trace each requirement from its source in the problem domain, through the various intermediate artefacts, so that it is possible to re-enact the important events that led to the final software. This ability, to trace the path of each requirement, is known as traceability [4][17].

Among other things, traceability is essential for dispute resolution, for seeing the effect, later in the project, of changing or deleting requirements, and for demonstrating that we have dealt with each requirement. The adopted SDLC model will determine which artefacts can be rebuilt and hereafter determine the traceability level. It is essential to recognize that the amount of documentation should be proportionate with the preferred level of traceability [17][28].

The different readers of the SRS and more precisely the stakeholders should never rely on their intuition or personal experience to guess the relationship between requirements and other artefacts from inside or outside the SRS, but rather to follow the traceability links offered by the SRS. Our hypothesis is that reengineering the SRS using IEEE 830 standard combined with some level of traceability will improve its quality.

3 Literature Review

Since this paper aims at reengineering the SRS based on IEEE 830 standard combined with traceability, this section will mainly cover the SRS using the standard IEEE 830, the requirements traceability and related works.

3.1 Software Requirements Specification

Software requirements need to be documented within a software project. Requirements documents aim to record decisions agreed among the system's stakeholders. They are the platform from which the system is designed and built, and are the reference for the validation of the system, once it is built.

The SRS is a complete description of the behaviour of a system to be developed from supplier perspective. It describes all the interactions between users and the system[12]. It is a formal document written as part of a contract to ensure understanding software requirements between a customer and a supplier at a specific time [5].

The SRS should only specify functions, services and constraints of software product without specifying any solutions to technology or business or issues design such as partitioning the software into modules, defining functions of each modules or choosing data structures. The SRS may take many forms. The one we adopt here is based on the IEEE830 standard which describes content and qualities of good SRS.

The IEEE standard 830 is considered as the most famous and universal standard that describes recommended approaches for the SRS. It is a very flexible standard because it provides the chance for the user to select the most appropriate format depending on the project type.

The general outline of the IEEE 830is shown in figure 1 [4].

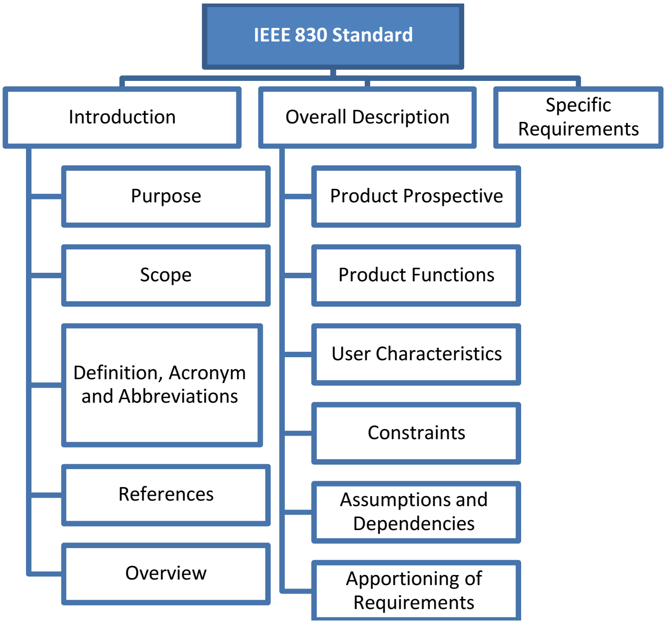


Fig. 1. The outline of the IEEE 830 Standard

3.2 Requirements Traceability

The IEEE Standard Glossary of Software Engineering Terminology defines traceability as the degree to which each element in a software development product (artefacts) establishes its reason for existing. Also, it defines a trace as "a relationship between two or more products of the development process". More specifically in requirements engineering field, the term traceability is usually defined as the ability to describe and follow the life of a requirement, in both forward and backward direction, from user demands (origins), through analysis (requirements specification), design, programming (deployment) and all its phases in the SDLC[17].

There are many standards that consider traceability as required activity such as IEEE standard 830-1998 which defines an SRS as traceable "if the origin of each of its requirements is clear and if it facilitates the referencing of each requirement in future development or enhancement documentation". That standard defines two types of traceability: backward traceability from each requirement to previous stages of development and forward traceability from each requirement to all documents derived from the SRS [4]. In addition, many standards suggest that requirements traceability should be practiced such as IEEE standard 1233a-1998 which lists traceability as one of the four properties that requirements should have and the American DoD (Department of Defence) standard 2167A which insists that a requirement should be traceable [6].

Requirements traceability allows among other advantages verifying artefacts by ensuring that a downstream artefact satisfies the upstream requirement. The purpose of verifying is to ensure that each requirement is implemented and tested and to ensure that each downstream artefact is referred to a requirement. This can guarantee that is no expanding in the project scope i.e. prevent the developer from wasting time in things the customer did not ask for [5]. Furthermore, it helps to detect defects early such as inconsistency and incompleteness.

A traceability scheme defines the guiding constraints to record traces by specifying artefacts and amount of details for each one of them. It is implemented as a model or metamodel when it is represented in a tool. There are two kinds of models: semantic or structural models. The models that explain domain concepts and replace natural language descriptions totally or partially are considered as semantic models such as goal models or business object. On the other hand, the models that assign importance to natural language and address requirements by using their elements are considered as structural models such as the requirements model in SysML [17].

However, it can be noticed that a trace can be documented using a set of (1) metadata such as creation and modification dates, creator and modifier; (2) relationships between artefacts often called traceability links.

3.2.1 Traceability Classifications

There are many ways for classifying traceability. The most common classifications are pre-RS (Pre-requirements specification) and post-RS (Post-requirements specification) traceability, forward and backward traceability, and horizontal and vertical traceability as shown in figure 2 [3][6][17].

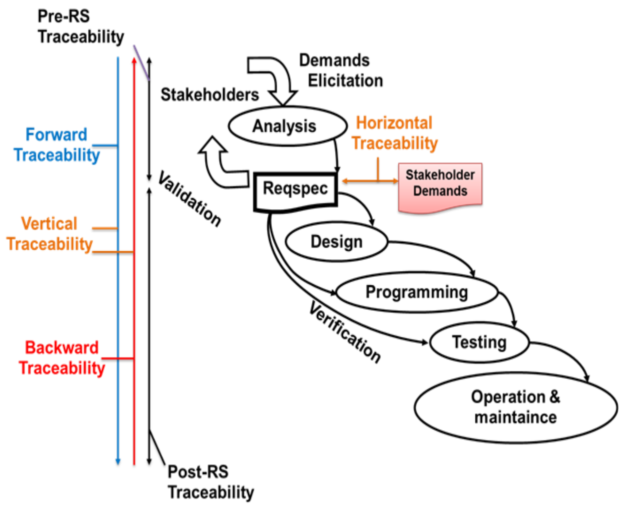


Fig. 2. The traceability classifications

3.2.2 Traceability Links Classifications

A traceability link can be defined as any relationship used to interconnect artefacts (e.g. by causality, content, dependency, influence…etc) in the software development life cycle. A traceability link can be unidirectional (such as depends- on) or bidirectional (such as alternative- for). The direction of a link only indicates the order in time or causality. Traceability links cardinality can be one-to-one, one-to-many, or many-to many [3][17]. According to the state of art in the field [17], there are many different classifications of traceability links types but none of them has been agreed as a commonly standard semantics for all these types.

Formal classification solves the problem of ambiguity and unclear formal definitions. It is more recent and much realistic in the SRE. Traceability links have been classified in [15][17], based on their semantic properties between two artefacts into eight types as follows:(1) dependency; (2) refinement; (3) evolution; (4) satisfiability; (5) overlap; (6) conflict; (7) rationalization; and (8) contribution.

3.3 Related Works

The empirical methods and approaches, developed to support requirements traceability activities, are based on: (1) information retrieval [2][8][9][10]; (2) reference model [7]; (3) rule based [14][18]; or (4) process based approach [1][11].

3.3.1 Information Retrieval Approaches

The purpose is to support establishing and maintaining traceability links between software artefacts based on textual similarity between documents [9].An example is the software concordance project [2][8][11] which is an integrated development environment for improving the management of software documents in SDLC using hypermedia technology to represent relationships between them. In general, it deals with the transition between software documents and code.

As shown in [8][10], traceability links are represented between software documents and source code using a hypertext model that is supported via XML representations. This hypertext model supports multi-links and conformance analysis i.e. the process of checking if the relationships between software documents are in agreement. These traceability links have three types: non-conformance, causal conformance, and non-causal conformance. The method used was depending on utilizing an advanced information retrieval technique, which is latent semantic analysis, to extract the semantics of the documentation and source code. This information was used to identify traceability links based on similarity measures to determine a conformance rating of retrieved links.[9]

3.3.2 Reference Model Approaches

Maletic, Collard, and Simoes [7] describe an xml-based approach to support the evolution of traceability links between models such as requirements model, design model and source models that are all represented in XML. They discuss the issue of evolution and propose to evolve traceability links along with models by detecting syntactic changes at the same level and type of the link. They do not explain the way of detecting these changes or the way of updating the affected traceability links. Their paper does not provide enough information regarding the practicability of the proposed way.

Soonsongtanee and Limpiyakorn [13] propose an approach to enhance the traceability matrix using UML state diagrams where requirements traceability link is represented as a state and a requirements change is represented as an event trigger. They deployed the UML state diagrams to describe the traceability states of different artefacts in order to know their events and to identify activities as the pre or post condition for state transition.

3.3.3 Rule-Based Approaches

Zisman et al. [18] present a rule-based approach for automatic generation and maintenance of bi-directional traceability relations between textual requirement statements (expressed in XML) and object models (expressed in UML). Traceability rules identify ways for matching syntactically related words in the requirements statements with related elements in an object model (e.g. classes, attributes, operations). When a match is found, a traceability relation of different types is created between these artefacts. Only three types of traceability relations are described which are "overlaps", "realizes" and "requires". Also, they only consider traceability between diverse requirements artefacts. Spanoudakis, Garces and Zisman [14] present a machine learning approach for generating traceability relations between requirement statements specified in natural language and object models. They construct a learning algorithm that creates traceability rules which are able to capture traceability relations.

3.3.4 Process-Based Approaches

Asuncion et al. [1] present a process-oriented approach for traceability practices that supports the whole software development life cycle. They describe a web-based end-to-end traceability application which is used to manage traces for all projects in Wonderware Company.

They identify two types of global trace artefacts: requirements trace and process trace artefacts. Marketing requirements, use cases, functional requirements, and test cases are included in requirements trace artefacts which are related to process trace artefacts. Process trace artefacts include product, project, and feature information. They model traceability links between these artefacts. Additionally, they list a number of general traceability guidelines that have to be addressed together in order to introduce traceability practices successfully. However, they limit the scope to post-RS traceability and text-based artefacts.

Ozkaya and Akin [11] present a prototype tool named “Design Track” which demonstrates an integrated design environment for requirements specification and outline exploration in the same design session. They used a process based approach that allows customization of requirement classifications and index schemas. Traceability links exist between requirements and between requirements and designs. Traceability links between complex requirements are classified into hierarchy, indexing, classification, association, dependency, and implication relationships.

4 The Traceability Based SRS Model

The proposed model of traceability based SRS uses a semi-structured data approach aiming at transforming the SRS into a hypermedia. The types of traceability links belong to the formal traceability links classification which includes dependency; refinement; evolution; satisfiability; overlap; conflict; rationalization; and contribution. These traceability links are represented through an automatic cross reference representation where each requirement artefact is assigned a unique identifier. The proposed SRS model is presented with its two structures: the tree structure showing the hierarchical composition of its sections and the network structure showing the traceability links that include:

1. System requirements - System requirements links.
2. System requirements - Design artefacts.
3. System requirements - Sources (User requirements or demands; regulations and standards).

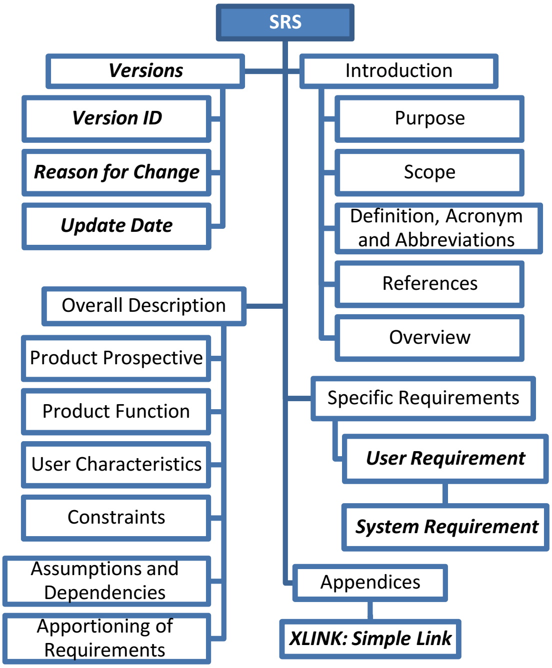


Fig. 3. The tree structure of the SRS

We assume that the SRS is conforming to IEEE 830 standard. A model of SRS allowing traceability is represented using XSD and XLINK; XSD is used to re-engineer the SRS according IEEE 830 standard while XLINK is used to represent the traceability hyperlinks. The tree structure of the SRS is presented in figure 3 where the highlighted parts are different from IEEE 830 standard. The network structure of traceability links is represented with a class diagram in figure 4.

As seen in figure 3, the main SRS components are versions, introduction, overall description, specific requirements and appendices. The first component is "Versions" which used for the design rationale to build a table in the beginning of the SRS document that keeps track for update number, update date and reason of that change. Next components are "Introduction" and "Overall Description" which are both used to describe SRS as recommended in IEEE 830 standard. Then there is the most significant section of the SRS which is "Specific Requirements" section. We make an important enhancement to the IEEE 830 standard to support requirement traceability by changing the structure of the "Specific Requirements" section. This section is organized into user requirements where each one of them has a list of system requirements.

Each system requirement has its own traceability links. The traceability links are specified by using the schema of traceability model as shown in figure 4. Finally, there is the "Appendices" component which presents each appendix as hyperlink.

In the network structure (figure 4), some traceability links can be noticed from the user requirement attributes. The "User" attribute represents a traceability link between a user and his user requirements. Moreover, "Analyst" attribute represents a traceability link between an analyst and his assigned user requirements in order to build system requirements from them. Therefore, "User" and "Analyst" attributes can be considered as traceability links with stakeholders.

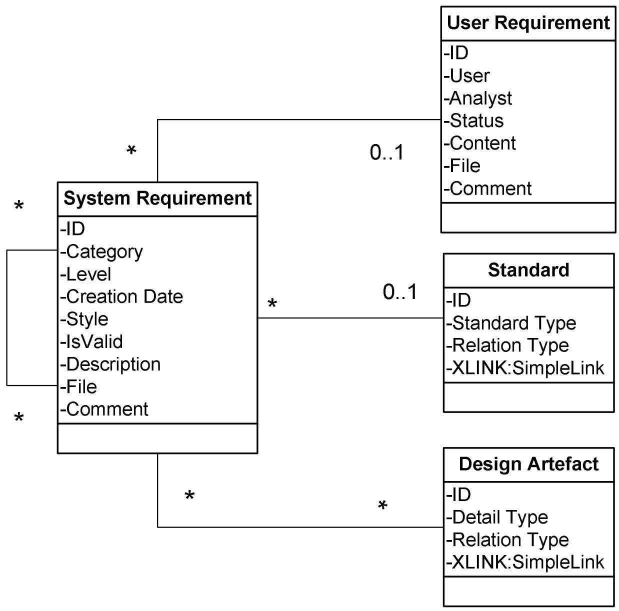


Fig. 4. The traceability model (Network structure)

XML increasingly become the universal format for storing and exchanging structured and semi-structured data on the Web [2]. Hence, we choose XML to support our semi-structured data approach for building the traceability based SRS model.

The formal classifications of traceability links are modified according to different artefacts generated during various phases in the SDLC. These traceability links are identified by the paired related artefacts as explained in table 1.

Table 1. Possible types of the traceability links

Traceability Link	**Link profile**
System requirement–Design artefact	Conflict; Dependency; Refinement; Rationalization; Satisfiability
System requirement –System requirement	Conflict; Overlap; Dependency; Refinement; Evolution; Rationalization;
System requirement – Standard	Conflict; Dependency; Refinement; Rationalization
System requirement–Stakeholder	Contribution
System requirement –User requirement	Evolution

Furthermore, there are many traceability classifications in our model oriented approach as depicted in figure 5.

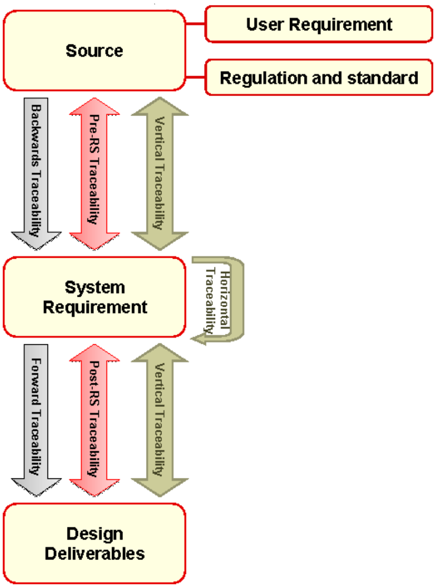


Fig. 5. The traceability classifications between sources, system requirements and design deliverables

5 The Software Requirements Specification Manager

In order to illustrate the previous traceability based SRS model, we developed a prototype of a web-based system named SRSM. The system is intended to ease the establishment and maintenance of accurate traces by providing access to all required information. We look for a way to browse traceability links through a semantic network. Such network links system requirements to related artefacts, which are other system requirements or design artefacts, and sources (user requirements, standards and regulations).

5.1 Structure

The SRSM structure as shown in figure 6 is composed of five modules: (1) the SRS hypermedia; (2) the SRS editor; (3) The SRS viewer; (4) the traceability generator; and (5) the traceability viewer.

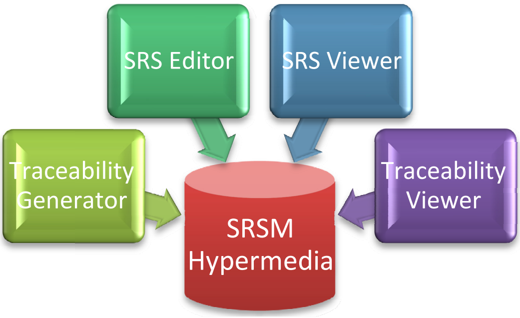


Fig. 6. The SRSM structure

1. **The SRS hypermedia** represents the SRS content as well as its tree and network structures.
2. **The SRS editor** is used for generating and editing (updating) the SRS content as well as its tree structure that were illustrated previously in figure 3.A sample of SRS editor is shown in figure 11.
3. **The SRS viewer** is used for viewing the formatted SRS. XSL is used to format the XML document of the SRS, which is created by SRSM. It can be displayed in many different formats such as HTML, MS-Word or PDF.As shown in figure 7, using the XML document of the SRS and the XSL template, will generate the XSL-FO document and the HTML which can be converted to the MS-Word file.PDF file will be generated based on the resulting XSL-FO document with the help of nFOP. A sample of SRS viewer is shown in figure 11.

4. **The traceability generator** is used for automatically generating the SRS traceability links according to the SRS model. A sample of traceability generator is shown in figure 9.
5. **The traceability viewer** is used for browsing and navigating the SRS traceability links according to the SRS model and the requirements level. A sample of traceability viewer is shown in figure 8.

Fig. 7. The XML formatting of the SRS

5.2 Implementation

The proposed SRS model was used in building the SRSM web-based system. SRSM is supported by.NET languages, such as ASP.NET, C# and LINQ to XML languages, and some of the W3C technologies such as XSD, XSL, XLINK, XQuery and XPath expressions.

Figure 8 displays a screenshot from the prototype which shows some SRS traceability links on the user requirements and on the system requirements levels. Figure 9 demonstrates how to generate these links on the system requirements.

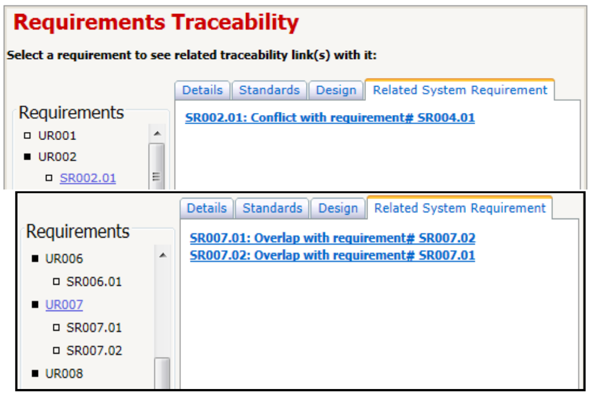


Fig. 8. Sample of Traceability viewer

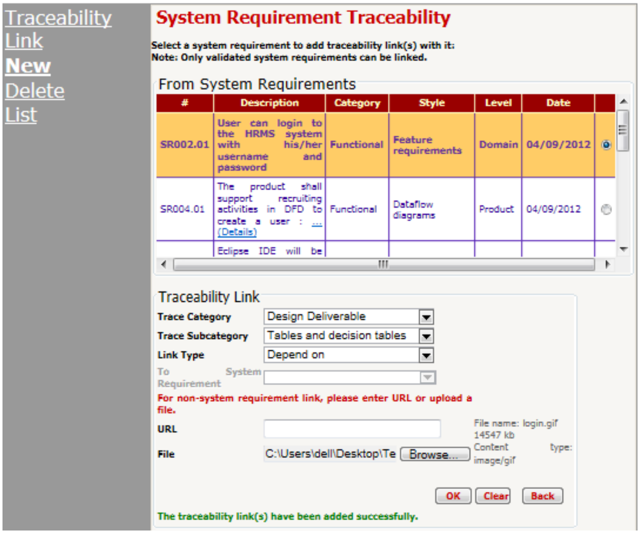
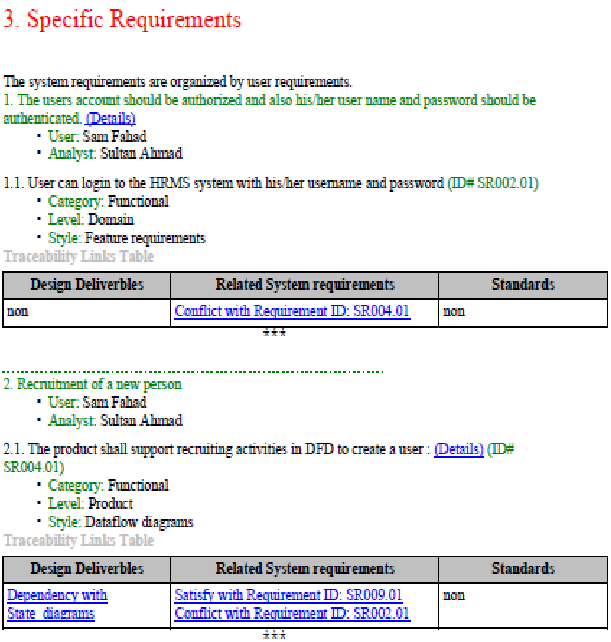


Fig. 9. Sample of traceability generator

Sample of the requirements in the "Specific requirements" section is shown in figure 10. The hyperlinks labelled with "details" describe the requirement in figures or other common types of files; while other hyperlinks represent traceability links between system requirements and related artefacts.



3. Specific Requirements

The system requirements are organized by user requirements.

1. The users account should be authorized and also his/her user name and password should be authenticated. (Details)

- User: Sam Fahad
- Analyst: Sultan Ahmad

1.1. User can login to the HRMS system with his/her username and password (ID# SR002.01)

- Category: Functional
- Level: Domain
- Style: Feature requirements

Traceability Links Table

Design Deliverbles	Related System requirements	Standards
non	Conflict with Requirement ID: SR004.01	non

***

2. Recruitment of a new person

- User: Sam Fahad
- Analyst: Sultan Ahmad

2.1. The product shall support recruiting activities in DFD to create a user : (Details) (ID# SR004.01)

- Category: Functional
- Level: Product
- Style: Dataflow diagrams

Traceability Links Table

Design Deliverbles	Related System requirements	Standards
Dependency with State diagrams	Satisfy with Requirement ID: SR009.01 Conflict with Requirement ID: SR002.01	non

***

Fig. 10. Sample of SRS viewer

The project manager generates SRS for the project and assigns analysts to user requirements. The analyst extracts system requirements from each user requirement. Analysts and end-users could respectively comment user requirements and system requirements to exchange their feedback. Traceability links are automatically built to connect each requirement backward from its source and forward to other derived or related system requirements and to its corresponding design artefacts.

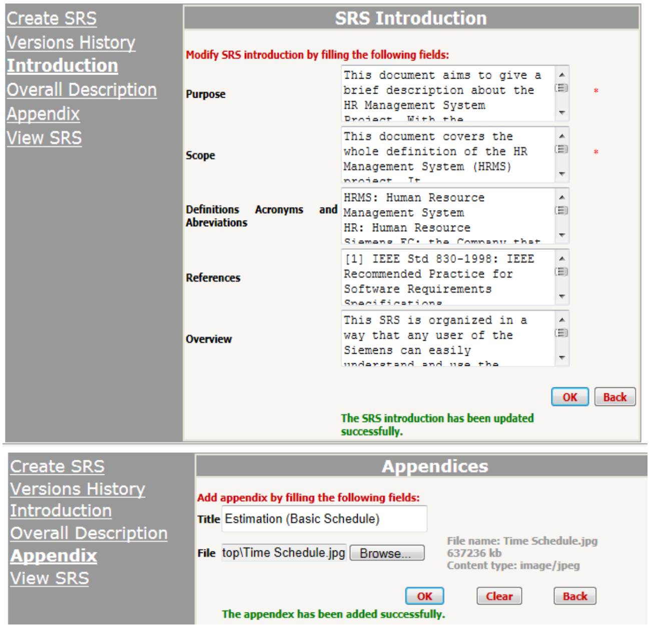


Fig. 11. Sample of SRS generator

The SRSM prototype arises some possible transitive relations. We found that the addition of explicit relationships between the system requirements along with the chaining of relationships leads to the discovery of implicit relationships between user requirements.

To illustrate the semi-structured data approach, we can see in figure 12 a sample of the generated XML code of the SRS from SRSM.

```xml
<SRS SRS_ID="3"xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"SRS_Title="Human Resource
Management"SRS_version="2.0" Company="Siemens Enterprise Communication" Domain="Human
Resource"SRS_CreationDate="2012-09-03T00:00:00">
<Versions>
<VersionversionID="1.0"UpdateDate="2012-09-05T00:00:00"Reason_for_change="initial draft"/>
<VersionversionID="1.1"UpdateDate="2012-09-08T00:00:00"Reason_for_change="baseline following changes
after inspection"/>
</Versions>
<Introduction>
<Purpose>***.</Purpose>
<Scope>***</Scope><Definitions_Acronyms_and_Abreviations>***</Definitions_Acronyms_and_Abreviations>
<References>***</References>
<Overview>***.</Overview>
</Introduction>
   <Overall_Description>
<Product_Perspective>***.</Product_Perspective>
<Product_Function>***</Product_Function>
<User_Characteristics></User_Characteristics>
<Constraints>***.</Constraints>
<Assumption_and_Dependencies>  Regularity Policies: Each user must be an employee of Siemens. In other
words, each user has account created by HR and authenticated by admin.</Assumption_and_Dependencies>
<Apportioning_of_Requirements></Apportioning_of_Requirements>
</Overall_Description>
   <Specific_Requirements>
<UserRequirementUserReq_ID="UR001" User="2" Analyst="1" Status="Wait">
<UserReq>
A user can refine the search of users based on the properties desired
</UserReq>
<Comment></Comment>
</UserRequirement>
<UserRequirementUserReq_ID="UR002" User="2" Analyst="3" Status="Accept">
<UserReq>The users account should be authorized and also his/her
user name and password should be authenticated.</UserReq>
<FileFile_Type="gif">4749463839612D019E00F70000000000000033000 …</File>
<Comment></Comment>
<SystemRequirementReq_ID="SR002.01" Category="Functional" Level="Domain"Creation_Date="2012-09-
04T00:00:00" Style="Feature requirements"IsValid="Yes">
<Description>User can login to the HRMS system with his/her username andpassword</Description>
<Design_G/>
<Related_Req_G/>
<Standard_G/>
<Comment></Comment>
</SystemRequirement>
<SystemRequirementReq_ID="SR002.02" Category="Functional" Level="Domain"Creation_Date="2012-09-
04T00:00:00" Style="Scenarios"IsValid="Wait">
<Description>User can logout from the HRMS system.</Description>
……
```

Fig. 12. The generated XML code for the SRS

6 Conclusion

This paper aimed at reengineering the SRS based on IEEE 830 standard combined with traceability.The traceability withinSRS has been recognized as a significant task where well-organized project management and software quality are supported. The adopted types of traceability links include dependency; refinement; evolution, satisfiability; overlap; conflict; rationalization; and contribution. These traceability links are represented through an automatic cross reference representation. Such links could connect each requirement backward from its source and forward to other derived or related system requirements and to its corresponding design artefacts.

The traceability based SRS model is implemented through a web-based system named SRSM (SRS Manager) to make the SRS easily traceable by linking each system requirement in the SRS to related artefacts such as other system requirements, detail design artefacts, and sources (user requirement, regulation and standard).

Now the SRSM prototype is being experimented in a school project in order to manage the SRS of a hotel booking system. As first results the prototype enabled the automatic generation of accurate traceability links and facilitated the navigation through the resulting SRS hypermedia. Future work involves a complete empirical evaluation of SRSM in order to improve it to be accepted in the industrial setting.

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A Sentence Meaning Based Alignment Method for Parallel Text Corpora Preparation

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Abstract. Text alignment is crucial to the accuracy of Machine Translation (MT) systems, some NLP tools or any other text processing tasks requiring bilingual data. This research proposes a language independent sentence alignment approach based on Polish (not position-sensitive language) to English experiments. This alignment approach was developed on the TED Talks corpus, but can be used for any text domain or language pair. The proposed approach implements various heuristics for sentence recognition. Some of them value synonyms and semantic text structure analysis as a part of additional information. Minimization of data loss was ensured. The solution is compared to other sentence alignment implementations. Also an improvement in MT system score with text processed with described tool is shown.

1 Introduction

Before a parallel corpus can be used for any processing, the sentences must be aligned. Sentences in the raw corpus are mostly misaligned, with translation lines whose placement does not correspond to the text lines in the source language. Moreover, some sentences may have no corresponding translation in the corpus at all. The corpus might also contain poor or indirect translations, making alignment difficult. Thus, alignment is crucial to many systems accuracy [1]. Sentence alignment must also be computationally feasible in order to be of practical use in various applications [2]. As a result, sentence alignment poses a significant challenge.

The Polish language is a particular challenge to such tools. It is a very complicated West-Slavic language with complex elements and grammatical rules. In addition, the Polish language has a large vocabulary due to many endings and prefixes changed by word declension. These characteristics have a significant effect on the requirements for the data and the data structure.

In addition, English is a position-sensitive language. The syntactic order (the order of words in a sentence) plays a very significant role, and the language has very limited inflection of words (e.g., due to the lack of declension endings). The word position in an English sentence is often the only indicator of the meaning. The sentence order follows the Subject-Verb-Object (SVO) schema, with the subject phrase preceding the predicate.

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Advances in Intelligent Systems and Computing 275,
DOI: 10.1007/978-3-319-05951-8_22,

On the other hand, no specific word order is imposed in Polish, and the word order has little effect on the meaning of a sentence. The same thought can be expressed in several ways. For example, the sentence "I bought myself a new car." can be written in Polish as one of the following: "Kupiłem sobie nowy samochód";" Nowy samochód sobie kupiłem."; "Sobie kupiłem nowy samochód."; "Samochód nowy sobie kupiłem.". It must be noted that such differences exist in many language pairs and need somehow to be dealt with, what is done in this research.

This paper proposes a language independent sentence alignment method that has been applied to Polish-English parallel corpora. First, the method is described. Next, an alignment metric is discussed. A quality comparison of this method to other alignment methods is then made using data from experiments. Lastly, conclusions are drawn.

The dataset used for this research was the Translanguage English Database (TED) [12], provided by Fondazione Bruno Kessler (FBK) [17]. Vocabulary sizes of the English and Polish texts in TED are disproportionate. There are 41,684 unique English words and 88,158 unique Polish words. This also presents a challenge for SMT systems.

2 Literature Overview

Early attempts at automatically aligning sentences for parallel corpora were based on sentence lengths, together with vocabulary alignment [19]. Brown's method [20] was based on measuring sentence length by the number of words. Gale and Church [21] measured the number of characters in sentences. Other researchers continued exploring various methods of combining sentence length statistics with alignment of vocabularies [22, 23].

Several text aligners implementing these methods are currently available, including Bleualign, which is an open source project developed by the University of Zurich. In addition to parallel texts, Bleualign requires a translation of one of the texts. It uses the length-based Bilingual Evaluation Understudy (BLEU) similarity metric to align the texts [11].

The Hunalign tool is another open source tool, developed by the Media Research Center. Based on Gale and Church's method, it uses sentence lengths and, optionally, a dictionary to align texts in two languages strictly on a sentence level. It does not address sentence-ordering issues [10].

ABBYY Aligner is a commercial product developed by the ABBYY Group. This product reportedly uses proprietary word databases to align text portions of sentences based on their meaning. [8]

Unitex Aligner [9] is an open source project primarily developed by the University of Paris-Est Marne-la-Vallée (France). It uses the XAlign tool [18], which uses character lengths at the paragraph and sentence level for text alignment [24].

3 Proposed Sentence Aligner

A sentence aligner was designed to find an English translation of each Polish line in a corpus and place it in the correct place in the English file. This aligner was implemented as a Python script. We assume that each line in a text file represents one full sentence.

Our first concept is to use the Google Translator Application Programming Interface (API) for lines for which an English translation does not exist and also for comparison between the original and translated texts. The second concept is based on web crawling, using Google Translator, Bing Translator, and Babylon translator. These can work in a parallel manner to improve performance. In addition, each translator can work in many instances. Our approach can also accommodate a user-provided translation file in lieu of crowd sourcing.

Our strategy is to find a correct translation of each Polish line aided by Google Translator or another translation engine. We translate all lines of the Polish file (src.pl) with Google Translator and put each line translation in an intermediate English translation file (src.trans). This intermediate translation helps us find the correct line in the English translation file (src.en) and put it in the correct position.

In reality, the actual solution is more complex. Suppose that we choose one of the English data lines as the most similar line to the specific translated line and that its similarity rate is high enough to be accepted as the translation. This line can be more similar to the next line of src.trans, so that the similarity rate of this selected line and the next line of src.trans is higher. For example, consider the sentences and their similarity rating in Table 1.

Table 1. Example Similarity Ratings

src.trans	src.en	Sim.
I go to school every day.	I like going to school every day.	0.60
I go to school every day.	I do not go to school every day.	0.70
I go to school every day.	We will go tomorrow.	0.30
I don't go to school every day.	I like going to school every day.	0.55
I don't go to school every day.	I do not go to school every day.	0.95
I don't go to school every day.	We will go tomorrow.	0.30

In this situation, we should select “I do not go to school every day.” from src.en instead of “I don't go to school every day” from src.trans, and not “I go to school every day.”. So, we should consider the similarity of a selected line with the next lines of src.trans to make the best possible selection in the alignment process.

There are additional complexities that must be addressed. Comparing the src.trans lines with the src.en lines is not easy, and it becomes harder when we want to use the similarity rate to choose the correct, real-world translation.

There are many strategies to compare two sentences. We can split each sentence into its words and find the number of words in both sentences. However, this approach has some problems. For example, let us compare “It is origami.” to these sentences: “The common theme what makes it origami is folding is how we create the form.”; “This is origami.”

With this strategy, the first sentence is more similar because it contains all 3 words. However, it is clear that the second sentence is the correct choice. We can solve this problem by dividing the number of words in both sentences by the number of total words in the sentences. However, counting stop words in the intersection of sentences sometimes causes incorrect results. So, we remove these words before comparing two sentences.

Another problem is that sometimes we find stemmed words in sentences, for example “boy” and “boys.” Despite the fact that these two words should be counted as similarity of two sentences, with this strategy, these words are not counted.

The next comparison problem is the word order in sentences. In Python there are other ways for comparing strings that are better than counting intersection lengths. The Python “difflib” library for string comparison contains a function that first finds matching blocks of two strings. For example, we can use difflib to find matching blocks in the strings "abxcd" and "abcd".

Difflib’s “ratio” function divides the length of matching blocks by the length of two strings, and returns a measure of the sequences’ similarity as a float value in the range [0, 1]. This measure is 2.0*M / T, where T is the total number of elements in both sequences, and M is the number of matches. Note that this measure is 1.0 if the sequences are identical, and 0.0 if they have nothing in common. Using this function to compare strings instead of counting similar words helps us to solve the problem of the similarity of “boy” and “boys”. It also solves the problem of considering the position of words in sentences.

Another problem in comparing lines is synonyms. For example, in these sentences: “I will call you tomorrow.”; “I would call you tomorrow.”

If we want to know if these sentences are the same, we should know that “will” and “would” can be used interchangeably.

We used the NLTK Python module and WordNet® to find synonyms for each word and to use these synonyms in comparing sentences. Using synonyms of each word, we created multiple sentences from each original sentence.

For example, suppose that the word “game” has the synonyms: “play”, “sport”, “fun”, “gaming”, “action”, and “skittle”. If we use, for example, the sentence “I do not like game.”, we create the following sentences: “I do not like play.”; “I do not like sport.”; “I do not like fun.”; “I do not like gaming.”; “I do not like action.”; “I do not like skittle.”. We must do the same every word in a sencence.

Next, we try to find the best score by comparing all these sentences instead of just comparing the main sentence. One issue is that this type of comparison takes too much time, because we need to do many comparisons for each selection.

Difflib has other functions (in SequenceMatcher and Diff class) to compare strings that are faster than described solution, but their accuracy is worse. To overcome all these problems and obtain the best results, we consider two criteria: the speed of the comparison function and the comparison acceptance rate.

To obtain the best results, our script provides users with the ability to have multiple functions with multiple acceptance rates. Fast functions with lower quality results are tested first. If they can find results with a very high acceptance rate, we accept their selection. If the acceptance rate is not sufficient, we can use slower but higher accuracy functions. The user can configure these rates manually and test the resulting quality to get the best results. All are well described in documentation [25].

Because we used the Google Translator API and comparison functions that are not specific to any language, the program should be able to align similarly structured languages that are supported by Google Translator with English. Alignment between a language pair not included in Google Translator or WordNet would require use of a different lexical library for synonyms or not using some comparison functions.

Information about each data domain would require adapting parameters in order to provide the best alignment. In general, texts is associated with a domain, i.e. a particular subject area and mode of writing, e.g., a political science essay [13]. As discussed in [14], texts from different domains are likely to use words with different meanings. If a domain is ignored, this can lead to translations that are misleading [26].

The proposed method automatically creates text corpora. Some other aligners work in only a semi-automatic or fully manual manner. If they are unable to align or there is no translation, they leave an empty line. Clearly, this result in problems and some information are lost in process, which does not occur in our solution.

4 Sentence Alignment Metric

We developed a special metric to evaluate aligner quality and tuned its parameters during this research. Special metric was needed to evaluate sentences properly aligned but built from synonyms or with different phrase order. For an aligned sentence, we give 1 point. For a misaligned sentence, we give a -0.2 points penalty. For web service translations, we give 0.4 points. For translations due to disproportion between input files, we give 1 point (when one of two files included more sentences). The score is normalized to fit between 1 and 100. A higher value is better. A floor function can be used to round the score to an integer value. Point weights were determined by empirical research and can be easily adjusted if needed. The score *S* is defined as:

$$S = floor(\frac{20(5A - M + 2T + 5|D|}{L}) \tag{1}$$

where A is the number of aligned sentences, M is the number of misaligned sentences, T is the number of translated sentences, D is the number of lines not found in both language files (one file can contain some sentences that do not exist in the other one), and L is the total number of output lines.

Some additional scoring algorithms were also implemented. These are more suited for comparing language translation quality. We added the BLEU and native implementations of Translation Edit Rate (TER) and Character Edit Rate (CER) by using pycdec and the Rank-based Intuitive Bilingual Evaluation Measure (RIBES). BLEU and TER are well-described in the literature [4-5]. RIBES is an automatic evaluation metric for machine translation, developed in NTT Communication Science Labs [6].

The pycdec module is a Python interface to the cdec decoding and alignment algorithms [15, 16]. The BLEU metric compares phrases from a source text with reference translations of the text, using weighted averages of the resulting matches. It has been shown that BLEU performs well in comparison to reference human translations. BLEU is defined in [3] in terms of the n-gram precision (using n-grams up to length N) p_n and weights w_n (positive only) whose sum is one:

$$BLEU = P_B \exp(\sum_{n=0}^{N} w_n \log p_n) \tag{2}$$

Here, P_B is the brevity penalty, which is given by [3] as:

$$P_B = \{ \begin{array}{c} 1, c > r \\ e^{(1-\frac{r}{c})}, c \le r \end{array} \tag{3}$$

In the equation above, c is the candidate phrase translation length, and r is the length of the reference translation phrase, e is Euler's constant. [3].

The TER metric is intended to capture the quality of essential meaning and fluency of SMT system translations. It measures human translator edits required for a machine translation to match a reference translation. TER accounts for word substitutions, word insertions and deletions, and phrase and word order modifications [5].

We use these algorithms to generate likelihood scores for two sentences, to choose the best one in the alignment process. For this purpose, we used cdec and pycdec. cdec is a decoder, aligner, and learning framework for statistical machine translation and similar structured prediction models. It provides translation and alignment modeling based on finite-state transducers and synchronous context-free grammars, as well as implementations of several parameter-learning algorithms [15, 16].

pycdec is a Python module for the cdec decoder. It enables Python coders to use cdec's fast C++ implementation of core finite-state and context-free inference algorithms for decoding and alignment. The high-level interface allows developers to build integrated MT applications that take advantage of the rich Python ecosystem without sacrificing computational performance. The modular architecture of pycdec separates search space construction, rescoring, and inference.

cdec includes implementations of the basic evaluation metrics (BLEU, TER and CER), exposed in Python via the cdec.score module. For a given (reference, hypothesis) pair, sufficient statistics vectors (SufficientStats) can be computed. These vectors are then summed for all sentences in the corpus, and the final result is converted into a real-valued score.

Before aligning a big data file, it is important to determine the proper comparators and acceptance rates for each one. Files of 1000 – 10,000 lines result in the best performance. We recommend first evaluating each comparison method separately, and then combining the best ones in a specific scenario. For this purpose, we recommend using the binary search method in order to determine the best threshold factor value.

5 Comparison Experiments

Experiments were performed to compare the performance of the proposed method with several other sentence alignment implementations on the data found in [7], using the metric defined earlier. The Polish data in the Translanguage English Database (TED) lectures (approximately 15 MB) includes over 2 million words that are not tokenized.

The additional aligners, all created to develop parallel corpora, used in this experiment were: Bleualign, hunalign, ABBYY Aligner, Wordfast Aligner, and Unitex Aligner. The performance of the aligners was scored using the sentence alignment metric described in Section 3. Table 2 provides the results.

Table 2. Experimental Results

Aligner	Score
Proposed Method	98.94
Bleualign	96.89
Hunalign	97.85
ABBYY Aligner	84.00
Wordfast Aligner	81.25
Unitex Aligner	80.65

Clearly, the first three aligners scored well. The proposed method is fully automatic. It is important to note that Bleualign does not translate text and requires that it be done manually.

As discussed earlier, it is important not to lose lines of text in the alignment process. Table 3 shows the total lines resulting from the application of each alignment method.

Table 3. Experimental Results

Aligner	Lines
Human Translation	1005
Proposed Method	1005
Bleualign	974
Hunalign	982
ABBYY Aligner	866
Wordfast Aligner	843
Unitex Aligner	838

All the aligners compared, other than the proposed method, lose lines of text as compared to a reference human translation. The proposed method lost no lines.

In purpose of showing the output quality with an independent metric we decided to compare results with BLEU, NIST, METEOR and TER (the lower the better), in a comparison with human B1aligned texts. Those results are presented in Table 4.

Table 4. BLEU Comparison Results

Aligner	BLEU	NIST	MET	TER	% of correctness
Human Translation	100	15	100	0	100
Proposed Method	98,91	13,81	99,11	1,38	98
Bleualign	91,62	13,84	95,27	9,19	92
Hunalign	93,10	14,10	96,93	6,68	94
ABBYY Aligner	79,48	12,13	90,14	20,01	83
Wordfast Aligner	85,64	12,81	93,31	14,33	88
Unitex Aligner	82,20	12,20	92,72	16,39	86

6 Conclusions

In general, sentence alignment algorithms are very important for creating of parallel text corpora. Most aligners are not fully automatic, but the one proposed here is, which gives it a distinct advantage. It also allows creating a corpus when sentences exist just in a single language. The proposed approach is also language independent for ones with similar structure to PL or EN.

The results show that the proposed method performed very well in terms of the metric. It also lost no lines of text, unlike the other aligners. This is critical to the end goal of obtaining a translated text. Our alignment method also proved to provide better score when comparing with typical machine translation metrics, and would most likely improve MT systems output quality.

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A Novel Approach to Endoscopic Exams Archiving

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Abstract. The technological evolution verified in recent years caused an increase in the number of therapeutic and diagnostic tests prescribed/performed that led to an exponential growth in the amount of data generated. In the particular case of endoscopy, the data resulting from the procedure is not stored, disallowing their use for future consultation or research purposes and thus forcing the repetition, sometimes unnecessary, of the exam. In order to overcome these issues, an archiving system was developed based on a NoSQL database. The proposed system is supported by a distributed architecture comprising different health care institutions and allows the archiving and replication of the produced examinations. Therefore, the system allows transparent and ubiquitous access to these exams that often correspond to large media files.

Keywords: e-Health; Endoscopy, Video Archiving, NoSQL, Storage, MongoDB.

1 Introduction

Nowadays it is hard to imagine making a diagnosis without resorting to therapeutic and diagnostic tests [1]. They play a key role in improving health care services, enabling health professionals to test and validate their diagnostic hypothesis [2]. The technological evolution has led to an enormous increase in the production of these diagnostics exams [3].

Among the therapeutic and diagnostic tests, endoscopy has an increasingly important role because of its low cost and the results obtained [4]. When there is a need to examine the mucosa of the high GastroIntestinal (GI), the Upper

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GastroIntestinal Endoscopy is considered the ideal method to be used [5]. This method is an endoscopic technique performed by a professional health specialist in the field – Gastroenterologist – who uses an endoscope that is inserted through the patient's mouth, which allows the observation of the upper digestive tract (i.e., esophagus, stomach and duodenum until 2nd part). The endoscope is an equipment with a thin, flexible tube of about 10mm in diameter, with a light system and with an embedded video camera on the end. This camera transmits enlarged images in real-time and with high definition to a display in the room [6].

Frequently, when performing an endoscopy, the resulting output (i.e. video stream) is not stored and it is only harnessed for the necessary data to carry out the report (i.e., some frames taken from the video). Moreover not storing exams can occasionally cause unnecessary exam repetition. The lack of storage in the endoscopic equipment contributes to the lack of a repository of exams. This shortage of repositories makes the research in the field of endoscopy very difficult.

Based on the scenario described previously, the system described in this paper was developed as a new solution to overcome the presented difficulties.

2 Data Storage

For data storage, relational databases are usually the main choice since developers are more familiarized with this model and also because this is the model that presents the greater stability [7]. With the rise of application complexity, more complex database models were developed, such as distributed databases, parallel databases, database clusters and data warehouses. Each of them with unique characteristics that satisfy specific user needs [8].

For Internet based applications with increased complexity the need for greater database performances has raised. Ideally, these databases should allow: a high concurrent reading and writing with high access speed; efficient big data storage with high traffic response capacity; high scalability to support data growth; high availability to avoid service interruptions and maintenance; reduced administration costs [9].

The need for databases with the previous characteristics led to the appearance of non-relational databases, also known as NoSQL databases. NoSQL databases allow non-structured data manipulation, have a better performance for larger quantities of data, allow fast reading and writing, easy scalability and offer inferior costs. Although, it is noteworthy to point out that there are still some downsides associated to this database type, such as not presenting natively the Atomicity, Consistency, Isolation, Durability (ACID) characteristics, which can lead to consistency problems [9, 10].

The data model in a NoSQL database can be one of three types [9, 10]:

- A **Key-value** data model, where a key corresponds to a specific value, which allows higher query speeds, support for mass storage and high concurrency;
- **Column-oriented,** stores data in one extendable column of closely related data;

- **Document-based,** stores and organizes data as collections of documents in JavaScript Object Notation (JSON) or Extensible Markup Language (XML) format.

There are many NoSQL database management systems that implement these models, each one with their own advantages and disadvantages. Some of these, frequently described in the literature, are:

- **Cassandra** – a column-oriented database that presents a very flexible schema, with high scalability, range queries for key support, rich data structure and a powerful query language. It is designed to support the spreading of large amount of data in multiple servers [7, 9, 11];
- **CouchDB** – a *collection* of documents. Documents consist of named fields that have a key/name and a value. It provides a REpresentational State Transfer (REST)-style Application Programing Interface (API) and complies with ACID properties. It supports a Peer-to-Peer (P2P)-based distributed database that supports bi-directional replication. The main disadvantage is that it only supports an interface based in HTTP REST [9, 12];
- **MongoDB** – a document-oriented database and schema-free. Since it does not present a schema, the migration of great quantities of data is usually unnecessary. It provides a key-value store that manages collections of JSON documents and presents a powerful query language and also supports index map-reduce [7, 9, 12, 13].

MongoDB was the chosen database management system for the developed system because of its desirable characteristics such as: *Replication*; *Sharding* (horizontal partition in a database); *GridFS* (allows the storage of files of any size without adding complexity); allows database optimization with *Full Support Index* and *Map/Reduce* [14]. Besides these, it also has a client library that allows applications to communicate with MongoDB, called Driver that handles all interactions with the database in a language appropriate to the application.

Sharding is a technique that allows the horizontal scaling of the database, dividing the data into shards that correspond to physical partitions that may be found at different databases and locations. This technique allows a transparent access to distributed data.

MongoDB databases use a *Sharded Cluster* consisting of three components: **Shards** that are the components that store the data; **Query Routers** that implement the interface with the client applications, directing the operations to the correct *shards* and returning the response; **Config Servers** that store the metadata from the cluster that maps the data of the cluster to the *shards*. The query routers use this information to direct the requests [14].

Replication is achieved from what the MongoDB refers to as *Replica Set* consisting of multiple replicas. In the used configuration there is one primary replica and all the others are considered secondary. Each of these replicas contains, at any time, the same data. In the event of a primary replica fail, a secondary can take its role without information loss [14].

This database stores its data in documents, but these documents have a size limit (16MB in the case of MongoDB). However MongoDB database provides a component called GridFS that divides a file of any size into smaller files that are stored in the database. The great advantage of this component is that it all happens transparently to the client application or user [14]. It is worthwhile noting that the resulting material from an endoscopy exam may contain large media files, which can reach a few gigabytes of data.

In the present paper we propose the architecture of a system designed to archive information and data (endoscopy videos, captured frames and report) produced by endoscopy exams.

3 *MIVarchive*

The system, called *MIVarchive*, allows a seamless integration in the medical facilities where the procedures are performed. It includes all the processes, from the moment of video capture to the moment of local and remote storage. In this system the device used to capture the data from de endoscopic equipment was the *MIVbox* [4]. The workflow of the system is presented in Fig. 1.

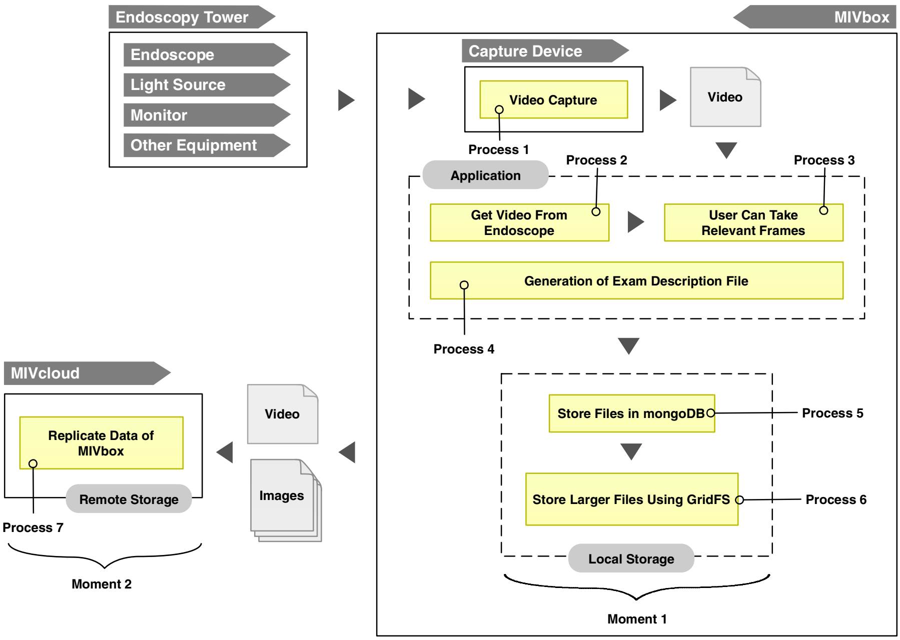

Fig. 1. Workflow of the *MIVarchive* system

During the examination, the video is captured in real-time via the *MIVbox* (**Process 1**).

In the *MIVbox* the video is converted to the desired format (**Process 2**) and transmitted in real-time to a monitor so that the Gastroenterologist can track the procedure [6]. During or after the procedure it is also possible to capture relevant frames (**Process 3**) and write the exam's report.

At this stage, after acquiring the video, the Gastroenterologist has at his disposal a diverse set of information (e.g. videos, frames, report) related to the examination performed. This information is described in a meta-data file stored together with the procedure data (**Process 4**). All this information needs to be archived to allow for subsequent viewing, analysis and editing. This is necessary not only to prevent the loss of relevant information but also to keep up with the progression of a diagnosis. With this, the professionals have at their disposal a basis for comparison between the new exam and examinations carried out previously. It is from this point forward that the *MIVarchive* system starts to provide archive functionalities that do not exist in traditional endoscopic equipments.

The process of data archiving is divided into two moments. In the **first moment**, the data is stored locally on the *MIVbox* (**Process 5 and 6**). In the **second moment,** called remote storage, the files are replicated (**Process 7**) on a remote storage service. This allows the files to be available everywhere in a transparent way to the user. The system assures the oneness of all archived exams, i.e., there will never coexist different versions of the same exam in the system.

4 Architecture

Due to the large volume of data produced by the endoscopic procedures spread across multiple medical facilities' equipment, it was necessary to develop a data storage architecture that allows transparent and ubiquitous access to this data. This architecture is scalable to deal with the continuous increase of data. The designed architecture includes an API accessible in different programming languages, since there are several software applications that need to store and read this data, namely C++ and PHP/JavaScript programs. The description of these applications does not fall within the scope of this paper, however this specification is very important in defining this architecture.

These requirements led to the development of the architecture illustrated in Fig. 2. The Database Layer has all the processes that relate to the database where *Shards* are responsible for the storage of data. Each shard is a different *MIVbox*, being replicated (*Replicas*) in *MIVcloud* (remote storage service). This way, new *Shards* can be added very easily whenever a new *MIVbox* is added. Thus, this system can scale and the information is always available, even in case of failure (since the data is replicated). The *Config Servers* component stores the metadata of the cluster by matching the data with their *Shard*.

The *Query Routers*, also called *mongos*, use the *Config Servers* information to access and perform operations in the desired *Shard*. This component interfaces with the client applications, receiving requests and providing replies, using the information contained in the *Config Servers* to make requests to the *Shard* containing the requested data.

In order to distribute the load of requests from client applications, multiple processes of *Config Servers* and *Query Routers* should be configured.

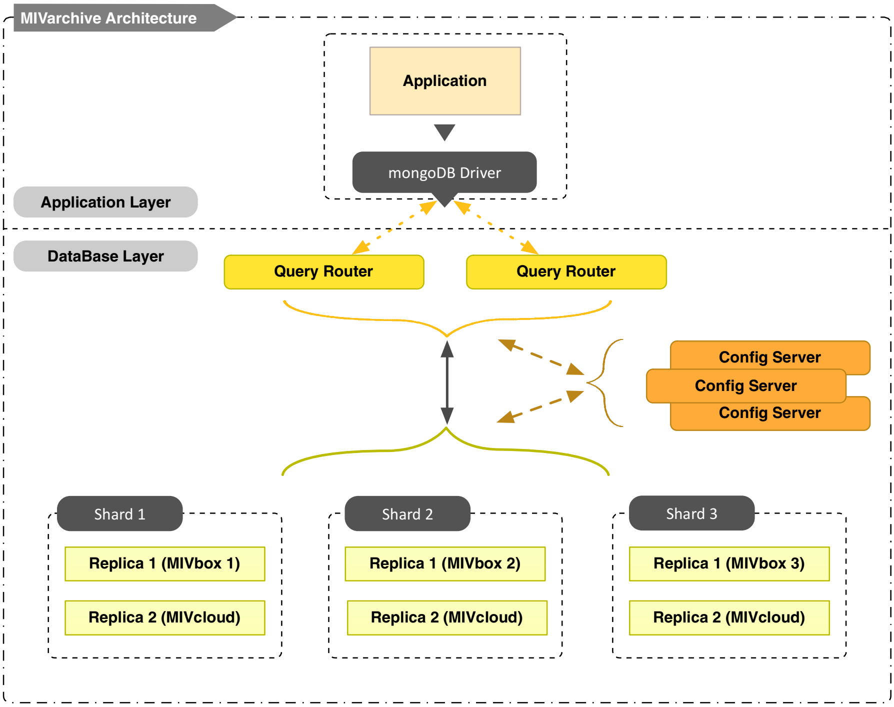

Fig. 2. Architecture of *MIVarchive* using MongoDB

5 *MIVarchive* Implementation Details

The MongoDB databases can be initiated, closed and accessed via the command line or through a driver specific to each programing language. In *MIVarchive*, each *Shard* is a *Replica Set* consisting of two instances of a daemon process called *mongod*. This is a primary daemon process for the MongoDB system that handles data requests, manages data formats, and performs background operations management. This daemon has the following syntax:

```
$ mongod --fork --master --replSet [replica set name] --
port [mongod process port] --dbpath [path to database
folder] --logpath [path to log file]
```

For example,

```
$ mongod --fork --master --replSet mivbox1 --port 10001 -
-dbpath ~/mongodb/mivbox11 --logpath
~/mongodb/mivbox11/mivbox11.log
```

is a command call where:

- **fork** - enables the *mongod* process to run in background which may not be desirable in testing;
- **master/slave** – chooses whether to run the *mongod* process as a replication master or slave. With this option we can specify which instance is the master and which ones are the slaves;
- **replSet** – is an options that allows to configure the replica set name for all the mongod instances belonging to the same replica set;
- **port** – specifies the port where *mongod* is going to run. By default a *mongod* instance listens on the 27017 port;
- **dbpath** – specifies the directory where the *mongod* instance store its data. The default location is in the /data/db directory (\data\db on Windows);
- **logpath** – specifies the path to the log file where all the logging information is written.

After initializing these processes (master-*MIVbox* and slave-*MIVcloud*), it is necessary to proceed with the initialization of the *Replica Set.* To do this, first we must connect the *mongo* shell to one of the nodes in the *admin* database as follows:

```
$ mongo [hostname]:[port]/admin
```

In our case,

```
$ mongo localhost:10001/admin
```

that opens a *mongo* shell, where we run a *Replica Set* initiate command:

```
> db.runCommand({"replSetInitiate" :
  {"_id" : "mivbox1", "members" : [
    {"_id" : 1, "host" : "localhost:10001"},
    {"_id" : 2, "host" : "localhost:10002"}
  ]}
})
```

This is the only necessary procedure in order to have a configured *Replica Set*. This configuration is enough to have a MongoDB database running and replicated. In the case of the system presented here, this corresponds to one of the *Shards* (one *MIVbox*) replicated. This process must be repeated for each *MIVbox* added to the system.

The system needs *Config Servers* to function as a shard cluster. In a production environment there should be at least three. In *MIVarchive*, each *MIVbox* will have a *Config Server* that is initialized running a command like the following:

```
$ mongod --fork --configsvr --port 20001 --dbpath
~/mongodb/config1 --logpath ~/mongodb/config1/config1.log
```

The *configsvr* option allows this *mongod* instance to run as a *Config Server* of a *Shard* cluster.

In *MIVarchive* the last step is to add the Query Router to the *shard/shards* as follows:

```
$ mongos --configdb
localhost:20001,localhost:20002,localhost:20003 --port
27017
```

The *configdb* option specifies the *mongod* instances that will be the *Config Servers* of the system were the hostnames and ports of each instance must be specified.

After the *mongod* instance initialization, it is necessary to proceed to its configuration, which means that the *shards* need to be added. To do that first we must connect to the *mongo* shell connecting to the *mongod* instance and run the command,

```
> db.runCommand({ addshard :
"mivbox1/localhost:10001,localhost:10002" } )
```

to add and configure each shard. It takes the replica set name of the *shard* as explained and configured previously and the *mongod* instance hostname and port of each member of the *shard*. The last step is to enable sharding in a database with the command:

```
> db.runCommand( { enablesharding : "test" } )
```

At this moment the system is up and running, and it is able to receive and respond to the requests from the applications [14].

6 Discussion

There are medical facilities that archive exams on site using its internal network. With the growth of this data they face storage challenges. Unlike solutions such as presented by *Teng et al.* [15] that use a proprietary platform to store the data and where the data goes to a third party, the *MIVarchive* uses an open-source database where the data is stored locally. Security issues are not addressed since the system was designed to work within the medical facility network.

Several existing systems for archive and access to medical exams employ PACS (Picture Archiving and Communication Systems) and use the Digital Imaging and Communications in Medicine (DICOM) standard as a way to integrate into the existing imaging archives. However the DICOM standard was not designed to store objects of information with a large size (e.g. endoscopic procedure video in high definition) [15, 16].

Other systems use commercially available relational database management systems to store the medical imaging data and to create data access interfaces to store, retrieve, modify and query the data present in that repository of data providing a way for multiple modalities to plug in their specific storage accessing mechanism [17]. The system we propose does not require major changes to existing workflows since it is connected to the endoscope and works independently of the workflow already in use.

The proposed architecture for *MIVarchive* is distributed over multiple machines and replicated in a remote storage service enabling fault tolerance and high scalability. The ease with which new machines can be added to the system is another of its advantages. Besides, this system allows transparent and ubiquitous access to very large sized media files.

MIVarchive is currently being assessed in a controlled environment with an amount of about 1.5 TB of data from Upper GI Endoscopy exams.

7 Conclusions

In this paper a novel approach to endoscopic exams archiving was presented. Although the projected system was primarily designed for the Upper GI Endoscopy, it can be easily extended to other instances that deal with large data files (e.g. Capsule Endoscopy, Colonoscopy, Ultrasound).

We believe that the system improves the quality of health care because of the increase of information that health professionals have at their disposal, regardless of where they do the consult/report and presents some unique characteristics at the levels of integration, availability and scalability.

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Design and Implementation of a Competency Repository

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Abstract. Software engineering has become increasingly important over the last years, not only for computer scientists. The research project EVELIN (Experimental improVEment of Learning software engINeering) aims at identifying competencies which students should have, and didactic approaches that most appropriate to foster a set of given competencies in the context of software engineering.

In this context, a web-based software system for storing research documents and research results has been designed and implemented. Important features of this software are its ability to store competencies and competency profiles, represent them in a graphical manner, and link them to courses and didactic approaches.

The repository and its data model are supposed to form the basis for in-depth analyses of influences on the teaching and learning of software engineering – for example by using data-mining methods. In the future, the software should actively support lecturers and educational scientists in their work on improving software engineering education.

Keywords: software engineering education, competencies, competency profiles, competency repository.

1 Introduction

During the last decades, the influence of software in business and everyday life has become greater and greater. The complexity of software is continuously rising and the technical progress in the range of software engineering is extremely rapid. These factors make it difficult to teach students how to design and develop high quality software. Since the boundaries between technical and software engineers become increasingly blurred, this issue is not only relevant for informatics students, but also in related disciplines such as electrical engineering or technical physics. Furthermore the time frame for teaching students software engineering is quite limited, and also soft skills like communication and team work are becoming increasingly important for business and need to be trained at an appropriate level.

Therefore educational processes need to be as effective and efficient as possible. This raises the following question: Which competencies should students have after

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graduating from university, and which didactic approach is appropriate or even best suited to foster a given competency? To find answers to these questions, the project EVELIN (Experimental improVEment of Learning software engINeering) has been established in 2012 as a collaboration of six universities of applied sciences, including the Coburg University of Applied Sciences and Arts.

The research project EVELIN is organized in a decentralized way and the involved universities largely work independently of each other. Yet, most of the researchers are part of cross-cutting working groups.

The improvement of learning software engineering is a complex iterative process. It is not sufficient to only create a competency profile. The lectures and their corresponding educational objectives are changing over time. To find out, which didactic method is appropriate to foster a given competency, promising methods need to be tried and tested in experiments, and results need to be evaluated. Experiments are always performed under certain environmental conditions which can be characterized by structural, process, and outcome variables [2]. Capturing these variables is essential for measuring the quality of an experiment. Finally the research process and the research results need to be substantiated with adequate scientific literature. Due to the fact that the research process is iterative, a significant amount of research data is expected in the next years. It is impossible to manage this data volume manually anyway, let alone in a research project with six distributed locations. Obviously, there is a need for a powerful application to assist the researchers in their duties. Due to the decentralized nature of EVELIN its research data need to be accessible over the internet. The application should also offer interfaces for remote access to easily connect future web based applications in a secured and seamless way.

To meet all these requirements, the development of an enterprise application named CORE (COmpetency REpository) is under way since March 2013. At the outset of the development of the competency repository, there was no shared project server available. Therefore nearly all working documents have been stored on the researchers' private computers, in local networks, or in emails. In addition some, of the research documents, e.g. hand-written notes, are not available in a digital form. Due to the missing integration of all these data sources, searching for a specific content was complicated and time-consuming.

In addition to the ability of merely storing and managing research data, the repository and its data model should form the basis for in-depth analyses of potential influences on the teaching and learning of software engineering – for example by using data-mining methods. In the future, the software should actively support lecturers and researchers in their work on improving software engineering education.

One typical application of the competency repository could be the description of a capstone software engineering project over multiple iterations, and to support lecturers and educational scientists by providing a view on the project's evolution, and highlight lessons learned from some of the iterations, as it is described in [6] and [12].

This article gives a brief overview about the current data model and architecture of the competency repository CORE.

2 The Competency Repository's Architecture

CORE is designed and implemented as a Java enterprise application consisting of a server side Enterprise Java Beans (EJB) module, a web based user interface, and a REST interface for developers of additional applications. The enterprise application also implicitly defines the structure of the relational database by using Persistent Entities as an object-oriented data model which is automatically mapped to a relational database via the features of the Java Persistence API and vice versa.

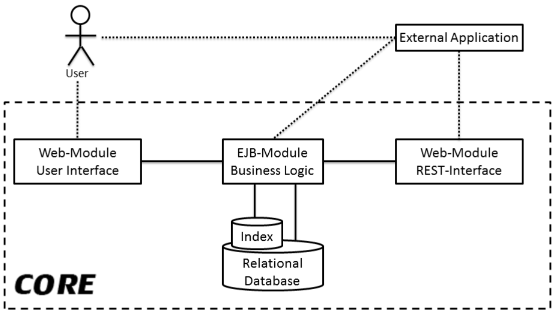

Fig. 1. Architecture of the competency repository

Due to the fact that the improvement of learning and teaching software engineering is an iterative process, an agile development strategy like SCRUM [11] seemed to be an obvious choice. The highly dynamic progress of the project in parallel to the development of the competency repository made it necessary to design the application and its data model in a very flexible, easily extensible, and adjustable way.

2.1 The Database Architecture

The relational database is the most important component of the competency repository. The physical data model must combine the logical data model with the technical demands of an efficient object-oriented enterprise application. Aggravating this situation, the logical data model is not finalized yet. Therefore the physical database architecture has to be as flexible and extensible as possible for future development.

Before the implementation of the competency repository has been started, an entity relationship diagram has been designed in [4], focusing on a specific course covering software requirements modeling and software architectures. This work tries to summarize the current understanding of the research content into a logical data model. The database architecture of the competency repository is inspired by these considerations, although many adjustments and extensions have been made during the research process. The following UML class diagram shows an excerpt of the current data model, with emphasis on competencies, educational objectives, and their relationships within the educational context.

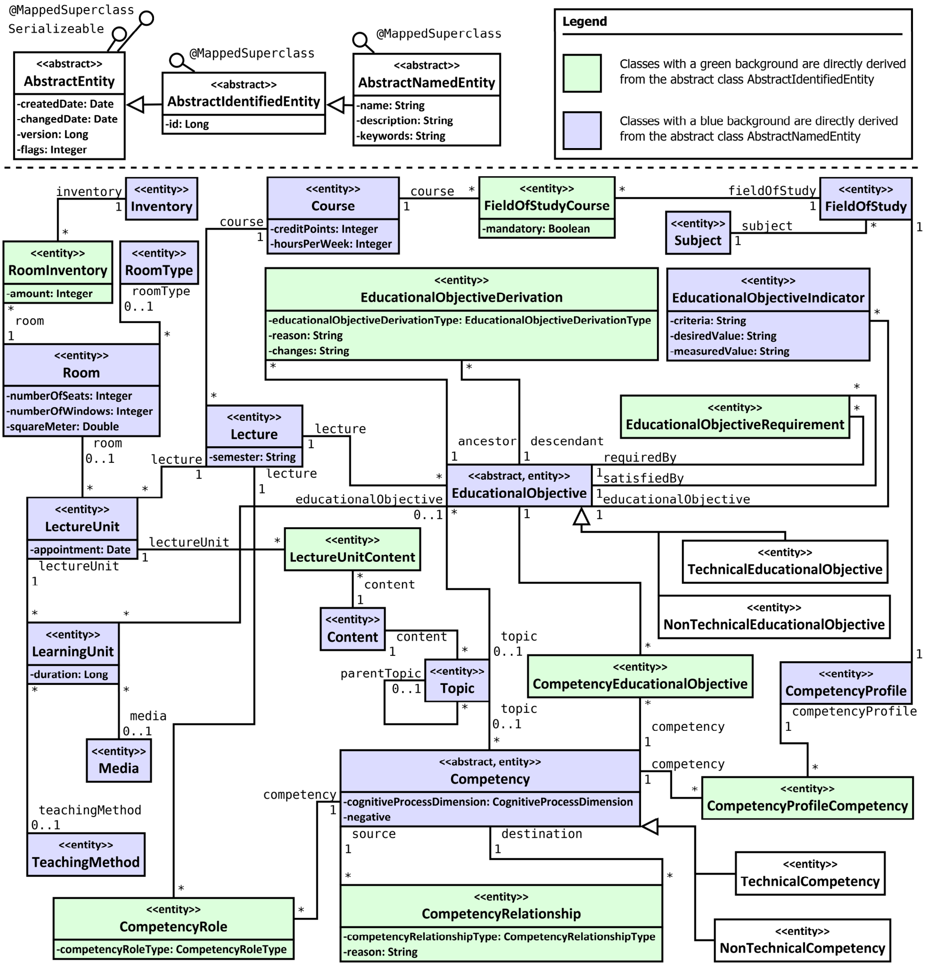

Fig. 2. An excerpt of the CORE data model

There are three abstract super classes – *AbstractEntity*, *AbstractIdentifiedEntity,* and *AbstractNamedEntity* – providing basic attributes for each concrete entity type.

As its name already indicates, one of the most important features of the competency repository is the possibility to store competency definitions and competency profiles for a field of study. Therefore it is necessary to determine, how competencies and their structure can be described and specifically tailored to the context of software engineering.

At this point it is necessary to differentiate between the technical or syntactical layer and the semantic layer. In [10], a competency is defined as a combination of skills, attitudes, and knowledge that enable a group or person to fulfill a role in an organization or society. With reference to [3], a competency consists of non-explicit knowledge in the form of emotions, motivations, attitudes, skills, experiences and willpower and the interiorized values and norms belonging to the emotions and motivations. A very basic approach for the technical description of competencies is the use of reusable competency definitions (RCD), as defined in [5] and [8]. RCD only pays attention to individual competencies and neglects their interrelationships. A proposal for describing relationships between competencies as a directed acyclic graph is given in [9]. In CORE, the data model builds upon these two approaches and extends them by allowing the definition of a taxonomy for competencies, additional relationship types, and the descriptions of negative influences.

In the data model, a competency profile is nothing more than a named set of competency definitions and has to be defined for each field of study. Competency profiles always describe which competencies students of a specific field of study should have acquired after graduating from university. Individual competency profiles of students are hard to handle for legal and technical reasons, and this is why EVELIN treats groups of students as atomic unit.

Another important aspect of CORE is the treatment of educational objectives. Educational objectives of a lecture may evolve over time. New educational objectives might be introduced while some previously used educational objectives are abolished in the course of time. Even a single educational objective may vary in some details. And last, but not least, educational objectives may be moved from one course to a different one. These changes are particularly interesting with respect to the improvement of learning software engineering. To capture the evolution of a given lecture and their related educational objectives, the repository allows the duplication of existing educational objectives. This evolution history is realized by the entity *EducationalObjectiveDerivation*. Educational objectives have to be measurable. Therefore each educational objective is associated with a set of indicators. Beside an atomic criterion, each indicator has a desired value and a measured value, the latter of which is always aggregated, due to the fact that EVELIN treats a group of students as atomic unit. This indicator-based concept is inspired by the goal question metric (GQM) paradigm [1] since educational objectives can clearly be viewed as goals.

Beyond this short excerpt, the data model contains much more entities to describe the research process. Due to the fact that the research process is very dynamic, significant changes on the database architecture are expected to occur in the future.

2.2 The Enterprise Java Bean Module

The business logic is implemented on the server side using stateless Enterprise Java Beans and can be accessed via remote interfaces. Since the development of the data model is still in progress, the architecture should be modular and flexible. This implies that the remote interfaces and the implementation of the business logic should be as generic as possible but should not preclude type specific extensions or variations if necessary. In addition to EJBs for general purposes, there is one EJB for each persistent entity offering type safe CRUD-operations [7] to manage the entities. Standard operations which are available for all entities are declared and implemented in an abstract superclass offering generic methods. In addition to the standard query operations, the repository also provides the capabilities for defining complex search queries by implementing Hibernate Search as full text search engine. All operations for searching and retrieving data are also accessible via a REST interface.

To ensure that only authenticated and authorized users are able to execute a specific operation, each method of an EJB is protected by the Java Authentication and Authorization Service (JAAS).

2.3 The Web Based User Interface

The web based user interface is offering authenticated and authorized users the possibility to interact with repository data. It offers search tools as well as a form based editor for each entity to perform CRUD operations, and allows the generation of predefined parameterized reports. It is built on the basis of Java Server Faces (JSF).

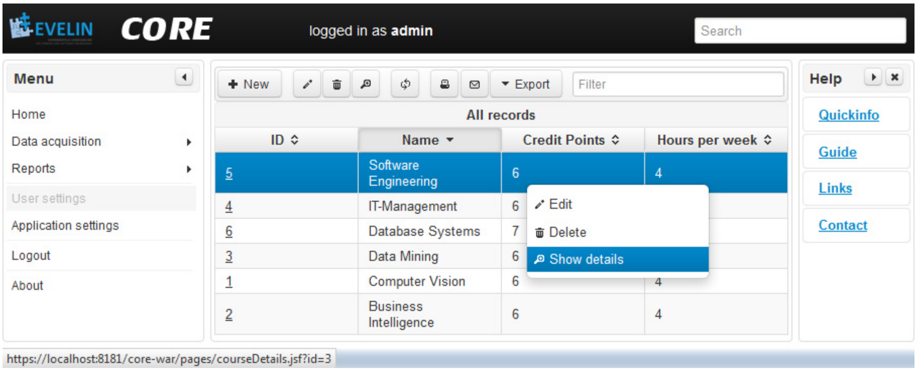

Fig. 3. The web based graphical user interface

3 Summary and Future Work

Competencies are a core concept in modern education, but still target of active research. In particular, the project EVELIN aims at improving software engineering education. Therefore, a large volume of data concerning competencies and various other issues that may affect teaching and learning must be managed and analyzed. To that end, a software system called CORE has been designed and implemented as a centralized repository for competency-related material.

The software was developed incrementally and offers a flexible, easily extensible and adjustable architecture, due to the highly dynamic research process of the improvement of learning and teaching software engineering. To allow access from everywhere, the software offers a web based graphical user interface and allows third party applications to access the repository's data via EJB or a REST interface. In the current version, the repository offers users capabilities to manage competencies, education objectives, and their environment.

The repository and its data model should form the basis for in-depth analyses of influences on the teaching and learning of software engineering – for example by using data-mining methods. In the future, the software should actively support lecturers and educational scientists in their work on improving software engineering education. It is also intended to provide a visual notation and an adequate graphical editor for modeling competencies, their structure, and their environment. Another possible extension could be the support of the SWEBOS (Software Engineering Body of Skills) [13] model for the description of non-technical competencies.

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Proposing Formal Notation for Modeling Collaborative Processes Extending HAMSTERS Notation

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Abstract. As it has been shown in several studies, work in a collaborative manner leads to a better achievement of the goals. There is a large number and variety of processes to achieve a certain goal; however, a lot of these processes have been designed to be carried out in individual work environments. For that reason, in the area of Collaboration Engineering it has been proposed a *Methodology for the Development of Collaborative Processes*, which allows obtaining the collaborative specification of a process. This methodology provides the *Facilitation Process Model* to represent the process flow, however, it has been identified the need to complement this model with elements that contribute to the understanding and future use. Thus, this paper presents a formal notation for modeling collaborative process extending HAMSTERS (Human-centered Assessment and Modeling to Support Task Engineering for Resilient Systems) notation, in order to complement the graphical representation of the model.

Keywords: Collaborative work, facilitation process model, methodology for the development of collaborative processes, HAMSTERS.

1 Introduction

Today it is increasingly marked the progressive trend to work in a collaborative way among people to achieve a common goal, where work is organized in teams and each member interacts with the rest of the group in order to obtain better productivity [1][2]. Integrating collaborative aspects in a process not only aims to improve communication, but also achieve greater participation, commitment, among members of a group working around a common activity, which leads to a better quality of the finished product.

The *Methodology for the Development of Collaborative Processes (MDCP)* [3] has been used to get the collaborative specification of a set of processes under study, specifically a set of usability evaluation methods [4]. In this specification some collaborative processes (involving several people from different areas of knowledge,

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which may be distributed geographically) have been defined, the roles of group members, the communication process, deliverables, among other relevant information in order to obtain results such as [5]: identify more usability problems, improve reliability/avoid that the findings were biased by personal perspective, generate better redesign suggestions, among others. In addition, the MDCP provides the *Facilitation Process Model (FPM)* [3] to represent the process flow and other elements of the collaborative activities.

Focusing on the FPM, it has a number of shortcomings that can be improved in order to enrich the graphical representation of the model. For this purpose, a set of formal notations among which the most prominent is HAMSTERS (Human-centered Assessment and Modeling to Support Task Engineering for Resilient Systems) [6] has been studied, because it provides a series of appropriate elements to complement the graphical representation of the FPM. Thus, this paper presents a proposal formal notation for modeling collaborative process extending HAMSTERS notation.

Section 2 presents the basic theoretical concepts. Section 3 details the analysis of existing notations; then a short introduction to HAMSTERS notation is presented in section 4. The proposal formal notation for modeling collaborative processes is described in section 5. Section 6 presents some notation extended benefits. Finally, section 7 presents some conclusions and future work.

2 Theoretical Concepts

2.1 Collaboration Engineering

The Collaboration Engineering (CE) is an approach to reuse collaborative process design [3]. Collaborative processes need to be explicitly designed, structured and handled. This is the main axis of the CE, in which "reusable collaborative processes are designed and can be transferred to groups, using collaboration techniques and technology" [7]. *Collaboration patterns* and *Thinklets* can be highlighted in CE, which are the base for integrating collaborative work to a determined process through the use of the MDCP [8].

2.2 Methodology for the Development of Collaborative Processes – MDCP

The MDCP allows obtaining the collaborative specification of a process [3]. The methodology is composed by the following phases [3]: task diagnosis, task assessment, activity decomposition, task thinklet match, design documentation and design validation. The methodology allows generating and structuring collaborative processes from identifying recurrent and/or highlights tasks/activities. Thus, the specified activities collaboratively promote communication, coordination and negotiation in order to increase productivity while such activities are performed. The procedure in each phase is as it follows:

Phase 1 – Task diagnosis: at this phase a detailed description of the process (task) is made. The description includes information about deliverables, requirements, participants and other relevant data about the process.

Phase 2 – Task assessment: the activities of the studied process are identified and sequenced.

Phase 3 – Activity decomposition: the activities that will be performed in a collaborative way are defined at this phase. One or more *collaboration patterns* are associated to each activity.

Phase 4 – Task Thinklet match: the relationships between *Thinklets* and collaborative activities are defined at this phase. Identified *Thinklets* should be adapted to resources, the group itself and even the abilities of the people involved in the execution of the process.

Phase 5 – Design documentation: based on the information gathered from the previous phases, the elements defined in the CE are generated [3]: *Facilitation Process Model (FPM)* and *Detailed Agenda*. These documents present the information related to the designed collaborative process.

Phase 6 – Design validation: the collaborative process specification is validated. The methodology offers the following ways of validation [3]: pilot testing, walk-through, simulation and discussion with colleagues.

3 Notations Analysis

Taking into account that the FPM presents the collaborative process flow and elements such as: ID, *Thinklet*, *collaboration pattern* and activity name (within rectangle divided into 4 sections), it has been identified the need to complement this model with elements that mainly contribute to the understanding and future use. For that purpose a series of formal notations have been studied as shown below.

The FPM (proposed by researchers in CE) has some shortcomings that can be improved in order to enrich the graphical representation of the model, these are:

1. Sequential representation of the process flow. There are activities that can be performed independently, concurrently, iteratively, optionally, with passage of information (inputs/outputs), among others. It is not possible to represent these aspects with the elements offered by the FPM.
2. Difficulty in identifying hierarchies of activities. For collaborative activities that are associated with several (2 or more) *collaboration patterns* it is difficult to identify hierarchies among the sub-activities of the associated *Thinklets* (for each *collaboration pattern*).
3. Absence of indicators of inputs and/or outputs. The FPM does not provide elements to represent the inputs (resources required) and/or outputs (deliverables to generate) of each activity that is part of the process.
4. It is not possible to identify participants that perform the activities.
5. Lack of information related with collaborative activities. Activities defined as collaborative ones have associated a collaboration pattern and a *Thinklet*, however, information about subactivities (or steps) that conform the *Thinklet* are not presented.

The FPM is basically a representation of a set of activities or tasks to achieve a goal, which should be performed according to specific protocol established. Based on the above, looking at the FPM it is possible to note the relationship with the notations used in the *Task Analysis (TA)* [9] area.

In HCI (Human-Computer Interaction) and Software Engineering areas, there is an extensive knowledge supporting that AT is useful for developers and/or designers of interactive systems. For this reason, it is appropriate to analyze if the existing TA notations are useful for this work. For this purpose, we have analyzed a set of existing notations for modeling tasks such as: CTT (Concur Task Trees) [10], HTA (Hierarchical Task Analysis) [11][12] and HAMSTERS [6]. These notations facilitate the modeling of tasks that a user can perform on an interactive system. Each of one provides a particular set of elements and they are especially useful for a specific type of system. Table 1 presents (in the left column) the set of requirements needed to represent the FPM based on TA and shows the support that each analyzed notations can provide (in second, third and fourth column). This table was developed based on our experience making FPM.

Table 1. Accomplishment of requirements by the notations

Requirement	CTT	HTA	HAMSTERS
Perform concurrently activities	X		X
Perform iteratively activities	X	X	X
Perform optionally activities	X	X	X
Representation of inputs/outputs of the activities			X
Representation of hierarchies of activities.	X	X	X
Representation of participants/roles that perform the activities.			
Representation of physical activities.	X		X
Representation of cognitive activities (analysis, decision making).	X		X
Representation of data inputs/outputs of the system.	X	X	X
Representation of collaborative/cooperative activities.	X		X
Representation of information sharing.			
Representation of collaborative cognitive activities (analysis, decision making).			
Representation of collaborative data input to the system.			

Based on the information in Table 1 (and considering the shortcomings of the FPM) we have chosen to use HAMSTERS notation (based on CTT notation) because it offers a set of appropriate elements to complement the graphical representation of the FPM as follows: a) shows graphically the relationships (concurrency, iteration, among others) between the activities to achieve a goal, b) it is easy to use and applicable to represent activities in different interactive software systems, c) generates a graphical representation as a tree allowing the hierarchical decomposition of the activities, d) it is possible to represent collaborative/cooperative activities.

Additionally, HAMSTERS includes extensions such as preconditions associated to task executions, data flow across task models, more detailed interactive tasks [6].

As above, we have considered that HAMSTERS is the appropriate notation to complement the graphical representation of the FPM. However, information in Table 1 suggests that this notation should still be complemented, so that detailed information about collaborative activities can be represented and participants/roles who execute these activities are visible in the FPM.

4 Introduction to HAMSTERS

HAMSTERS (Human-centered Assessment and Modeling to Support Task Engineering for Resilient Systems) [6] is a notation for modeling tasks proposed by researchers from the Informatics Research Institute of Toulouse, University Paul Sabatier (Toulouse, France). HAMSTERS notation is inspired by existing notations, especially CTT [13], and it has been designed to remain compatible with CTT (from de the point of view of people building the models) as models are hierarchical and graphically represented featuring operators between tasks [6]. HAMSTERS includes extensions such as [6]: more detailed interactive activities, preconditions associated to task executions, data flow across task models, among others. Furthermore, this notation provides additional extensions that are required for structuring models. Tasks types and the representation of inputs/outputs are presented in [6].

As in CTT [13], each particular task of the model can be either optional, iterative or both. Optional tasks do not require to be executed for the goal to be reached. Iterative property of tasks means that a task can be executed 1 or several times. Additionally, (as in CTT again) temporal relationship between tasks is represented by means of operators as described in [14].

5 Proposal: Extending HAMSTERS Notation for Use in the FPM

Based on the information presented above, and taking into account the shortcomings in the FMP, all the elements of the HAMSTERS notation (such as: types and properties of tasks, relationships between tasks, data inputs/outputs) will be considered to complement the graphical representation of the FPM. Extensions made to HAMSTERS are described in the following points. Examples of notation extensions are based on a case study of usability evaluation.

Representation of an Activity. The image that represents a task/activity (in HAMSTERS) was replaced by the rectangle (divided into 4 sections) used in the FPM traditionally defined. Thus, the task/activity name will be accompanied by the identifier, *Thinklet* and *collaboration pattern*. Additionally, participants of the activity are indicated and if there are data inputs/outputs (see Figure 1).

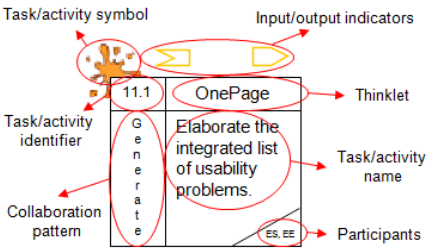


Fig. 1. Representation of an activity in the FPM using HAMSTERS elements

Identification of Participants of the Activities. With HAMSTERS is not possible to represent the roles of the participants in a task/activity, for that reason in the lower right corner of the rectangle (that represents the activity) will be represented the symbol corresponding to the participants of the activity (see Figure 1). In the case of collaborative specification of usability evaluation methods, Table 2 presents the symbols used in the FMP corresponding to the participants of the evaluation methods.

Table 2. Participants symbols

Participant	Symbol
Evaluator Supervisor	ES
Expert Evaluators	EE
User (s)	U
Organization Representative	OR

Relationships between tasks/activities and data input/output. Figures 2 and 3 show the representation of the activity: *Create an integrated list of usability problems* (which belongs to the collaborative specification of usability evaluation method: *heuristic evaluation*) in the traditional FMP and using only HAMSTERS elements, respectively. In the traditional FPM (see Figure 2) the activities are connected by arrows indicating the flow direction of the process, so that representation is sequentially. Using only HAMSTERS elements (see Figure 3) it is possible to identify different types of relationships between activities and if there are data inputs/outputs, but it is not possible to represent elements such as: *collaboration patterns*, *Thinklets* and detailed information about collaborative activities.

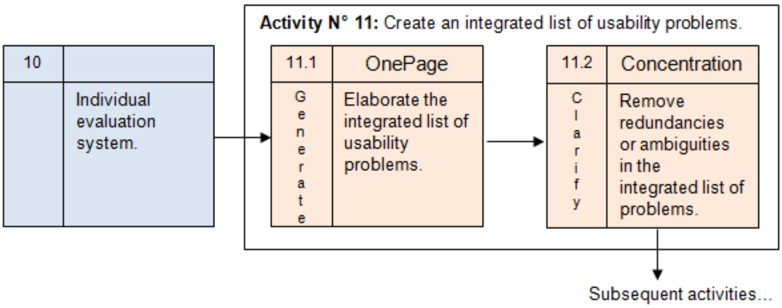


Fig. 2. Representation of the activities in the FPM traditionally defined

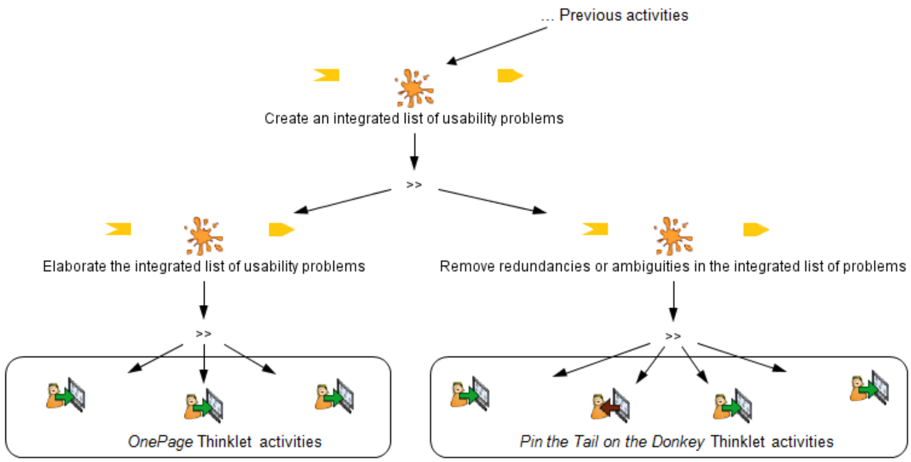
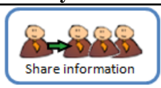
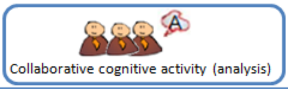


Fig. 3. Representation of the activities using only HAMSTERS elements

Detailed Collaborative Tasks/Activities. The CTT and HAMSTERS notations allow the representation of collaborative/cooperative activities. For this case, this representation has a high level of generality, because we cannot represent detailed information about these activities such as group decision making (consensus), data analysis, among other. Based on the above, the notation is extended through a series of activities/tasks that complement the information related to collaborative activities. Table 3 presents the images that can be used to represent the sub-activities that make up a collaborative activity, these sub-activities correspond to the steps defined in the *Thinklet* used.

Table 3. Graphical representation of collaborative activities

Task/activity	Symbol
Share information.	
Collaborative cognitive activity (analysis).	
Collaborative cognitive activity (decision making).	
Collaborative input data to the system.	

Taking into account the above information, Figure 4 presents a fragment of the FPM extending HAMSTERS notation. In this figure can be seen the extensions made to HAMSTERS in order to satisfying the shortcomings identified in the FPM (see section 3).

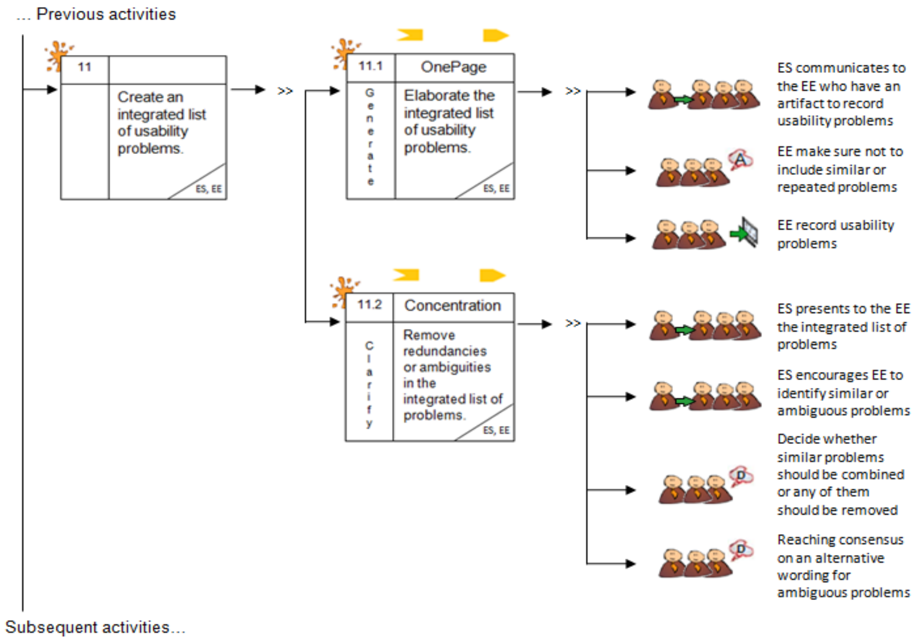


Fig. 4. MFP extending HAMSTERS notation

6 Preliminary Results

Due to space limitations, it is impossible to present the collaborative specification of a usability evaluation method and the results obtained from the *simulation* (way validation proposed by the MDCP).

The collaborative specification has been obtained for the following usability evaluation methods: heuristic evaluation, cognitive walkthrough, formal experiments, questionnaires, constructive interaction, interviews and driver. The activities included in the evaluation methods have been divided into two stages: planning and execution, so for each stage a FPM was developed using the proposed notation. Then, through *simulation* it was verified the set of activities that make collaborative design of the evaluation methods, as well as the set of deliverables specified in each activity. This validation was performed in order to test the logic design and from it make appropriate improvements.

7 Benefits of Extended Notation: MFP + HAMSTERS

Increased Expression/Representation: with the use of the features offered by HAMSTERS we have the ability to provide much more information on the FPM. In the traditionally defined FPM it was possible to see the name, *collaboration pattern*, *Thinklet* and the identifier of the activities, as well as the process flow (activities connected by arrows). Now, using HAMSTERS will be possible to observe all the above information, along the following additional elements: detailed collaborative activities, different types of relationships between activities, inputs/outputs indicators and participants. Thus, for a person interested in carrying out a collaborative process, the information presented in the FPM is easier to understand.

Flexibility in FPM Representation: it is possible to represent concurrent and iterative activities that make up a collaborative process. In addition, through connectors that provide the notation the activities flow is represented not only sequentially, as it was done in the traditional FPM.

Synchronization of Activities: because the HAMSTERS notation is based on CTT, it is possible to synchronize two activities. This is a positive aspect, for example when it is necessary to exchange information, because the output of one activity is the input for the next one.

Hierarchical Decomposition of Activities: this allows better understand the sequence of sub-activities involved in carrying out a general activity that is part of a specified process collaboratively.

The graphical representation of the activities (like a tree) allows a person to see better the hierarchical decomposition of them.

8 Conclusions and Future Work

Because in the FPM have been identified a series of shortcomings related to the representation of information, this paper presents a proposal formal notation for modeling collaborative process extending HAMSTERS notation, this in order to enrich the graphical representation of the FPM. It is expected that through the extensions made to HAMSTERS we can contributed to the understanding and future use of the model.

The inclusion of HAMSTERS elements to a FPM brings a series of benefits that help a person (in charge) when designing and/or implementing a collaborative process. In addition, the extended notation is applicable to represent activities of various processes related to different interactive software systems and facilitates the work of those practitioners of CE who require a collaborative process modeling tool. However, it is necessary to refine the extended notation in order to provide a reliable tool for designers of collaborative processes.

As future work, the extended notation should be evaluated and extensive experimentation should be made, this in order to obtain feedback regarding the use of the same. In the short term we plan to evaluate the collaborative specification of a set of usability evaluation methods, so the FPM's that use the extended notation will be evaluated. On the other hand, it is desirable to develop a software tool that gives support to the modeling and execution of activities (collaborative and non-collaborative) that make up a specific process.

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Selection of Safeguards for Fuzzified Risk Management in Information Systems*

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Abstract. This paper deals with the selection of failure transmission, preventive and palliative safeguards that minimize the maximum risk caused by threats to the assets of an information system (IS) for a given budget. We assume that all the elements in the IS, i.e., the degree of dependence between assets, the valuations of the assets, the severity and frequency of the threats, and the effect induced by safeguards, can be valuated using a fuzzy linguistic scale. This is less stressful on experts and suitable for accounting for imprecision and/or vagueness about the inputs. We model and solve the respective fuzzy optimization problem by means of the simulated annealing metaheuristic and give an example to illustrate the safeguard selection process.

Keywords: Selection of safeguards, risk analysis, information systems, fuzzy logic.

1 Risk Analysis in Information Systems

An information system (IS) [10] consists of a set of *assets*. An *asset* is anything that is of value to the organization and therefore requires protection. These assets are divided into *terminal assets*, which often account for the total value of the IS and are usually data, information or business processes, and *support assets* (hardware, software, personnel, facilities...), which support terminal assets enabling data processing and proper services development.

Although essential, support assets are a continuous source of threats and constitute the *vulnerabilities* of the IS, since a support asset failure may prevent the correct operation of terminal assets. In fact, IS assets are interrelated, forming a directed and acyclic graph. Thus, a failure in one asset can be propagated via other assets to the terminal assets, which are located at the end of the graph, causing huge losses for the organization. We will suppose that the assets, $A_1, ..., A_n$, are arranged so that the first m assets are support assets and the others are terminal assets.

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Risk analysis in IS entails computing the failure transmission probabilities between the system assets, the value of the terminal assets, the degradation caused by threats and their probabilities of materialization or frequencies. There are, however, no historical data, nor any possibility of putting in place mechanisms for obtaining empirical data. Consequently, subjective knowledge from experts is the only way to determine these factors.

Besides, experts may find it difficult to elicit crisp values for these parameters. Alternatively, the experts can select linguistic terms from a linguistic term scale to represent these values, see Table 1. Trapezoidal fuzzy numbers are usually associated with these linguistic terms and risk analysis and management computations are based on trapezoidal fuzzy number arithmetic.

Table 1. Linguistic term scale

Term	Trapezoidal fuzzy number
Very low (VL)	(0, 0, 0, 0.25)
Low (L)	(0, 0.05, 0.15, 0.25)
Medium low (ML)	(0.15, 0.25, 0.35, 0.45)
Medium (M)	(0.35, 0.45, 0.55, 0.65)
Medium high (MH)	(0.55, 0.65, 0.75, 0.85)
High (H)	(0.75, 0.85, 0.95, 1)
Very high (VH)	(0.95, 1, 1, 1)

A more efficient way of allocating the probability of an event without the biases inherent in the use of linguistic scales is reported in [11]. Nevertheless, direct assessment on the basis of this kind of scales is much faster and usual in decision-making processes involving fuzzy logic.

Fuzzy logic was introduced by Lofty A. Zadeh in 1965 [13]. A normalized trapezoidal fuzzy number with support in the interval $[a_1, a_4]$ is a t-tuple $\widetilde{A} = (a_1, a_2, a_3, a_4)$, with $a_1 \leq a_2 \leq a_3 \leq a_4$, and a function $\mu_{\widetilde{A}}(x) : \mathbb{R} \longrightarrow [0, 1]$:

$$\mu_{\widetilde{A}} = \begin{cases} \frac{x-a_1}{a_2-a_1}, & \text{if } a_1 \leq x < a_2 \\ 1, & \text{if } a_2 \leq x < a_3 \\ \frac{x-a_4}{a_3-a_4}, & \text{if } a_3 \leq x \leq a_4 \\ 0, & \text{otherwise} \end{cases},$$

which indicates the degree of membership of each value $x \in \mathbb{R}$ to the number $\widetilde{A}$.

Let us denote by $\mathbb{R}^{\mathcal{TF}}$ the set of all these numbers. If $a_2 = a_3$, then we have a triangular fuzzy number. Note that trapezoidal fuzzy numbers extend to the real numbers. The real number $a \in \mathbb{R}$ can be represented by the trapezoidal fuzzy number (a, a, a, a) and an interval of real numbers, $A = [a, b]$, by the trapezoidal fuzzy number (a, a, b, b).

The usual arithmetic for trapezoidal fuzzy numbers is as follows:

- $(a_1, b_1, c_1, d_1) \oplus (a_2, b_2, c_2, d_2) = (a_1 + a_2, b_1 + b_2, c_1 + c_2, d_1 + d_2)$.

- $(a_1, b_1, c_1, d_1) \ominus (a_2, b_2, c_2, d_2) = (a_1 - d_2, b_1 - c_2, c_1 - b_2, d_1 - a_2)$.
- $(a_1, b_1, c_1, d_1) \otimes (a_2, b_2, c_2, d_2) = (a_1 \times a_2, b_1 \times b_2, c_1 \times c_2, d_1 \times d_2)$.
- $(a_1, b_1, c_1, d_1) \oslash (a_2, b_2, c_2, d_2) = (a_1/a_2, b_1/b_2, c_1/c_2, d_1/d_2)$.

We also consider the internal composition law $\uplus$, which is used in the algorithm to compute the failure transmission probability between support and terminal assets, described in [10]:

$$(a_1, b_1, c_1, d_1) \uplus (a_2, b_2, c_2, d_2) = (a_1 + a_2 - a_1 a_2, b_1 + b_2 - b_1 b_2, c_1 + c_2 - c_1 c_2, d_1 + d_2 - d_1 d_2).$$

Indeed, $\uplus$ is an internal composition law in $\mathbb{R}^{\mathcal{TF}}$, and specifically in $[0, 1]^{\mathcal{TF}}$, because if $0 \leq a_1 \leq b_1 \leq c_1 \leq d_1 \leq 1$ and $0 \leq a_2 \leq b_2 \leq c_2 \leq d_2 \leq 1$, then $0 \leq a_1 + a_2 - a_1 a_2 = 1 - (1 - a_1)(1 - a_2) \leq 1 - (1 - b_1)(1 - b_2) = b_1 + b_2 - b_1 b_2 \leq 1$. Analogously, $0 \leq b_1 + b_2 - b_1 b_2 \leq c_1 + c_2 - c_1 c_2 \leq d_1 + d_2 - d_1 d_2 \leq 1$.

The failure transmission probability $\widetilde{D}(A_i, A_k)$ is computed considering all possible paths connecting A_i with A_k, as well as the failure transmission probability between two consecutive assets A_u and A_v belonging to a path from A_i to A_k in the graph, $\widetilde{d}(A_u, A_v)$. For example, the failure transmission probability from A_1 to A_4 in Fig. 1(a) is computed as

$$\begin{aligned}\widetilde{D}(A_1, A_4) &= \widetilde{d}(A_1, A_3) \otimes \widetilde{d}(A_3, A_4) \uplus \widetilde{d}(A_1, A_2) \otimes \widetilde{d}(A_2, A_4) = \\ &= \widetilde{d}(A_1, A_3) \otimes \widetilde{d}(A_3, A_4) \oplus \widetilde{d}(A_1, A_2) \otimes \widetilde{d}(A_2, A_4) \ominus \\ &\ominus \widetilde{d}(A_1, A_3) \otimes \widetilde{d}(A_3, A_4) \otimes \widetilde{d}(A_1, A_2) \otimes \widetilde{d}(A_2, A_4).\end{aligned}$$

The algorithm proposed in [10] can be used for computing failure transmission probabilities in more complex ISs.

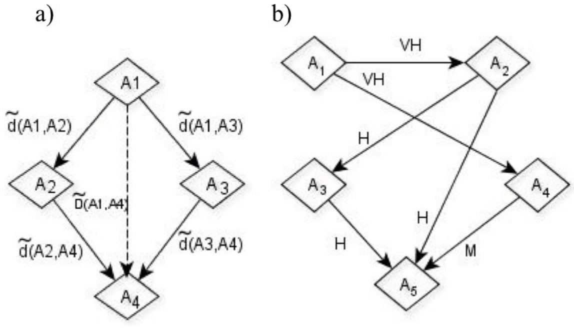

Fig. 1. Examples of ISs

Assets are usually evaluated by taking into account three components: *confidentiality*, *integrity* and *authenticity*. A very common practice is to give each component a monetary value, i.e., attempt to quantify the losses that would be incurred if there were a breach of the confidentiality of terminal assets, the terminal assets were damaged or the terminal assets were unavailable for any length of time. This is a practice recommended by international standards based on ISO 27000 [3–5, 7, 9]. Let us denote the value of the terminal asset A_k by $\widetilde{\mathbf{v}}_k = (\widetilde{v}_{k1}, \widetilde{v}_{k2}, \widetilde{v}_{k3})$.

When a *threat* to a support asset A_i materializes, causing a failure, the organization's biggest concern is to prevent the failure from being transmitted to terminal assets, since this would lead to losses in the value components. We denote by T_j^i the j-th threat to asset A_i, $i = 1, ..., n$, $j = 1, ..., n_i$. T_j^i is defined by the corresponding *degradation* of value components, $\widetilde{\mathbf{d}}^{T_j^i} = (\widetilde{d}_1^{T_j^i}, \widetilde{d}_2^{T_j^i}, \widetilde{d}_3^{T_j^i})$, and the frequency $\widetilde{f}^{T_j^i}$ with which the threat to A_i materializes, where $\widetilde{d}_l^{T_j^i}$ and $\widetilde{f}^{T_j^i}$ are represented by a linguistic term and the respective trapezoidal fuzzy number. Then, the *impact* that threat T_j^i has on the terminal asset A_k, with degradation $\widetilde{\mathbf{d}}^{T_j^i}$, is $\widetilde{\mathbf{I}}_k^{T_j^i} = (\widetilde{d}_1^{T_j^i} \times \widetilde{v}_{k1}, \widetilde{d}_2^{T_j^i} \times \widetilde{v}_{k2}, \widetilde{d}_3^{T_j^i} \times \widetilde{v}_{k3})$.

Finally, the *risk* to asset A_k caused by the threat T_j^i is the product of the impact on the terminal asset multiplied by the probability, $\widetilde{p}$, of this threat reaching asset A_k: $\widetilde{\mathbf{R}}_k^{T_j^i} = \widetilde{p} \times \widetilde{\mathbf{I}}_k^{T_j^i} = \widetilde{p} \times \left(\widetilde{d}_1^{T_j^i} \otimes \widetilde{v}_{k1}, \widetilde{d}_2^{T_j^i} \otimes \widetilde{v}_{k2}, \widetilde{d}_3^{T_j^i} \otimes \widetilde{v}_{k3}\right)$.

However, $\widetilde{p}$ is the product of the frequency $\widetilde{f}^{T_j^i}$ multiplied by the failure transmission probability between assets A_i and A_j, $\widetilde{D}(A_i, A_k)$. Therefore,

$$\widetilde{\mathbf{R}}_k^{T_j^i} = \left(\widetilde{R}_{k1}^{T_j^i}, \widetilde{R}_{k2}^{T_j^i}, \widetilde{R}_{k3}^{T_j^i}\right) = \widetilde{D}(A_i, A_k) \otimes \widetilde{f}^{T_j^i} \otimes \widetilde{\mathbf{I}}_k^{T_j^i} =$$
$$= \widetilde{D}(A_i, A_k) \otimes \widetilde{f}^{T_j^i} \otimes \left(\widetilde{d}_1^{T_j^i} \otimes \widetilde{v}_{k1}, \widetilde{d}_2^{T_j^i} \otimes \widetilde{v}_{k2}, \widetilde{d}_3^{T_j^i} \otimes \widetilde{v}_{k3}\right).$$

The *total risk* for each component l ($l = 1, 2, 3$) of the IS for threat T_j^i is the sum of the risk for each terminal asset:

$$\widetilde{R}_l^{T_j^i} = \bigoplus_{k=m+1}^{n} \left(\widetilde{D}(A_i, A_k) \otimes \widetilde{f}^{T_j^i} \otimes \widetilde{v}_{kl} \otimes \widetilde{d}_l^{T_j^i}\right).$$

In the next section we tackle with selection of safeguards for risk management. A fuzzy optimization problem is modeled to perform this selection process, and a simulated annealing technique is proposed to solve the problem. In Section 3, we illustrate the selection of safeguards with an example. Finally, some conclusions are provided in Section 4.

2 Optimal Selection of Safeguards in Risk Management

The safeguards that should be implemented to reduce the total risk in the IS have to be identified according to the established risk indicators for each threat to the IS.

Safeguards can be *preventive*, if they reduce the frequency $\widetilde{f}$ of threats; *palliative*, if they reduce the degradation $\widetilde{\mathbf{d}}$ caused by threats to assets; or *fault* *transmission safeguards*, if they reduce the fault transmission probability between a pair of consecutive assets, i.e., $\widetilde{d}(A_u, A_v)$.

If the effect of a safeguard is $e\%$, then its parameter is reduced by that amount. The effect caused by a safeguard can be also represented by a linguistic term from the scale in Table 1. For example, the probability of a threat after the implementation of a preventive safeguard with effect $\widetilde{e}$ is reduced to the level $(\widetilde{1} \ominus \widetilde{e}) \otimes \widetilde{f}$.

Let us denote the sets of safeguards by:

- $S : \{S_t^{ik}, i, k = 1, ..., n; t = 1, ..., n_{ik}\}$ is the set of failure transmission safeguards, where S_t^{ik} is the t-th failure transmission safeguard between the consecutive (connected) assets A_i and A_k. The corresponding effect of each safeguard S_t^{ik} on the failure transmission probability $\widetilde{d}(A_i, A_k)$ is denoted by $\widetilde{e}^{S_t^{ik}}$.
- $S^{(pr)} : \{S_t^{(pr)T_j^i}, i = 1, ..., n; j = 1, ..., n_i; t = 1, ..., m_{ij}^{pr}\}$ is the set of preventive safeguards, where $S_t^{(pr)T_j^i}$ is the t-th preventive safeguard for the j-th threat to asset A_i. Its effect on the frequency of the threat T_j^i is $\widetilde{e}^{S_t^{(pr)T_j^i}}$.
- $S^{(pa)} : \{S_t^{(pa)T_j^i}, i = 1, ..., n; j = 1, ..., n_i; t = 1, ..., m_{ij}^{pa}\}$ is the set of palliative safeguards, where $S_t^{(pa)T_j^i}$ is the t-th palliative safeguard for the j-th threat to asset A_i. Its effect on the degradation in the component l of the threat T_j^i is $\widetilde{e}_l^{S_t^{(pa)T_j^i}}$.

We can select different packages of safeguards for reducing risk. These packages will be represented by binary vectors $\mathbf{x}_{ik} = (x_t)_{t=1}^{n_{ik}}$, $\mathbf{x^{pr}}_{ij} = (x_t)_{t=1}^{m_{ij}^{pr}}$, $\mathbf{x^{pa}}_{ij} = (x_t)_{t=1}^{m_{ij}^{pa}}$, respectively, where $x_t = 1$ if the t-th safeguard is selected.

The optimization problem to be solved consists of minimizing the maximum risk for the IS subject to a financial budget c:

$$\begin{aligned} &min\ z = max_{i,j,l}\{\widetilde{R}_l^{T_j^i}\} \\ &\text{s. t.} \\ &\qquad \textstyle\sum_{i=1}^{n}\sum_{k=1}^{m_{ik}}\mathbf{x}_{ik}\mathbf{c}_{ik} + \sum_{i=1}^{n}\sum_{j=1}^{n_i}\mathbf{x^{pr}}_{ij}\mathbf{c^{pr}}_{ij} + \sum_{i=1}^{n}\sum_{j=1}^{n_i}\mathbf{x^{pa}}_{ij}\mathbf{c^{pa}}_{ij} \leq c \end{aligned}$$

where $\mathbf{c}_{ik}$, $\mathbf{c^{pr}}_{ij}$ and $\mathbf{c^{pa}}_{ij}$ are safeguard cost vectors.

Note that we have a set of threats that have to be considered sequentially rather than simultaneously to compute the risk in the IS. However, no information about this sequentiality is available. Consequently, we have a fuzzy multi-objective optimization problem whose objective functions represent new (reduced) risks as a result of the possible application of preventive and palliative safeguards regarding these threats and the application of failure transmission safeguards. Thus, these risks are not summable, and we have decided to minimize the maximum risk.

The objective function has to be total order and fuzzy numbers are not. The definition of indexes to rank fuzzy trapezoidal numbers has been a transcendental issue in the history of fuzzy logic. More than thirty ranking methods for trapezoidal fuzzy numbers are described in [1, 2, 12]. In this paper we use the index proposed by Murakami et al [8], which computes the centroid of the compared fuzzy numbers: If $\widetilde{A} = (a_1, a_2, a_3, a_4)$ then its centre of gravity is the point $(\bar{X}_{\widetilde{A}}, \bar{Y}_{\widetilde{A}})$, with

$$\bar{Y}_{\widetilde{A}} = \frac{\frac{a_3-a_2}{a_4-a_1}+2}{6} \quad \text{and} \quad \bar{X}_{\widetilde{A}} = \bar{Y}_{\widetilde{A}}\,(a_3-a_2) + \left(1-\bar{Y}_{\widetilde{A}}\right)(a_4-a_1)\,.$$

The Murakami index first compares the abscissas of the centroids. The fuzzy numbers whose centroids have bigger abscissas are better ranked. If abscissas are equal, then the one with the higher ordinate is ranked first.

The fuzzy optimization problem is a combinatorial problem: its complexity increases with the dimension of the asset network since different packages of failure transmission safeguards could be considered in each arc, and the selected safeguards for the assets closest to the terminal assets also reduce the fault transmission probability of the assets that are farthest away. Moreover, the solutions would be less computationally feasible with a larger asset network, since it would be more involved to compute the new failure transmission probabilities across the network.

Metaheuristics have to be used to solve this especially complex and combinatorial problem ($2^{\sum_{i,k} n_{ik} + \sum_{i,j} m_{ij}^{pr} + \sum_{i,j} m_{ij}^{pa}}$ possible solutions and $3 \times s$ (number of threats under consideration) fuzzy risk elements in the objective function), it is necessary the use of metaheuristics for its resolution.

Simulated annealing (SA) is one of the most used metaheuristics because of its ease of implementation and efficiency [6]. Its pseudocode is as follows:

- Randomly generate an initial feasible solution x_0. Do $x^* = x_0, f^* = f(x_0), i = 0$. Select the initial temperature $T_0 = T$ (T_i temperature at step i).
- Repeat until the stopping criterion is satisfied:
  - Randomly generate $y \in N(x_i)$
  - If $f(y) - f(x_i) \leq 0$, then
    - $x_{i+1} = y$
    - If $(f(x^*) > f(x_i))$, then $x^* = x_i, f^* = f(x_i)$

    otherwise:
    - $p \sim U(0,1)$
    - If $p \leq e^{-(f(y)-f(x_i))/T_i}$, then $x_{i+1} = y$
  - Update temperature, $i = i + 1$

The basic idea of SA is as follows. An initial feasible solution is randomly generated. A new solution is randomly generated from the neighborhood of the current solution at each iteration. If the new solution is better than the current one, then the algorithm moves to that solution. Otherwise, there is a certain probability of moving to a worse solution. The acceptance of worse solutions makes for a broader search for the optimal solution and avoids trapping in local optima in early iterations.

The search is initially very diversified, since practically all moves are allowed. As the temperature drops, the probability of accepting a worse move decreases, and only better move will be accepted when it is zero. This makes SA work like hill climbing.

3 An Illustrative Example

Let us consider the IS in Fig. 1(b). The asset A_5 is terminal and its monetary value (in thousands of units) is $\widetilde{\boldsymbol{v_5}} = ((10, 15, 20, 25), (18, 20, 23, 30), (12, 15, 26, 30))$, for the three components, respectively. The probabilities of failure transmission from each support asset to the terminal asset are:

$$
\begin{aligned}
\widetilde{D}(A_4, A_5) &= \widetilde{d}(A_4, A_5) = M = (0.35, 0.45, 0.65, 0.75),\\
\widetilde{D}(A_3, A_5) &= \widetilde{d}(A_3, A_5) = H = (0.75, 0.85, 0.95, 1),\\
\widetilde{D}(A_2, A_5) &= \widetilde{d}(A_2, A_5) \uplus (\widetilde{d}(A_2, A_3) \otimes \widetilde{D}(A_3, A_5)) =\\
&= H \uplus (H \otimes H) = (0.93, 0.97, 0.99, 1),\\
\widetilde{D}(A_1, A_5) &= (\widetilde{d}(A_1, A_4) \otimes \widetilde{D}(A_4, A_5)) \uplus \left(\widetilde{d}(A_1, A_2) \otimes \widetilde{D}(A_2, A_5)\right) =\\
&= (VH \otimes M) \uplus (VH \otimes (0.93, 0.97, 0.99, 1)) = (0.92, 0.98, 0.99, 1).
\end{aligned}
$$

We consider five threats with frequencies and degradations shown in Table 2. The risks induced for each individual threat are shown in Table 3.

Let us consider the 32 failure transmission safeguards in Table 4 and the 22 palliative and 16 preventive safeguards for the threats in Table 5. The budget is $c = 5000$ monetary units. Then, we have to solve the following fuzzy optimization problem to identify the safeguards to be implemented:

$$
\begin{aligned}
&min\ z = max_l\{\widetilde{R}_l^{T_1^1}, \widetilde{R}_l^{T_1^2}, \widetilde{R}_l^{T_2^2}, \widetilde{R}_l^{T_1^3}, \widetilde{R}_l^{T_1^4}\}\\
&\text{s. t.}\\
&\qquad \textstyle\sum_{i=1}^{n}\sum_{k=1}^{m_{ik}} \mathbf{x}_{ik}\mathbf{c}_{ik} + \sum_{i=1}^{n}\sum_{j=1}^{n_i} \mathbf{x^{pr}}_{ij}\mathbf{c^{pr}}_{ij} + \sum_{i=1}^{n}\sum_{j=1}^{n_i} \mathbf{x^{pa}}_{ij}\mathbf{c^{pa}}_{ij} \le 5000
\end{aligned}
$$

with

$$
\begin{aligned}
\widetilde{R}_l^{T_1^1} &= \widetilde{D'}(A_1, A_5) \otimes \widetilde{f}^{T_1^1} \otimes (\otimes_{t=1}^{4}(\widetilde{1} \ominus \widetilde{e}^{S_t^{(pr)T_1^1}})) \otimes \widetilde{d}_l^{T_1^1} \otimes (\otimes_{t=1}^{6}(\widetilde{1} \ominus \widetilde{e}^{S_t^{(pa)T_1^1}})),\\
\widetilde{R}_l^{T_1^2} &= \widetilde{D'}(A_2, A_5) \otimes \widetilde{f}^{T_1^2} \otimes (\otimes_{t=1}^{2}(\widetilde{1} \ominus \widetilde{e}^{S_t^{(pr)T_1^2}})) \otimes \widetilde{d}_l^{T_1^2} \otimes (\otimes_{t=1}^{3}(\widetilde{1} \ominus \widetilde{e}^{S_t^{(pa)T_1^2}})),\\
\widetilde{R}_l^{T_2^2} &= \widetilde{D'}(A_2, A_5) \otimes \widetilde{f}^{T_2^2} \otimes (\otimes_{t=1}^{2}(\widetilde{1} \ominus \widetilde{e}^{S_t^{(pr)T_2^2}})) \otimes \widetilde{d}_l^{T_2^2} \otimes (\otimes_{t=1}^{3}(\widetilde{1} \ominus \widetilde{e}^{S_t^{(pa)T_2^2}})),\\
\widetilde{R}_l^{T_1^3} &= \widetilde{D'}(A_3, A_5) \otimes \widetilde{f}^{T_1^3} \otimes (\otimes_{t=1}^{4}(\widetilde{1} \ominus \widetilde{e}^{S_t^{(pr)T_1^3}})) \otimes \widetilde{d}_l^{T_1^3} \otimes (\otimes_{t=1}^{5}(\widetilde{1} \ominus \widetilde{e}^{S_t^{(pa)T_1^3}})),\\
\widetilde{R}_l^{T_1^4} &= \widetilde{D'}(A_4, A_5) \otimes \widetilde{f}^{T_1^4} \otimes (\otimes_{t=1}^{4}(\widetilde{1} \ominus \widetilde{e}^{S_t^{(pr)T_1^4}})) \otimes \widetilde{d}_l^{T_1^4} \otimes (\otimes_{t=1}^{5}(\widetilde{1} \ominus \widetilde{e}^{S_t^{(pa)T_1^4}})),
\end{aligned}
$$

where $\widetilde{D'}(A_i, A_5)$ is obtained from $\widetilde{D}(A_i, A_5)$ by multiplying the initial value of each arc by the reduction caused by the effect of failure transmission safeguards on that arc.

This optimization problem has $3 \times 5 = 15$ fuzzy risk elements in the objective function and $2^{(32+22+16)} = 1.18 \times 10^{21}$ possible solutions.

The initial solution consists of randomly generated packages of failure transmission, preventive and palliative safeguards. The total cost of the initial solution obviously has to be below 5000 to be feasible. The neighborhood of a given solution x_i, $N(x_0)$, includes all the feasible solutions (associated costs $\le$ 5000) whose associated packages of safeguards differ by at most one safeguard from x_i.

The initial temperature is computed so that the acceptance probability of a worse solution than the initial one is at least 0.9, i.e., $e^{-(f(y)-f(x_0))/T_0} \ge 0.9$,

Table 2. Threats to the assets

Asset	Threat (T_j^i)	Frequency ($\widetilde{f}^{T_j^i}$)	Degradation ($\widetilde{\mathbf{d}}^{T_j^i}$)
A_1	T_1^1	H	(M, H, MH)
A_2	T_1^2	M	(H, M, MH)
A_2	T_2^2	H	(M, M, M)
A_3	T_1^3	MH	(H, H, M)
A_4	T_1^4	H	(H, MH, M)

Table 3. Risks to A_5 before applying the safeguards

Threat	Confidentiality	Integrity	Authenticity
T_1^1	$(2898, 5622.7, 13449.1, 19500)$	$(6210, 10620.7, 23230.3, 30000)$	$(4554, 8121.7, 18339.7, 25500)$
T_1^2	$(2929.5, 5565.4, 13449.1, 19500)$	$(1367.1, 2946.4, 7786.3, 12675)$	$(2148.3, 4255.9, 10617.7, 16575)$
T_2^2	$(2929.5, 5565.4, 13449.1, 19500)$	$(2929.5, 5565.4, 13449.1, 19500)$	$(2929.5, 5565.4, 13449.1, 19500)$
T_1^3	$(3712.5, 7044.4, 17598.7, 25500)$	$(3712.5, 7044.4, 17598.7, 25500)$	$(1732.5, 3729.4, 10188.7, 16575)$
T_1^4	$(2362.5, 4876.9, 12905.7, 19500)$	$(1732.5, 3729.4, 10188.7, 16575)$	$(1102.5, 2581.9, 7471.7, 12675)$

$\forall y \in N(x_0)$. If we identify an upper bound for $(f(y) - f(x_0))$, i.e., $M \geq f(y) - f(x_0)$ then, $T_0 = -M/\ln(0.9)$. According to the Murakami ranking index, we can consider $M = max_{i,j,l}\{\mathbf{x}_{\widetilde{R}_l^{T_j^i}}\}$, which is obviously achieved when no safeguard is considered, leading to $M = 19077$ and $T_0 = 181064$.

Table 4. Failure transmission safeguards

Asset	Safeguards (Tag, Effect, Cost)
A_4	$S^{45} = \{(S_1^{45}, M, 205), (S_2^{45}, L, 124), (S_3^{45}, ML, 230), (S_4^{45}, M, 189),$ $(S_5^{45}, L, 104), (S_6^{45}, M, 167), (S_7^{45}, M, 178), (S_8^{45}, L, 98)\}$
A_3	$S^{35} = \{(S_1^{35}, M, 198), (S_2^{35}, L, 100), (S_3^{45}, M, 123), (S_4^{35}, M, 167),$ $(S_5^{35}, L, 89), (S_6^{35}, M, 178), (S_7^{35}, M, 209), (S_8^{35}, L, 100)\}$
A_2	$S^{25} = \{(S_1^{25}, M, 203), (S_2^{25}, M, 198), (S_3^{25}, L, 170)\}$
	$S^{23} = \{(S_1^{23}, L, 143), (S_2^{23}, M, 178), (S_3^{23}, M, 154), (S_4^{23}, M, 190), (S_5^{23}, L, 102)\}$
A_1	$S^{14} = \{(S_1^{14}, M, 178), (S_2^{14}, M, 160), (S_3^{14}, L, 120), (S_4^{14}, L, 105)\}$
	$S^{12} = \{(S_1^{12}, L, 120), (S_2^{12}, M, 180), (S_3^{12}, L, 104), (S_4^{12}, M, 200)\}$

Table 6 shows the solutions output, whose associated cost is 4850 monetary units, whereas Table 7 shows the new risk values once the selected safeguards are implemented. If we compare the risk values for A_5 in Tables 3 and 7, i.e., before and after the implementation of the selected safeguards, we find that the risk reduction is significant. Note that the risks for the whole IS are the same as for asset A_5, since it is the only terminal asset.

The maximum risk is associated with threat T_1^1 both before and after the implementation of the selected safeguards, but the sum of the centroids of each component are 48.560 and 10.373 monetary units, respectively.

Table 5. Preventive and palliative safeguards

Palliative	Safeguards (Tag, Effect (C, I, A), Cost)
$S^{T_1^1 pa}$	$\{(S_1^{T_1^1 pa}, (H,H,H), 520), (S_2^{T_1^1 pa}, (M,L,M), 250), (S_3^{T_1^1 pa}, (L,L,VL), 100), (S_4^{T_1^1 pa}, (ML,VL,L), 96), (S_5^{T_1^1 pa}, (VL,L,ML), 110), (S_6^{T_1^1 pa}, (ML,M,L), 78)\}$
$S^{T_1^3 pa}$	$\{(S_1^{T_1^3 pa}, (H,H,H), 535), (S_2^{T_1^3 pa}, (L,L,VL), 89), (S_3^{T_1^1 pa}, (H,H,H), 670), (S_4^{T_1^3 pa}, (ML,H,L), 537), (S_5^{T_1^3 pa}, (H,L,ML), 477)\}$
$S^{T_1^2 pa}$	$\{(S_1^{T_1^2 pa}, (H,H,H), 496), (S_2^{T_1^2 pa}, (VL,L,ML), 110), (S_3^{T_1^2 pa}, (ML,M,L), 78)\}$
$S^{T_2^2 pa}$	$\{(S_1^{T_2^2 pa}, (M,L,M), 195), (S_2^{T_2^2 pa}, (L,L,VL), 89), (S_3^{T_2^2 pa}, (ML,VL,L), 56)\}$
$S^{T_1^4 pa}$	$\{(S_1^{T_4^3 pa}, (H,H,H), 539), (S_2^{T_1^4 pa}, (L,L,VL), 110), (S_3^{T_1^4 pa}, (ML,H,L), 478), (S_4^{T_1^4 pa}, (ML,H,L), 495), (S_5^{T_1^4 pa}, (H,H,H), 689)\}$
Preventive	**Safeguards (Tag, Effect, Cost)**
$S^{T_1^1 pr}$	$\{(S_1^{T_1^1 pr}, H, 367), (S_2^{T_1^1 pr}, H, 485), (S_3^{T_1^1 pr}, ML, 100), (S_4^{T_1^1 pr}, ML, 120)\}$
$S^{T_1^3 pr}$	$\{(S_1^{T_1^3 pr}, M, 198), (S_2^{T_1^3 pr}, L, 100), (S_3^{T_1^1 pr}, M, 123), (S_4^{T_1^3 pr}, M, 167)\}$
$S^{T_1^2 pr}$	$\{(S_1^{T_1^2 pr}, M, 203), (S_2^{T_1^2 pr}, M, 198)\}$
$S^{T_2^2 pr}$	$\{(S_1^{T_2^2 pr}, M, 178), (S_2^{T_2^2 pr}, M, 160)\}$
$S^{T_1^4 pr}$	$\{(S_1^{T_4^3 pr}, M, 178), (S_2^{T_1^4 pr}, M, 160), (S_3^{T_1^4 pr}, L, 120), (S_4^{T_1^4 pr}, L, 105)\}$

Table 6. Final selection of failure transmission, preventive and palliative safeguards

Arc	Failure transmission safeg.	Threat	Preventive safeg.	Palliative safeg.
(A_4, A_5)	(10100111)	T_1^1	(0011)	(000011)
(A_3, A_5)	(10111110)	T_1^2	(00)	(110)
(A_2, A_5)	(110)	T_2^2	(00)	(101)
(A_2, A_3)	(01111)	T_1^3	(0010)	(00000)
(A_1, A_4)	(0100)	T_1^4	(0100)	(00000)
(A_1, A_2)	(0101)			

Table 7. Risks to A_5 after the implementation of the selected safeguards

Threat	Confidentiality	Integrity	Authenticity
T_1^1	(16.9, 161.72, 936.2, 3681.5)	(32.70, 239.7, 1295.6, 5197.4)	(25.1, 198.6, 1576.7, 5777.1)
T_1^2	(0, 49.6, 458.1, 1791.2)	(0, 29.7, 289.7, 1397.1)	(0, 24.6, 352.6, 1552.9)
T_2^2	(0, 49.6, 458.1, 1791.2)	(0, 29.7, 289.7, 1397.1)	(76, 379.3, 2074.3, 5588.4)
T_1^3	(12.2, 110.5, 647.2, 2465.6)	(21.9, 147.3, 744.3, 2958.7)	(6.8, 58.5, 487.1, 1923.2)
T_1^4	(34.8, 245.5, 1176.8, 3793.2)	(62.7, 327.4, 1353.3, 4551.9)	(19.5, 129.9, 885.7, 2958.7)

4 Conclusions

The selection of failure transmission, preventive and palliative safeguards that minimize the maximum risk caused by threats to the assets of an information system (IS) for a given budget is a combinatorial optimization problem, which has to be solved by means of a metaheuristic.

Moreover, we have assumed that all the elements in the IS risk analysis can be rated using linguistic terms with associated normalized fuzzy numbers. This is less stressful on experts and useful for accounting for imprecision and/or vagueness concerning the elements. However, this involves the inclusion of fuzzy elements in the optimization problem, such as the ranking of fuzzy numbers to derive a total order in the objective function. We have modeled this optimization problem, which we have solved by means of simulated annealing.

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Understanding Information Security Culture: A Survey in Small and Medium Sized Enterprises

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Abstract. Information security is a relevant fact for current organizations. There are factors inextricably linked to this issue, and one cannot talk about information security in an organization without addressing and understanding the information security culture of that institution. Maximizing the organizational culture within an organization will enable the safeguard of information security. For that, we need to understand which the inhibiting and the enabling factors are. This paper contributes to point out those factors by presenting the results of a survey concerning information security culture in small and medium sized enterprises (SMEs). We discuss the results in the light of related literature, and we identify future works aiming to enhance information security within organizations.

Keywords: Security Culture, Information Security, Small and Medium Sized Enterprises, Information Security Culture.

1 Introduction

One of the major benefits of the creation of an information security culture is the protection of the organization assets in which will have "direct interaction with information assets and thereby minimize the threats that user behaviour poses to the protection of information assets" [1] (p.1). The importance of creating a security culture within organization settings arises from the fact that the human dimension in information security is always considered to be the weakest link [2]; [3]; [4]; [5]; [6]. Therefore, the creation of an information security culture is necessary for effective information security management [7]. Within the scope of this paper, a review of literature on security culture was done. Although there is a high number of works concerning security culture, there seem to be no agreement on the meaning of this term. Therefore, we proceed to present some concepts in order to help frame and understand this study:

- The author [8] defines security culture as: the whole of human attributes, such as behaviors, attitudes and values which may contribute to the protection of all kinds of information within a certain organization.
- Another author [9] claims that security culture reflects the attitudes, beliefs, perceptions and values that employees share as far as security is concerned.

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- For [10], security culture consists of attitudes, beliefs and perceptions shared by the members of the group, who define norms and values which, in turn, determine the way they act and react regarding risk and the risk control system.

The definitions listed are clear with respect to the definition of security culture, and although they mention different aspects, they are consensual in some respects, namely when considering security culture as values and beliefs.

In this work, we consider that beyond the beliefs, values and behaviors of executives and workers regarding information security, security culture is also a policy that must be conducted according to the mission of the organization with a focus on information security.

There is another term closely related to security culture: organizational culture. This concept holds a more subjective aspect, which at times makes it different within the organization itself.

This subjectivity, as well as the lack of agreement on what constitutes a security culture, represents a deadlock regarding the identification of the factors needed to create a security culture. This paper attempts to fill this gap by studying the enabling and inhibiting factors for the implementation of an information security culture within SMEs in Portugal.

The structure of the paper is as follows. After this introduction, we proceed with a review of literature on information security and relevant terms. Afterwards, in section 3, we approach the theoretical foundations guiding this study. In section 4, we describe the research methodology. The results of the study are discussed in section 5. In the last section, we present conclusions in the light of the results and we propose future works.

2 The Importance of Information Security

Information is one of the present organizations main assets. Therefore, it is natural that the systems supporting information are increasingly exposed to either intentional or accidental threats. These threats put at risk the confidentiality, integrity and availability of information as well as the systems which manipulate it. Consequently, the people in charge of organizations should consider and implement measures aiming to prevent, detect and respond to such threats.

In order to succeed in their IS protection actions, organizations need to adopt several types of measures. They need to implement not only information security technical measures, but also and ever more organizational and social measures, as this is the only way to reach organizational well-being as well as to maintain organizations integrity [11].

Information security is a critical aspect for most organizations. The growing importance of information technology and the massive use of internet and its related services brought about an increasingly higher number of attacks which information is exposed to. Therefore, the need to protect information is urgent.

Information represents one of the current organizations main assets, and the systems which support that information are increasingly more exposed to threats. The CIA triad – Confidentiality, Integrity and Availability – represents the conventional properties which guide the analysis, planning and implementation of information security. Other properties such as legitimacy and authenticity are emerging because of the widespread of the use of commercial transactions through computer networks worldwide.

The classic principles of CIA can be explained as follows:

- Confidentiality – access to information restricted to legitimate entities, that is to say those authorized by the information owner.
- Integrity – manipulated information must preserve all the original features established by the information owner, ensuring that the content is not altered without permission.
- Availability – the information is available for legitimate use at all times, whenever necessary.

These principles are considered traditional for the authors [11], who claim that they are good as long as they serve their purpose, but who find them very restrictive and applicable mainly to the information viewed as data kept in computer systems. Therefore, these authors add other principles without which future organizations may face serious problems. These new principles were condensed in the acronym RITE – Responsibility, Integrity, Trust and Ethicality – and they are viewed by the authors as instrumentals for the creation of an information security culture within organizations in a near future.

RITE principles can be explained as follows:

- Responsibility – It gains importance as organizations are abandoning the vertical/hierarchic organizational structure.
- Integrity – Dealing with valuable information without revealing it or giving in to pressures.
- Trust – Higher self-control and responsibility at the expense of external control and supervision.
- Ethicality – Ethics must be present in all informal, new and dynamic situations in order to enhance an appropriate response from cooperators when faced with those new situations.

In order to reach this level of protection, companies must stop worrying only about crackers' attacks or about the implementation of firewalls and/or anti-viruses. They must start focusing their attention on the creation of an actual information security culture, which includes the measures mentioned above, but with a wider scope and a higher degree of complexity. For [13], setting a firewall does not alone ensure the security of internet access. Therefore, according to this author, a set of other considerations must be established, such as policies, procedures, norms and other management instructions.

3 Theoretical Foundations

Turning to organizations whose information assets are the least protected, experts suggest that small and medium sized enterprises (SME) are particularly disadvantaged in the development of secure employee behavior [13]; [14]; [15]; [16]. We suggest that developing a strong information security culture in SMEs may address many of the behavioral issues that underpin information security breaches in such companies.

Although all organizations have their own requirements as far as information security is concerned, SMEs offer one of the most interesting cases for studying the issue of information security in particular, and information security culture in general. Within the organizational universe in Portugal, SMEs assume a unique relevance due to their high number, which makes information security efficiency a crucial issue.

No company is immune to the effects of the revolution caused by information. They must be aware that information is an asset as valuable as human resources, since the success or failure of the daily decision-making within the organization depends on it.

For these reasons, this study aims to identify the enabling or inhibiting factors for the adoption of an information security culture within SMEs in Portugal. By doing so, we intend to give our contribution so that SMEs may over time have their assets more safeguarded.

4 Research Methodology

In order to characterize empirically the adoption of an information security culture by the Portuguese SMEs, the most appropriate applicable technique was found to be the Survey, as it enables a clear, direct and objective answer to the questions presented to the respondents. Besides this, as the universe under study comprises about 348,552 companies, among which 350 were surveyed, we thought that this number undermined the adoption of alternative research techniques.

Considering the fact that the survey addressed SMEs, it is essential to define this latter concept. The status of SME (Small and Medium sized Enterprise) is defined in the Decree-Law n. 272/2007 of November 6, according to the companies number of permanent workers, which must be under 250; the turnover, which must be less than or equal to 50 million Euros; and an annual balance-sheet total which must be less than or equal to 43 million Euros.

The selection of the companies surveyed in this study was made considering the geographical area and the number of workers. In Table 1, we present the number of workers and their representativeness within Portuguese business.

Table 1. Number of workers and percentage in 2012 in Portugal

Type of Enterprise	N. of Workers	Percentage
Micro	1-9	94.6
Small	10-49	4.7
Medium sized	50-249	0.7
SME= 1+2+3	1-249	99.8

As shown in the above table, SMEs in Portugal represent 99.8% of business. Their representativeness is extremely high, which makes them deserve more attention in many respects.

4.1 Population

Among the 348,552 SMEs which represented the target of the survey under analysis, 350 questionnaires were conducted. However, only 307 obtained an effective answer, which corresponds to an 88% answer rate. The selection was made through a random sampling based on the number of workers and on the scope of the 18 districts in Portugal plus those of Madeira and Azores.

Among the answers obtained in the 307 contacts established, 288 were obtained by telephone and 19 via email after a previous telephone contact.

An effort was made to ensure that, in the highest possible number of cases, the respondent to the survey would be the person in charge for the IT sector.

The study was conducted between September and October 2013.

4.2 Structure

The structure of the survey resulted from the review of literature on information security culture. The questions of the survey were of individual and confidential answer, and they were organized in three groups.

The first group aimed to obtain a brief characterization of the company and of the respondent. The other two groups contained questions concerning the information security culture, with a first main question: "Does the company have an information security culture?"

When the answer to that main question was negative, the next step consisted of answering the group of questions concerning the possible adoption of an information security culture. The respondents were asked whether they intended to adopt any measures and behavior which might contribute for the company to have an information security culture, and if so, whether such measures were already being prepared or not. If they were not planning to adopt any measure, the respondents were asked whether such option was being made for not considering information security an important issue.

When the answer to the main question was positive, the respondents would proceed to answer the groups of questions focusing on the type of measures adopted, and were asked to list relevant enabling and inhibiting factors regarding the adoption of such measures.

One last question was asked to the respondents, which regarded the existence and identification of other information protection mechanisms.

5 Results

Among the 307 SMEs involved in this study, 100 are Micro enterprises (up to 9 workers); 90 are Small enterprises (between 10 and 49 workers); and 117 are Medium sized enterprises (between 50 and 249 workers). An effort was made to ensure that the number of the different company types and their geographic distribution would be as analogous as possible.

We tried to enquire the person in charge of the IT sector whenever possible, which happened in 57% of the cases.

When asked about who was responsible for the company's information technology, the answers showed that in most companies (52%) there is an internal department or a worker in charge, whereas in the remaining 48%, such responsibility belonged to external companies.

The main question of the survey aimed to provide information on the existence of an information security culture. In order to define and tell whether a company has an information security culture, we relied on the norm ISO IEC 27002:2005 [18], which defines 127 controls making up the endeavor of the Information Security Management System, grouped in 11 control sections: Security Policy; Organization of Information Security; Asset Management; Human Resources Security; Physical and Environmental Security; Communications and Operations Management; Access Control; Information Systems Acquisition, Development and Maintenance; Information Security Incident Management; Business Continuity Management; and Compliance.

We considered that a company adopts an information security culture whenever at least 5 of the above controls are adopted.

As shown in Fig.1, among the 307 SMEs, 29 (9%) reported to have an actual information security culture and 278 (91%) have some measures adopted, but these are not relevant enough to enable them to say that they actually have an information security culture.

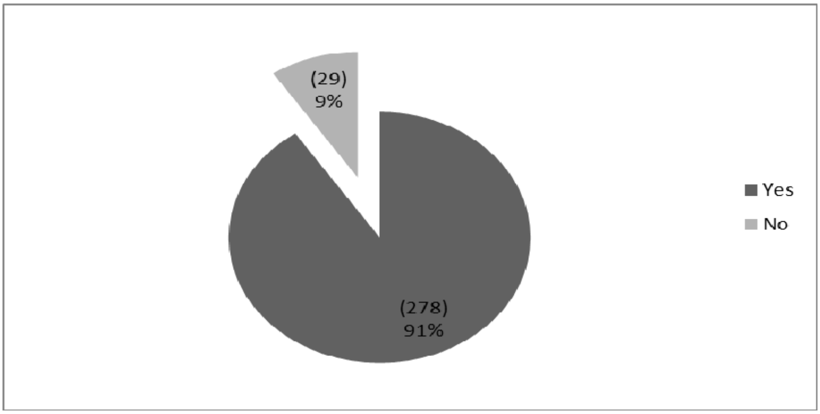

Fig. 1. Adoption of an information security culture

The cross-reference of this data with the distribution per number of workers in the respective company shows that among the 29 companies which have an information security culture, 2 are "Micro" enterprises; 10 are "Small" and 17 are "Medium sized". These numbers must be weighed up with the number of companies per type comprised in each of the three existing types. The results are presented in Table 2.

Table 2. Distribution per number of workers

Type de enterprise	N. of Workers	N. of enterprises	N. of enterprises surveyed	N. of enterprises with a security culture	%
Micro	1-9	329,730	100	2	2
Small	10-49	16,381	90	10	11
Medium sized	50-249	2,439	117	17	15

Overall, the data shows that "Medium sized" enterprises are the ones possessing a higher number of policies, closely followed in numbers by the "Small" enterprises. "Micro" enterprises, which largely differ from the others as far as their number in Portugal is concerned, showed to be the ones adopting the fewest information systems security cultures.

Among the respondents who reported not to have an information security culture in their company, 151 (54%) are not planning to adopt information security measures. However, and although this may seem contradictory, when questioned about whether they consider information security important, they unanimously reported to considered it very important.

The remaining 127 (46%) respondents who do not have an information security culture in their company are planning to implement information security measures. The measures they are thinking of adopting range from information systems security policies to higher investments in IT and software which safeguards the company's information. In 30% of the cases, tenders were or are being conducted viewing the acquisition of such means.

Within the 29 companies which adopt an information security culture, the kinds of measure implemented are as presented in the chart below.

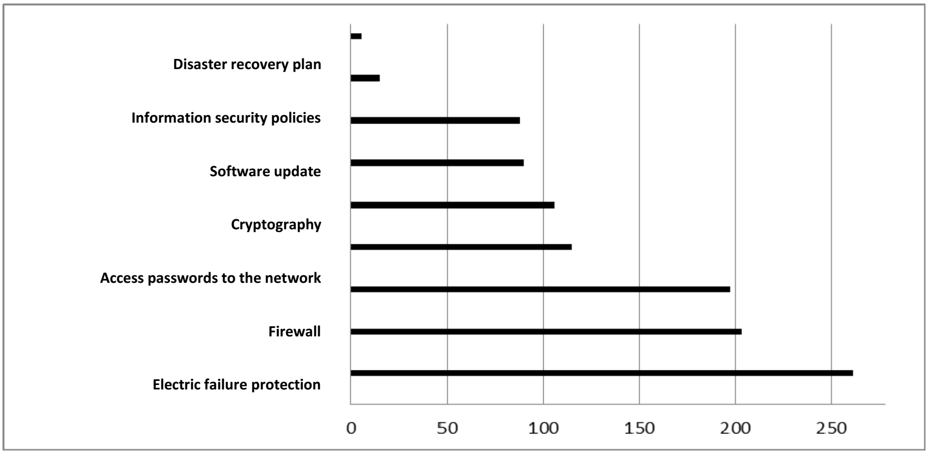

Fig. 2. Adopted information security measures

The data presented in the chart shows that the measures taken in a largest scale are those related to physical equipment, followed by those linked to the logical layer, and finally by those associated with the human aspect of the company, which is the one presenting the highest lack of concern from the company and its leaders. It is important to highlight that many of the measures within the human layer are not difficult to implement and require, in most cases, low investments from the executive board either in IT tools or in time and dedication.

With regard to which factors may be considered enabling for an information security culture, the results obtained assume various natures and can be grouped as follows:

Political

- Defining the goals for security
- Having the board's approval
- Being acknowledged by all users

Human

- Qualified workers
- Users' training
- Compliance monitoring
- Commitment towards implementation
- Users understanding of the advantages
- Technicians' training

Technological

- ICT Acquisition

On the other hand, the results of this analysis show that the inhibiting factors for an information security culture in a SME can be grouped into the following categories:

Political

- The non-approval of measures

Human

- Lack of time and of human resources
- Users resilience
- Users' disobedience

Technological

- Satisfaction towards the ICT currently used
- The existence of enough technology to ensure security

Among the inhibiting factors for the adoption of an information security culture, we highlight two: users' resilience and users' disobedience. Resistance to change is always high when users' work routines are altered, and the adoption of measures is no exception. Thus, converting mere recommendations into compulsory normative acts which include the adoption of restrictions for those who do not comply with the rules defined may turn into a strong inhibitor for the implementation of actual information security measures. Therefore, such measures should be complemented with a strong investment both in the promotion of the importance of complying with the security rules and in users' training.

Finally, the existence of other information protection mechanisms is a reality in most companies. The protection mechanism most commonly used is the anti-virus software. Firewalls also exist in high numbers, and anti-spam filters and backups are also widely used.

Organizational culture is composed of guidelines and values concerning security which enable the implementation of a security culture. Defining a policy as well as the goals for security may be an indicator that there is a commitment towards a security culture. The security culture must be build up from the executive board, as this is where the organization's central values are defined. Meanwhile, the main indicator is the behavior of all its cooperators within their daily activities.

In other words, it is necessary to consider not only the technical aspects but also and ever more the organizational, human and social aspects, as only this will enable organizational well-being.

6 Conclusion

Despite the crucial role played by organizational culture in determining an organization's success or failure, there seem to be no consensus regarding the description of organization culture [18]. Each organization has a culture (or perhaps a set of subcultures) and such culture may have an effect on security. Understanding how this happens may provide insights on possible ways to change organizational cultures so that security is given higher priority.

The SMEs under analysis are open systems, which means that they interact with the outside environment within which they are located, receiving trends and being influenced. Similarly, the individuals working in those organizations also take part in that same interaction process. In the light of this, we perceive the existence of various cultures within the same organization.

For some authors, each organization has a security culture of some kind, which may be described as strong or weak, as positive or negative. For other authors, only an organization which has a strong commitment towards security may be said to have a security culture. From this point of view, relatively few organizations have security policies.

We hope that this work can represent a positive contribution to SMEs. Although it is impossible to ensure that companies will be totally free of information security incidents, it is possible to make these companies more secure day by day.

Companies must clearly define their strategic goals and identify their culture's characteristics, boosting the areas which enhance the intended results and reinforcing the ones which are less developed. Acknowledging the characteristics of the organizational culture and committing towards the achievement of the strategic goals is not the responsibility of the leadership only, but of all the company's workers.

Among future works which can be conducted, we highlight the extension of the scope of this study towards large enterprises and the creation of a model of an information systems security policy which may be adopted and adapted by various companies according to their organizational culture.

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Software Process Improvement from a Human Perspective

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Abstract. Most of the approaches to improve software process focus on formal process descriptions where models and standards of best practices have been developed; however human factor has been forgotten, as a result arises an important gap between processes as described and process as applied. This gap takes special value in Small and Medium Enterprises (SMEs) because even when many of them are motivated to implement software process initiatives, most of them do not know how best to do so. In order to help SMEs in the implementation of software process improvements, this paper presents how two factors have been developed performing two systematic reviews. Besides, the paper includes one local study to SMEs of Zacatecas. Finally, the paper shows two proposals derived of analyzing both the two systematic reviews and the local study which are: to address the characterization and to create and select implementation strategies.

Keywords: Software Process Improvement, SPI, Characterization, Strategies, SME's, small and medium enterprises, SPI human perspective.

1 Introduction

Nowadays the competitiveness of software development organizations is a challenge that they must face to survive in the software industry. Therefore, it is necessary to have the skills to create strategic advantages with respect to its competitors [1-3]. In this context, since it is well know that software products quality is directly related to process quality used to develop it [4], improving the organizational process offers a key opportunity for organizations to become more efficient, therefore, more competitive [5].

Unfortunately, even when many authors have recognized the importance of the Software Process Improvement (SPI)[1] implementation as a mechanism to launch the competitiveness and efficiency in software industry, implementing SPI in organizations has been a path full of obstacles for most organizations [6].

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[1] Software Process Improvement (SPI) is the action arising of the need to solve software development issues that organizations take to change processes taking into account the organization business goals, so that, the business goal are achieving more effectively.

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As a result in the last 10 years there has been arising a set of models and standards such as CMMI, ISO 15504 and Moprosoft that are focused on provide a framework of best practices that serve as reference in the implementation of SPI in organizations. However, as mentioned in [7] these models and standards by themselves do not have the power to create competitive advantages.

Respect to this, the human factor is highlighted in SPI to create strategic advantages because it is the main source of commitment and responsibility necessary to achieve effective, efficient and quality processes [7].

Authors such as O'Connor and Basri [8] and, Janh and Nielsen [9] have identified the involvement of stakeholders in the implementation of improvements as a key aspect for achieving a successful SPI.

Focusing on the point of view that processes are nothing without be performed by people [7], therefore, processes entirely depend on the way the organization works and the motivation of people to evolve processes. In this research work, two key aspects, which should be analyzed to focus the SPI in human factor, were developed:(1) to characterize the organization, so the SPI can be addressed focused on organization's needs and environment; and (2) to create strategies for implementing SPI in the organization according to the way they work, their environment, needs and business goals.

These two factors are potentiated in SMEs because their limited budget to improve their software processes, all the barriers that they must be overcome due to their nature and the resistance to change arising from their staff by either ignorance or past frustrated SPI experiences [6].

Therefore, this paper presents how the two developed factors have been addressed to provide organizations, specially SMEs, support in the implementation of SPI focused on human aspect. This paper is structured as follows: section 2 introduces to the generic concept of SMEs; section 3 shows the systematic reviews carried out to address the two key aspects related to human factor in software process improvements; section 4 describes a field research focused of software development SMEs done in Zacatecas Region; section 5 presents two proposals derived of analyzing the results obtained performing the systematic reviews and the local study, and finally, section 6 presents the conclusions.

2 Small and Medium Enterprises

Nowadays software development Small and Medium Enterprises (SMEs) are considered an important worldwide piece in the software development industry. In recent decades this industry has grown and strengthened, so it represents one of the biggest development activities in generating jobs [10,11]. Then it occupies a considerable percentage of the number of companies around the world. SME's generate the 52% of the gross domestic product of the countries and around 72% of the formal employees.

The term "SME" is used to classify companies according to the number of workers they have. SMEs change according to the region or country in which it is established [12], [13], therefore a categorization taken in this research work for SMEs is: (1) Micro from 1 to 9; (2) Small from 10 to 50; (3) Medium from 51 to 130.

In Mexico 99.8% of SMEs generate 52% of gross domestic product (GDP) and 72% of employment in the country [14] that is the reason this work is focused on SMEs, specifically this paper analyzes SMEs of software development industry.

Some of the advantages of SMEs are that they: a) are an important development engine of a country contributing to local and regional development; b) have growth possibilities and eventually become a big enterprise because of their dynamism; c) they incorporate a major portion from the economically active population due to its ability to generate jobs; and d) adopt new technologies easily [14].

3 Systematic Literature Review

To achieve an overview of the state of the art for the research, two systematic literature reviews were carried out on the following topics: Strategies for SPI implementation and Characterization of software development SMEs' needs for implementing a SPI.

Systematic Literature Reviews (SLR) allow to identify, to evaluate, and to interpret all available research relevant to a particular research question, topic area, or phenomenon of interest using a formal method[15]. Some of the features that make distinction between SLR and conventional expert literature review are that SRL starts defining a review protocol based on a defined search strategy that is documented and requires explicit inclusion and exclusion criteria.

SLR consists of three phases and each one has a set of activities as follows: (1) Planning review: identify the needs for a review, specify the research questions and develop a review protocol; (2) Conducting review: identify the research sources, select primary studies and extract and summarize data; and (3) Reporting review: publishing the results.

Next, Table 1 shows a summary of protocols developed to perform the SLRs. It is important to mention that both SLRs use the next inclusion and exclusion criteria:

- *Inclusion Criteria*: 1) studies writing in English or Spanish language; 2) studies from 2000 to current date; 3) studies containing in the title the key words; 4) studies which summary contains the key words or is related to the main theme; 5) studies with a length of 4 or more sheets; 6) studies containing information at SPI in software development SMEs and; 7) studies containing information at SPI implementation.
- *Exclusion Criteria:* 1) studies that are not written in the indicated languages; 2) studies that are not within the indicated period; 3) studies repeated in more than one source and/or search string; 4) studies with a long less than 4 sheets and 5) studies that do not contain relevant information about the main theme.

It is important to mention that both systematic reviews have been validated for the software engineering research team of CIMAT- Zacatecas Unit which has a lot of experience in performing SLRs. For more detail about SRLs and obtained data see: [16] for Characterization of software development SMEs' needs for implementing a SPI and [17] for Strategies for SPI Implementation Strategies for SPI Implementation. Next, sections 3.1 and 3.2 show the main results obtained by performing the SRLs.

Table 1. Summary of the protocols developed for the SRLs

Theme	*Characterization of software development SMEs' needs for implementing a SPI*	*Selection of strategies for SPI Implementation*
Questions	- What is the software development SME's business domain? - How many employees do the SME have? - Is there any process performing at the organization? - Have the SME had any experience implementing a SPI initiative? - What problems have the SME handed in the implementation of the process or process improvement?	- What are the methods that exist to establish strategies for implementing SPI? - How have these methods been employed? - What methods have been most effective? - How is the current way for developing strategies to implement software process improvement in organizations?
Search Strings	- process AND smes AND (software or development) - sme AND software process improvement AND needs	- software AND process AND improvement AND implementation AND strategies AND (organizations OR teams OR companies OR sme) - software process improvement AND (implementation OR strategies) AND (organizations OR teams OR companies OR sme)
#Primary Studies founded	40	60

3.1 Characterization of Software Development SMEs' Needs for Implementing a SPI Results

3.1.1 Models and Standards Used

This section shows a set of models and standards most commonly used by software development SMEs in the implementation of SPI. Then, models and standards were classified according to their use as follows:

- The implementation percentage of models and standards focused on software process assessment: SPICE 67%, Observatoire Wallon des Practique Logicielles (OWPL) 17% and Express Process Appraisal (EPA) 16%.
- The implementation percentage of models and standards focused on processes improvement: Capability Maturity Model Integration (CMMI) 25%, SPICE 25%, MesoPyme 19%, Moprosoft 13%, and (IDEAL), Team Software Process (TSP) and ISO 9001:2000 with 6%.
- The implementation percentage of models and standards focused on software lifecycle: ISO 12207 66%, RUP 26% and ISO 29110 8%.
- The implementation percentage of models and standards focused on SMEs process models: MesoPyme and Melhoria de Processos do Software (MPS) 43%, Moprosoft 29% and MSP and ISO 29110 with 14%.

3.1.2 Improved Processes

This section shows a set of processes most focused in the implementation of SPI initiative in software development SMEs. Next the most improved processes and their percentage of improvement are showed: Project Planning (PP) 27%; Requirements Management (RM) 19%;Configuration Management (CM) 16% and Risk Management (RSKM) 12%. However some organizations focus in less percentage in processes such as Verification and Verification (V&V) 8%; Requirements Development (RD) 7%; Process and Product Quality Assurance (PPQA) 6% and; Project Monitoring and Control (PMC) and with 5%.

3.2 Strategies for SPI implementation Results

3.2.1 Models and Standards Focused on Implementing Software Process Improvements

This section shows an analysis of the methods, models and frameworks currently used in the implementation of improvements based on the next set of characteristics: A) it provides an improvement implementation integrate framework, B) it analyzes the organization' needs, C) it has been validated and D) it has a support tool. Table 2 shows the analysis performed.

Table 2. Characteristics of methods, models and frameworks analyzed

Method/ Model /Framework	*A*	*B*	*C*	*D*
SPI implementation maturity model [18]	✓		✓	
iFLAP [19]	✓	✓	✓	
Karlstrom D. et all [20]	✓	✓	✓	
Asato, R et all [21]	✓	✓	✓	
iSPA framework [22]			✓	✓
METvalCOMPETISOFT [23]			✓	✓
Galinac Tihana et all [24]	✓	✓	✓	
Knowledge driven model (KDM) [25]	✓	✓	✓	
MPS model [26]	✓		✓	✓
SPI Framework: OWPL [27]	✓	✓	✓	
Organizational-level SPI Model (O-SPI) [28]			✓	✓
MIGME-RCC [29]	✓	✓	✓	

3.2.2 Experiences in the Implementation of SPI

This section shows manager's needs, the problems found in the SPI implementation and some lesson learned:

a) *Manager's Needs*: studies show that 67% of the managers seek guidance on how to implement process improvement initiatives software, instead of what activities to implement [17,18,30].
b) *Problems*: the common problems identified when organizations implement SPI strategies are: 1) they do not have clear SPI objectives; 2) they do not pay enough attention to the factors that promote or inhibit organizational process improvements and; 3) they do not take into account the human resource, and therefore tend to have an unexpected or undesirable performance of human behavior [17].

c) *Lesson Learned*: 1) the business goals and SPI should be successfully combined; 2) an explicit definition of SPI goals help stakeholders to have a good information of operational tasks and supervision; 3) providing and using interviews in the early stages of SPI help stakeholders to understand the organization knowledge and specific problems; 4) the learning curve when an organization implement SPI is improved using automated tools, metrics and organization' data; and finally 5) persistence and patience is necessary to face the internal resistance of implementing new processes and standards. Besides, organizations need to take into account that the people need to know the benefits involved in the SPI [17].

4 Local SMEs Study

An analysis of SMEs of Zacatecas Region was performed. The analysis aimed to obtain the main characteristics and strategies of the software development SMEs.

4.1 SMEs' Description

The interviews were conducted in 8 SMEs, for confidentiality reasons they are named as SME1, SME2, SME3, SME4, SME5, SME6, SME7 and SME8.
SME1 is a company dedicated to develop products and services with high impact in the education of children and teenagers. Currently, it doesn't have staff, but it hires external staff to develop a project.
SME2 is a company dedicated to develop software and web products; support and marketing. Currently, it has a staff of 4 people, including developers and marketing.
SME3 is a company dedicated to TI consulting, marketing, digital media and web development. Currently, it has a staff of 37 employees, including developers, graphic designers, maintenance personnel and executives.
SME4 is a company dedicated to develop the organizational software for educational institution. Currently, it has a staff of 13 employees, including developers, project leaders and managers.
SME5 is a company dedicated to develop high quality software. Currently, it has a staff of 8 employees, distributed in the state of Zacatecas and Mexico City.
SME6 is a company dedicated to TI consulting and training, they have PSP and TSP couches. Currently, it has a staff of 2 people.
SME7 is a company dedicated to develop software and web development, support and security. Currently, it has a staff of 16 people, including developers and marketing.
Next, Figure 1 shows a summary of the main features of them.

4.2 Results

Analyzing the interviews, the SMEs were characterized according six categories:

- *Organization*: a) flat organizational structure; b) highly dependence on a reduce group of customer and c) use agile methodologies' practices.
- *Financial Resources*: limited resources to invest in SPI.

• *Human Resources*: a) reduce number of employees, b) defined roles, c) lack of knowledge about SPI and, d) employees without experience in software engineering practices.
• *Processes*: lack of defined processes, therefore, the software is developing as a craft.
• *Projects*: very small projects with time duration around 1-3 development months (some up to two weeks).
• *Models and/or Standards*: a) lack of any model or standard use and b) lack of experience in the adoption of SPI model and or standard.

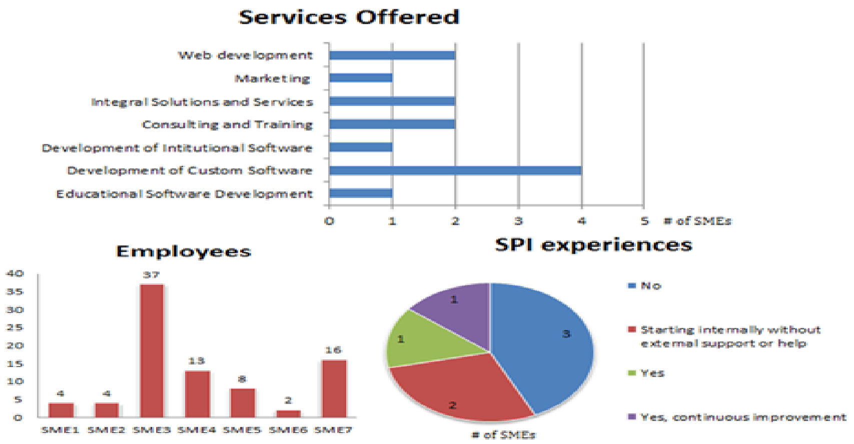

Fig. 1. Main characteristics of the SMEs interviewed

On the one hand, in general there were perceived a poor understanding of using a process approach to develop software product and services, as consequence, organizations believe it is unnecessary to implement software engineering practices contained in models and standards. Besides, organizations do not have enough budgets for performing improvement activities. Moreover, the main limitations toward the implementation SPI identified in the SMEs analyzed are: a) lack of enough budget to invest in process improvement; b) high dependence on external budget and support to implement SPI; c) lack of necessary knowledge and skills to implement SPI; d) lack of initiative to implement SPI; and e) lack of experience in the implementation of SPI.

On the other hand, derived from interviews with organizations that have already had experience implementing SPI there were identified some practices that have helped them in the implementation of a successfully SPI such as: a) setting goals since the beginning help the organization to understand why it is necessary the implementation of process improvement; b) convincing senior management to be promoters, sponsors and guide in the improvements implementation achieve better results than without its support; c) highlighting the benefits derived to the implementation of the improvement; and d) betting on the intellectual capital of the company to achieve better results.

5 Proposals

5.1 Characterization of Software Development SMEs' Needs for Implementing a SPI Proposal

Analyzing the SME's characterization obtained performing the systematic review and the study of local SMEs, it was identified that SME's have specific features that make them different from each other. Besides, features such as not having defined process, roles and experience in the implementation of SPI can be the difference.

In this context, this proposal aims to identify and define process improvements patterns, so patterns enable each organization to identify its current scenario and help them to address a SPI effort in the best way according to its specific features.

Then, this proposal is focused on providing a set of process patterns as a solution to the problems that SMEs should face when they should select a way to implement a SPI initiative.

According to [31] process patterns are reusable building blocks that an organization can adapt or implement to achieve mature software process.

In order to define processes patterns in this proposal, three key aspects are taken in account:

1. *Pattern elements*: elements to define processes patterns (name, context, problem, forces, solution, resulting context, related patterns and known uses) proposed in [32, 33];
2. *Characterization*: features identified as a result of performing the systematic review and the local SME's study [16];
3. *Contextual aspects:* a selection of contextual aspect proposed in [34] which are considered key aspect in the implementation of SPI such as: product, process, practices, tools, techniques, people, organization and finally market.

Besides, to use the defined patterns a software tool is proposed. The software tool aims to guide SME's in the selection of the optimal path to begin a SPI initiative adapted to its current environment, features and needs.

Figure 2 shows the proposal diagram.

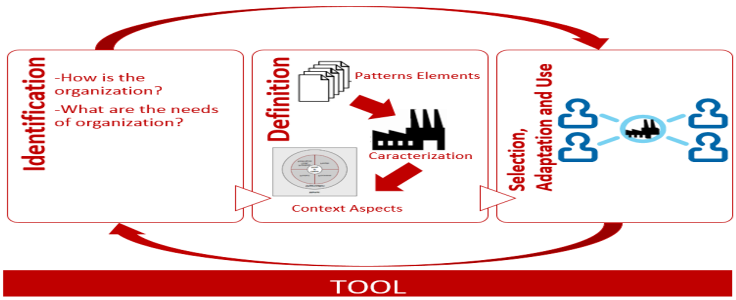

Fig. 2. Proposal one, Characterization of software development SMEs' needs for implementing a SPI

5.2 Selection of Strategies for SPI Implementation Proposal

The experiences identified in the literature review and the local study of SME's have allowed to identify different strategies that have guided and helped some organizations in the implementation of process improvements. However, even when these strategies have reported some benefits, this does not guarantee that they are suitable for all organizations because there is no single rule that ensure success [35].

According to [34], the software development process should be in harmony with the context in which the software is developed and delivered. Then, in order to establish if a specific strategy is adequate to an organization, it is necessary to take into account the context and work culture of the organization in which the improvement will be implemented as completely and accurately as possible.

In this context, this proposal is focused on help organizations to select the right strategy to implement process improvements in an appropriate way according to the specific context and organizational work culture.

As Figure 3 shows, the proposal begins with a pre-phase that uses a checklist to confirm that the organization knows: its work culture, business goals and the goal for implementing the process improvement. Then, the organization identifies its environment according to the set of categories established. After that, there can be provide a strategy that suits the organization' needs. To establish the set of strategies there are used the six contextual aspects proposed in [34]: product, process, practices and techniques, resource human, organization and market, because they are considered key in the implementation of process improvement in any organization.

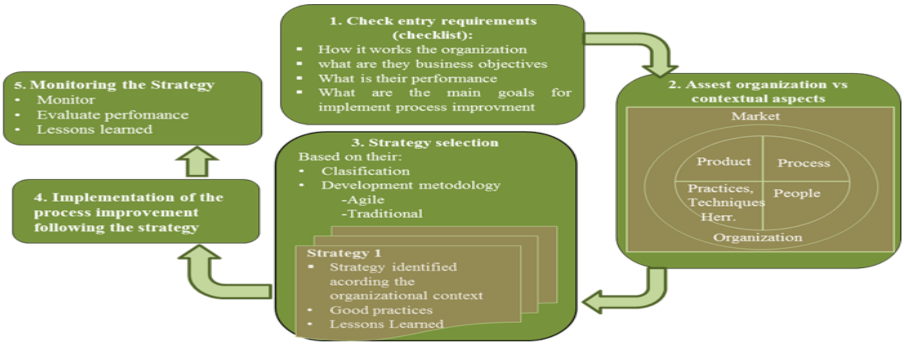

Fig. 3. Proposal two, selection of strategies for SPI Implementation

Moreover, to achieve the establishment of this set of strategies, main methods / models for implementing strategies, lessons learned and barriers and de-motivators identified in both the literature review and the local SME's study will be analyzed.

6 Conclusion

The implementation of software process improvements enables organizations to create strategic advantages with respect to its competitors taking into account that the quality of software product and services has a directly dependence of the quality of processes used to develop them. However, not all organizations obtain the same results when implementing improvements in their processes. One of the problems is associating the process improvement with models and standards and a good process definition without taking into account the human factor.

This paper showed two proposals derived from the two factors developed by performing two systematic literature review and a local study to SMEs of Zacatecas which were focused on analyze the SPI since the human factor perspective: Characterization of software development SMEs' needs for implementing a SPI and Selection of strategies for SPI Implementation.

As a result, on the one hand the first proposal pretends to address the organization improvement effort showing a way that the organization should follow when implementing SPI according to its actual environment and needs. On the other hand, the second proposal pretends to create an adequate strategy to guide the implementation of the new processes focusing on the specific actual context and the organizational work culture.

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Viewpoints for Requirement Engineering in a Cooperatif Information System (VpCIS)

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Abstract. In this paper we propose an approach which allows to define the Requirement Engineering step of a Cooperatif Information System. We used a notion of software engineering: the viewpoints. CIS is a complex system; it involves the cooperation of many stakeholders in a common purpose and each with their own viewpoint. This is why we used the notion of viewpoints, in order to decompose and partition the needs of a CIS according to the viewpoint of each stakeholder, to simplify its modeling. This approach defines a meta-model of viewpoint that will allow us to instance the necessary viewpoint to define the needs and requirements of a CIS.

Keywords: viewpoints, needs analysis, requirements engineering, cooperatif information system.

1 Introduction

In a context of globalization of markets, companies of today face many challenges posed by: increased competition, the exceptional growth of services they must offer to their customers, the increased need to provide better quality of service and the necessity of cooperation and collaboration with other business partners to stay competitive in their activity domain and operating in socio-economic environments characterized by dynamism and increased turbulence.

Thus, a company can no longer be content with a closed information system, which would cause it to be unable to exchange information with its collaborators and partners. The Cooperatif Information System (CIS) area allows to support the inter-company relations in order to improve interactions and communication between partners. The size and complexity of these cooperatif information systems is therefore growing, their complexity makes their design more difficult. It is so very important to understand the needs and requirements of the system, which leads us to interest and define the first step of development of a CIS, ie the step of Requirements Engineering. The methods that exist in the domain of RE in software engineering does not allow to address the complex needs of a CIS which involves the cooperation of many stakeholders in a common purpose and each with their own viewpoint. To minimize this complexity we proposed an approach that incorporates a notion of software engineering which is the viewpoints from the RE step. It will allow us to

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decompose the needs of a CIS according to the viewpoint of each stakeholder. We called our approach: VpCIs (Viewpoints for Cooperatif Information System), it is a viewpoint's meta-model; it defines the necessary viewpoints that will allow us to define the needs of a CIS. To set this meta-model we have proposed a framework of 5 essential dimensions to describe a CIS. In what follows we present our motivations for the use of viewpoints in CIS, we then propose the VpCIs approach, we compare after that VpCIs with other approaches oriented viewpoints in RE domain and conclude we with our perspectives.

2 Motivation

RE is the first step of the life cycle development of every project[1], defining what the stakeholders (users, customers, suppliers, developers, businesses) in a potential new system need from it, and also what the system must do in order to satisfy that need.

The RE process includes the elicitation phases, analysis, specification, validation and management of requirements [8]. We need to find a set of requirements that reflect the needs of these stakeholders. It will be necessary to determine who does what, on what, when, after what and before what, we must define the systems actors and relations or actions that may exist between them. System modeling supports the analysis and design process by introducing a degree of formality into the way systems are defined. Modeling provides a way of formalizing these representations, by not only defining a standard syntax, but also providing a medium for understanding and communicating the ideas associated with system development. So RE can be represented by using for example diagrams like data flow diagrams, Entity-Relationship Diagrams, Statecharts, Object-Oriented Approaches(class diagram, use case), in our case we choose the diagrams (use case diagram). A method is a degree more prescriptive than a modeling approach, it tells us what to do to and in what order to do it. Methods use various representations ranging from natural language, through diagrammatic forms to formal mathematics like: viewpoints methods, Object-Oriented Methods, Formal Methods [1]. as we focus on methods oriented viewpoint, we talk about it in the following:

Viewpoints Methods: A viewpoint-based approach to requirements engineering recognizes that all information about the system requirements cannot be discovered by considering the system from a single perspective. Rather, we need to collect and organize requirements from a number of different viewpoints. A viewpoint is an encapsulation of partial information about system requirements. Information from different viewpoints must be integrated to form the final system specification [2]. There is several viewpoints methods in RE like : SADT [3],[4] CORE [5], VOSE [6], [7], VORD [8], [9], [10], [11], PreView [12].

We chose to use the viewpoints in the RE step of cooperatif information systems, being complex systems, the viewpoints can decompose system requirements and minimize the complexity, also for these arguments:

- Systems usage is heterogeneous there is no such thing as a typical user.
  Viewpoints may organize system requirements from different classes of system end-user and other system stakeholders.

- Different types of information are needed to specify systems including information about the application domain, information about the systems environment and engineering information about the systems development. Viewpoints may be used to collect and classify this information.
- Viewpoints may be used as a means of structuring the process of requirements elicitation. [2]

Given the complexity of CIS, modeling is done by splitting the system into several independent sub-models to avoid the design of a large system. This leads to management problems of coherence between these partial models, because they are never independent, since they contain information often functionally related. Object-oriented methods cannot therefore be as such to solve the problems of inconsistency between the partial models. [13].That is why we have chosen to integrate the viewpoints which will therefore allow us to decompose the system into several partial models. We propose in following our VpCIS approach oriented viewpoint, we believe that this approach is suitable for CIS.

3 VpCIS Approach

We work along the axis level modeling M2, M1, M0; we begin with the M2 level where we propose a meta-model of viewpoints representation in 5 dimensions for a CIS, we pass next to the M1 phase where we instantiate viewpoints from the meta-model which can be applied to an example in the M0 level.

3.1 Viewpoint Referential for a CIS

We propose in what follows a viewpoint referential of 5 dimensions that we consider fundamental to describe a CIS viewpoint, we will describe later an explicit meta-model representation of viewpoint that will allow us to define our viewpoint in order to describe our system:

Level of Description: defines at what phase of the life cycle of development is situated the VpCIS approach (analysis, specification, high-level design, design, code), in our case we are interested in the analysis needs phase.

Domain: the approach concerns a domain which can be generic, or focused on the business application or on a specific area of business. In our case we'll choose a generic domain which is CIS, we will after study an example and there so we move to business application.

Expression Mode: the scheme and notation by which the viewpoint expresses what it can see (representation of RE), it can be text, graphics, diagram or using a formalism. In our case we chose to use graphics and diagrams (use case diagram).

Level Modeling: the approach may be in one of the four layers of the architecture modeling:

- M3, the meta-meta-model such as MOF (self-descriptive layer);
- M2 the meta-models such as UML;
- M1, the models such as the class diagram;
- M0, the real world (case study);

The VpCIS approach in this case (VpCIS meta-model) is in the M2 layer.

For Reuse Process/ By Reuse Process: the VpCIS approach can be by reuse (using viewpoints already defined) or for reuse (creating its own definition viewpoints), in our case we propose a meta-model for reuse but we can have to use viewpoints by reuse.

These dimensions are shown in the following figure 1.

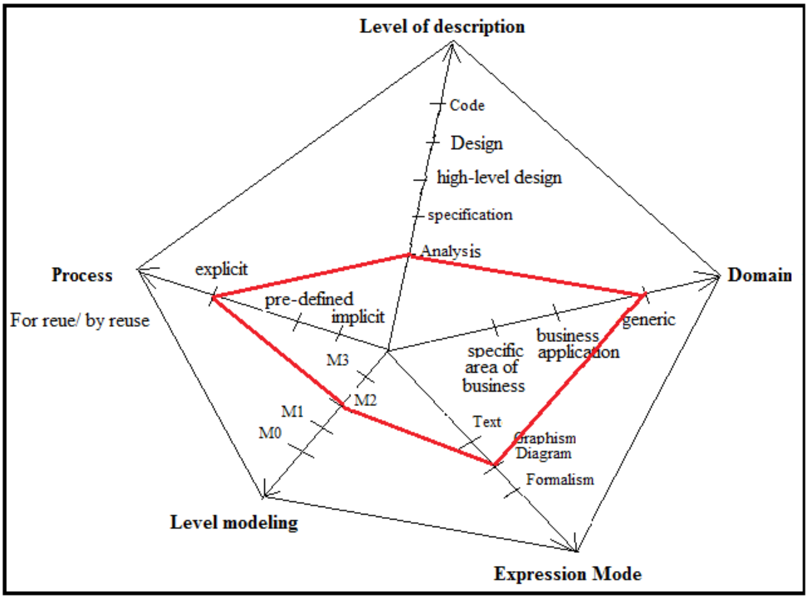

Fig. 1. Shows 5 Dimensions of a meta-model of viewpoint (VpCIS)

3.2 An Explicit Meta-model Representation of a Viewpoint

We then propose an explicit meta-model representation of a viewpoint using the dimensions just mentioned as shown in Figure 2, this explicit representation will also enable other developers to define their own viewpoints.

We explain the detail of the figure 2 in following, a viewpoint meta-model has these attributes:

Viewpoint Type: We have two types of VP: Actor VP and Activity (action) VP, and as we choose use case diagram like expression mode, we then deduce two types of actor (primary and secondary) and so two types of action (primary and secondary).

Name: the name of the viewpoint (if it is a viewpoint actor it will be the actor's name.

Goal: The aim and purpose of the viewpoint (for example, what should do the actor).

Level of Description: in our case we said we are situated in the analysis phase.

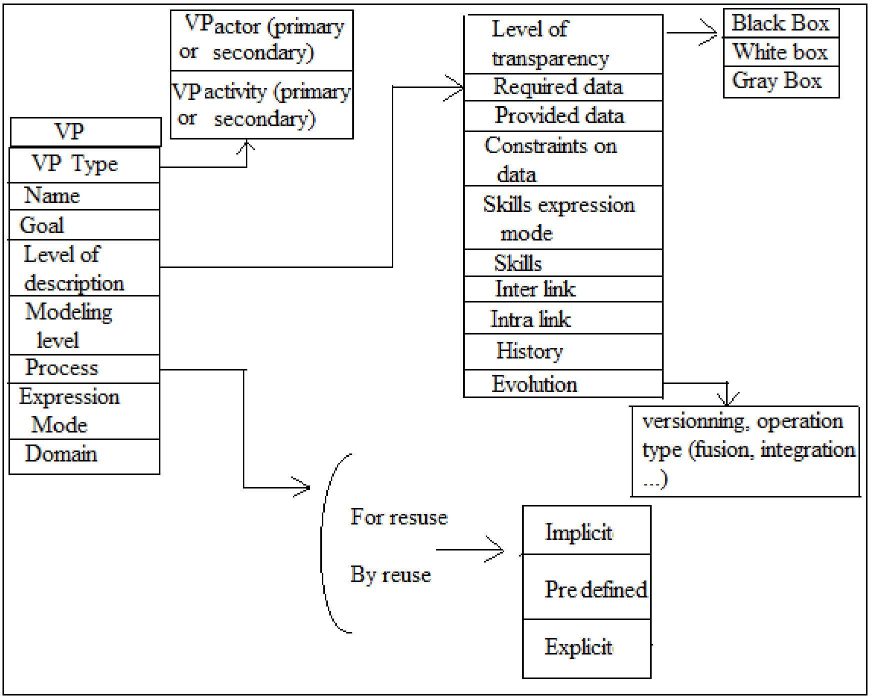

Fig. 2. Shows an explicit meta-model representation of a viewpoint (VpCIS)

- **Level of transparency:** can be: Black Box (we don't know about the viewpoint attributes), White Box (we can see the viewpoint attributes and even modify them), Gray Box (we can see the attributes but can't change them) in our case it is White Box.
- **Required data:** input information needed by the VP to accomplish its action or goal: functional requirements.
- **Provided data:** output information provided from the VP accomplishing his goal.
- **Constraints on data:** defines the non-functional requirements.
- **Skills expression mode**: the skills can be described textually or using a formalism or diagram as the activity diagram.
- **Skills:** the VP skills: description of its business and job.
- **Inter Link**: the links that may exist between different VP of various organizations.
- **Intra link**: links that may exist between different VP from the same organization.
- **History:** Historical actions.
- **Evolution:** the possible evolution of a VP (fusion, integration ...).

Modeling Level: in our case we said that it is the level M2.

Process: the construction process can be implicit, explicit or pre-defined, in our case it is explicit.

Expression Mode: we choose graphics and diagrams (use case diagram).

Domain: we chose a generic domain: CIS.

This explicit description will allow us now to instantiate the viewpoints of the M1 level required to describe the needs of a CIS.

3.3 VpCIS Viewpoints Definition in M1 Level

At the level M2 we choose as expression mode the use case diagram, as it is characterized by the notion of actors and relations between them, we deduced then two types of viewpoints: viewpoints to define the actors of the cooperation and viewpoints to define the relations (actions) between them. In a use case diagram we have two types of actors: primary and secondary actors. We therefore define two types of VP actors (primary and secondary), we also have therefore deducted two types of actions: primary and secondary action. In what follows we show the viewpoints actor and action at M1 level modeling, the dimension modeling level consists in the meta-model of a set of attributes that will be used depending on the type of viewpoint.

The following Table 1 shows a primary actor viewpoint.

Table 1. Primary Actor Viewpoint

Attributs	Description
Type	Primary Actor.
Name	Name of the Actor.
Goal	What have to do the Actor.
Skills expression mode	Skills expression mode of the actor like an activity diagram or text.
Skills	Description of the actor's job (primary actor will also delegate certain actions or will have to be in contact with others to accomplish its task, so we will list these actions).
Intra Link	The actor has links with other actors from the same organization where he works.
Inter Link	The actor has links with other external actors from other organizations.
Required data: (functional requirements)	Requirement that can have the actor and information needed to accomplish his actions.
Constraints on data (non-functional requirements)	Non-functional requirements that can have the actor.
Provided data	Output information provided from the VP accomplishing his goal.
History	When start the actions and when finish.

The following table 2 represents a secondary actor viewpoint.

Table 2. Secondary Actor Viewpoint

Attributs	Description
Type	Secondary actor.
Name	Name of the Actor.
Goal	What have to do the Actor.
Skills expression mode	Skills expression mode of the actor like an activity diagram or text.
Skills	Description of the actor's job
Intra Link	The primary actors with he has relations.
Required data: (functional requirements)	Requirements which can have the primary actor who delegated him this action or asked him to do it and the information needed to accomplish the actions.
Constraints on data (non-functional requirements)	non-functional requirements that can have the primary actor.
Provided data	output information provided from the VP accomplishing his goal.
History	When start the actions and when finish.

The following table 3 represents an activity (action) viewpoint.

Table 3. Activity (Action) Viewpoint

Attributs	Description
Type	Primary or secondary.
Name	the title of the action that connects two actors.
Goal	What have to do the Actor.
Skills expression mode	Skills expression mode of the action.
Skills	Description of the activity.
Inter or Intra Link	Inter or Intra link between the actors, we deduce then two attributes :(done by and asked by).
-Done by	actor by which this action will be done
-Asked by	the actor who asked to accomplish the task.
Required data: (functional requirements)	the different requirements needed to accomplish the action .
Constraints on data (non-functional requirements)	Non-functional requirements to accomplish the action.
History	When start the action and when finish.

4 Comparison and Analysis of VpCIS with Other Approaches

The following table 4 shows a comparison between the methods oriented viewpoints : VpCIS, VORD, SADT, CORE, VOSE, PreView, MAMIE [14], taking into account the dimensions that we have cited, we note that VpCIs encompasses most of the methods such as VORD, which has been used in different articles like in [9], [10], [11], this is why we propose also a comparison between VpCIS.

Table 4. Comparison between methods oriented viewpoints

	SADT	CORE	VOSE	VORD	PreView	MAMIE	VpCIS
Level of description	Analysis	Analysis	Analysis	Analysis	Analysis	Analysis	Analysis
Domain	Generic (No explicit)	Business application real time system)	Generic (composite system)	Business application (System oriented service)	Business application (projet REAIMS but can be generic)	Generic (cooperatif information system)	Generic (cooperatif information system)
Expression mode	Graphe/ diag	Graphe/ diag	Graphe/ diag	Graphe/ diag	Graphe/ diag	Graphe/ diag	Graphe/ diag
Level modeling	M1	M1	M1	M1	M1	M1	M1, M2
Process	Implicit	Explicit	Explicit	Pre-defined	Explicit	Pre-defined	Explicit

The following figure 3 shows a comparison between VpCIs and VORD, we note that VpCIs includes VORD method.

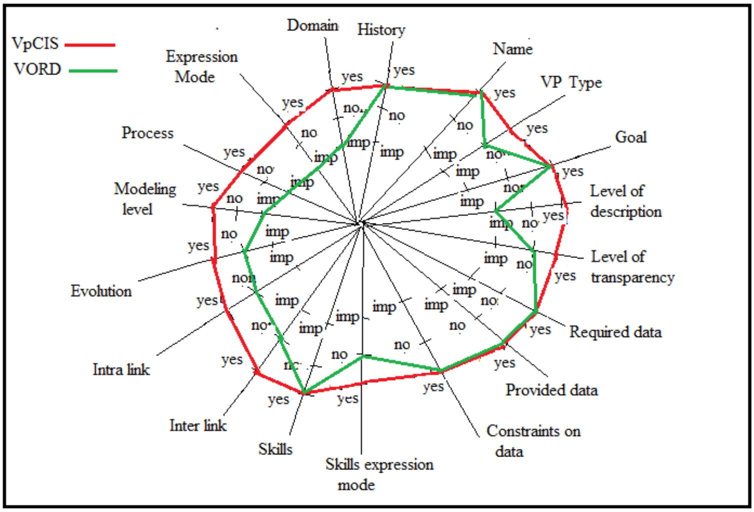

Fig. 3. Shows a comparison between VpCIS and VORD

5 Case Study

We pass now to the level modeling M0 where we apply the viewpoints of the level M1 to a case study. Several examples have used the method VORD such as in the article [9][10][11], We choose one of them : [10]. The viewpoint domain is now: business application: MCS. **Medical Care System (MCS)** is an attempt to provide the awareness of the First- Aid to the community in an easy, cheap and rapid way, at their door steps. People can interact with the system, simply by connecting with the internet and the system will show them First-Aid procedures for different situations that required medical treatment. The paramedic connect on the system to find the first aid to provide it to the victim, if he has difficulties he contact the hospital staff to explain him how to use the system or to make him in contact with a specialist doctor, the hospital staff can also contact the system administrator to maintain the system.
The figure 4 following shows the use case diagram of the system

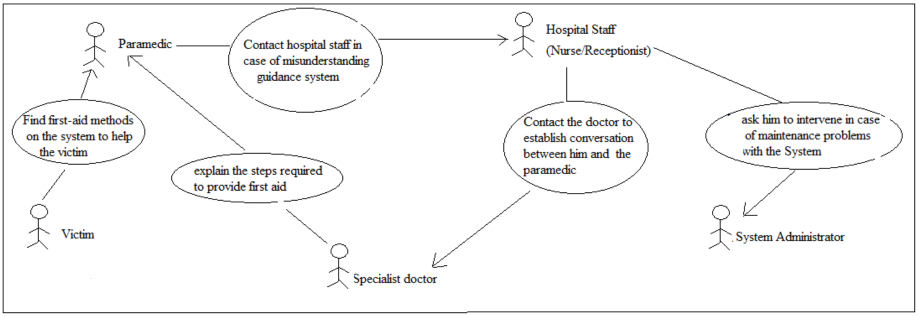

Fig. 4. Shows the use case diagram of MCS

Once we have indentified the actors and the actions that rely them in the use case, we pass now to the definition of the viewpoints:

The primary actors VP are: Paramedic, Hospital Staff, Specialist doctor
The secondary actor VP is: System Administrator
The primary actions VP: Find first-aid methods, contact the hospital staff in case of problems, contact the specialist doctor, explain the steps required to provide first-aid
The secondary actions VP **:** contact the system administrator to maintain the system
Let's take an example of viewpoint: the specialist doctor viewpoint:
Type: primary
Name: Adam
Goal: assist the paramedic and explain the procedure to follow
Skills expression mode: textual
Skills: he is responsible for the medical treatment of any sudden case, or to provide online help to any first aid provider.
Required data: describe how is the victim and details of the accident
Provided data: the first-aid method
Constraints on data: the information about the victim must be detailed.

Intra link: hospital staff
Inter link: paramedic
History: receive the call from the hospital staff, be in contact with the paramedic and explain the steps to follow in order to give first aid to the victim

6 Conclusion

In this article we discussed our motivation for the use of viewpoints in the RE step of a CIS, We proposed after that an approach which define a viewpoint meta-model the analysis needs phase of a CIS: VpCIS. We choose the use case diagram like expression mode to instance VpCIS to define the actors and the relations between them, we expect to develop a tool which allows to support the VpCIS approach and develop a CIS using this definition of the viewpoints from the analysis needs phase.

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Learning from the Experience. Systemic Thinking for e-Government Development in Developing Countries: A Question Unsolved

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Abstract. e-Government has become one of the most important issues on political agendas today, and is a concept which seems to be constantly developing. Most e-Government research has focused on developed countries, neglecting the area of emerging economies. Nonetheless, this analysis is of particular importance in developing countries because prior research has indicated that e-government constitutes a central element in the process of modernising public administrations. Therefore, the objective of this paper is to analyse past experiences in the implementation of e-government in developing countries to learn some lessons for improving this implementation in the future, which could help to achieve more transparent, participative and democratic societies.

Keywords: E-government efficiency; developing countries; challenges innovation; solutions; future research.

1 Introduction

Public administrations need to be more efficient, citizens demand more transparency from public administration, companies require an operative framework which facilitates competitiveness and all social agents expect greater information and participation in public life [1]. In this context, the question of e-Government has become one of the most important issues on political agendas today, and is a concept which seems to be constantly developing [2]. This tendency is understood to be one of the forms of expression of the information society, in addition to being a central part of the process of the modernization of public administration, allowing a strategic and intensive use of ICTs [3], both in the internal relations of public administrations [4] and in terms of their relationship with citizens [5] and with companies in the private sector [6].

To date, most e-Government research has focused on developed countries, neglecting the area of emerging economies. Nonetheless, this analysis is of particular importance in developing countries because prior research has indicated that e-government constitutes a central element in the process of modernising public administrations [7] and strengthening governance within democratic societies [8].

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In addition, it has been demonstrated that countries which invest more in e-government achieve larger reductions in levels of corruption [9] and increases citizens' trust in governments, improving the evaluations made concerning political management [10].

Nonetheless, in order to be more efficient and to improve transparency and democracy, it is not only relevant to introduce e-government into developing countries, but also e-government initiatives must be successfully implemented. History of e-government implementations in developing countries show that most of them fail because a great deal of them were not implemented, were implemented but immediately abandoned, or were implemented but major goals were not attained and/or there were undesirable outcomes [11]. In addition, research in this issue show that only an adequate implementation of e-government, and their subsequent evolution and development, promotes economic growth of the country [12], especially those in developing countries [13], seeking settings where build solid structures participatory democracies [14].

Therefore, the success in the implementation of e-government is essential, especially as developing countries, since these countries have a limited number of resources at their disposal, and cannot afford to wastefully spend large amounts of money typical of such projects [15]. In this regard, there is a need to examine past experiences in the implementation of e-government in developing countries with the aim at identifying mistakes in order to correct and prevent them in the future.

Despite previous comments, up to now, research has not been focused on this topic. Therefore, the objective of this paper is to analyse past experiences in the implementation of e-government in developing countries to learn some lessons for improving this implementation in the future, which could help to achieve more transparent, participative and democratic societies. With this objective in mind, authors seek to shed some light for future successful implementations of e-government in developing countries suggesting a route to design and monitor these implementations.

To achieve this aim, this paper analyses prior research about implementations of e-government in developing countries and examine the main limiting factors in these implementations. Therefore, a complete search on e-government research in developing countries has been performed. In order to provide a complete review of the current state of research into e-government in developing countries, we focused on analyzing ISI journals listed in the areas "*Information Science and Library Science*" and "*Public Administration*", excluding listed journals of marginal importance, i.e. those with an impact factor of less than 0.25 or with fewer than 50 total citations for the year 2012 [16]. In addition, since the considerable degree of current research interest in the implementation of e-government in Latin America [17], Malaysia [18] and Romania [19], we analyzed all the journals published in Latin America, Malaysia and Romania and which were indexed in the ISI in 2012, in this case, we made an exception in the selection criteria. The no-inclusion of these journals may offer a partial view of research, particularly regarding the e-Government initiatives and efforts in developing countries.

In order to analysis the articles, we first examined the title and the keywords of each one, title and abstract [16]. If at this point, we have doubts, we then read the introduction to identify the research goals and to determine the main factors analysed. Finally, in the very few cases when these discriminate criteria were insufficient, we read the whole article. As a result, we obtained a database composed of 155 articles about e-Government in developing countries published in 114 journals catalogued by the ISI as belonging to the areas of *Public Administration* and of *Information Science and Library Science* during the period 2000-2012 (see Table 1).

Table 1. E-government articles in developing countries found in each of the ISI Journals (2000-2012)

Position	Abbreviated journal name	Impact Factor 2012	5-year Impact Factor	E-government articles
14	J PUBLIC POLICY	1.033	-	1
22	AM REV PUBLIC ADM	0.781	1.257	1
26	LOCAL GOV STUD	0.690	0.912	1
28	PUBLIC ADMIN DEVELOP	0.655	0.815	11
31	INT REV ADM SCI	0.559	0.940	5
34	J COMP POLICY ANALY	0.509	-	1
35	ADMIN SOC	0.730	1.247	1
40	TRANSYLV REV ADM SCI	0.380	-	3
43	REV CLAD REFORMA DEM	0.199	-	15
45	GEST POLIT PUBLIC	0.100	0.115	3
46	INNOV-REV CIENC AD	0.058	-	1
	TOTAL ARTICLES IN PUBLIC ADMINISTRATION			**43 (27.74%)**
1	MIS QUART	4.659	7.474	1
4	J INF TECHNOL	3.532	3.801	1
5	INFORM TECHNOL MANAG	3.025	2.261	1
7	SCIENTOMETRICS	2.133	2.207	1
10	J AM SOC INF SCI TEC	2.005	2.159	1
11	GOV INFORM Q	1.910	2.263	36
12	INT J INFORM MANAGE	1.843	1.898	4
13	J COMPUT-MEDIAT COMM	1.778	4.748	3
15	INFORM MANAGE-AMSTER	1.663	3.178	2
17	TELECOMMUN POLICY	1.594	1.672	2
18	EUR J INFORM SYST	1.558	2.422	6
19	J STRATEGIC INF SYST	1.500	2.433	2
24	SOC SCI COMPUT REV	1.303	1.448	5
26	J INFOR SCI	1.238	1.384	2
30	INFORM SOC	1.114	1.389	4
33	J ASSOC INF SYST	1.048	2.766	1
37	ONLINE INFORM REV	0.939	1.277	1
38	J GLOB INF TECH MAN	0.917	-	5
42	INFORM TECHNOL PEOPL	0.767	-	6
52	J GLOB INF MANAG	0.452	1.179	7
55	MALAYS J LIBR INF SC	0.423	0.450	1
60	INFORM TECHNOL DEVE	0.378	-	14
62	INFORM DEV	0.375	-	5
	TOTAL ARTICLES ON INFORMATION SCIENCE			**112 (72.26%)**
	TOTAL ARTICLES			**155**

Source – The authors/ ISI of Knowledge.

The articles included in this database were read and analysed to identify the limiting factors that could have provoked not to have success in the implementation of e-government in developing countries and, on other hand, to examine possible solutions for preventing failed implementations of e-governments in the future. These topics are involved in the next two sections of this paper. Finally, a reflexion is made in the discussions and conclusions section, suggesting some measures to be taken for both governments in developing countries and international bodies that could finance e-government implementations in these countries, with the aim at improving the grade of success of these implementations.

2 Challenges in e-Government Innovation for Developing Countries

Previous research has shown that the unsuccessful implementation of e-Government initiatives by Public Administrations in developing countries is due to initiate the project without a strategy, clear objectives, and a clear description of the role of the government [20] –see Table 2-. Many studies about e-government in developing countries show the lack of strategic e-business plan for government to factor in the Internet integration of services across agencies, lack of a project over scoping and unrealistic goals, and alignment of organizational goals and the project [21], [22], [23] are the main challenges that public managers in these countries should consider if they want to achieve a similar e-government adoption to that achieved by industrialized countries.

Together with the above, researchers emphasize that the organizational and management structures do not favour implanted appropriate coordination and evolution of e-government initiatives [24], [25], which could lead to incorrect use ICT [20]. In addition, technological incompatibility, complexity, newness of technology and lack of IT technical skills and experience and security issues are some challenges that can potentially affect e-government development [15], [26] –see Table 2-.

In this sense, studies show a lack of technical knowledge by employees assigned to IT departments, they are not prepared to work in an electronic environment [20], [27], [28] –see Table 2-, i.e. public servants and managers for the implementation of these initiatives lack the skills, competencies and internal experiences necessary not only to understand the strategies of e-Government but to provide new electronic services [15], [22], [23]. This poor training and knowledge, lead to a lack of vision of the IT department.

This lack of knowledge is compounded by the lack of training for employees to use this kind of tools [17], [20], which stimulate the development of knowledge and skills in the ICT sector [26], [27]. In this sense, Gupta et al. [28] believe that government pay little attention to training their employees and do not provide adequate support for the implementation of e-Government –see Table 2-. Furthermore, it is considered that the managers should provide an environment where employees are encouraged to use the new technologies making clear the benefits of its use and the impact this would have on their work, trying to reduce resistance among staff to use of ICT, and their negative attitude [28], [29]. Hence, there are studies that claim that the use of ICTs is blocked by the lack of computer skills, low levels of trust, and negative perceptions of ICTs by civil servants and citizens [22], [29].

The implementation initiatives of e-Government are blocked by the lack of necessary to adopt these policies financing [15], [30], and lack of support from the main leaders –see Table 2-. In this regard, some official fear that the use of ICT in the loss of status and power, so many projects are delayed by several unjustified interruptions [15]. This is due to ignorance and the unwillingness of top officials of the government to adopt new ICTs enabling processes suffer from a lack of leadership that encourages the creation of team to undertake such initiatives [25].

Table 2. Limiting factors for e-government successful implementations in developing countries

Limiting Factors		Main articles
INTERNAL FACTORS		
Institutional Weakness	**1. Lack of strategic planning in e-government projects** a. Lack of coordination and cooperation b. Dissemination of knowledge about the overall objectives and goals d. Lack of business plan **2. Non-alignment with organizational goals** a. Progress limited and conservative breed bureaucrats	Picazo-Vela et al. (2012) Weerakkody et al., (2007) Mbatha et al. (2011) Zhao et al., (2012) Luna-Reyes and Gil-García (2011)
Human Resources	**1. Lack of IT technical skills by employees** a. Resistance to change b. Limitations of the Web portals b. Lack of human capital development **2. Lack of support of the main leaders** a. High risk for the managers b. Unwillingness to take risk c. Unplanned decisions and fear of being made redundant. d. Lack of leadership and coordination	Weerakkody et al. (2007) Brown and Thompson (2011) Mbatha et al. (2011) Zhao et al., (2012) Picazo-Vela et al. (2012) Gupta et al., (2008) Valdés et al. (2011) Maloi and Mutula (2007) Luna-Reyes and Gil-García (2011)
Technology	**1. Technological complexity** a. Incompatibility of systems b. Efforts to introduce ICTs into business processes c. Integration of different organizational structures – Interoperability d. Large multinationals dependence by applications **2. Security and authentication issues**	Picazo-Vela et al. (2012) Luna-Reyes and Gil-García (2011) Weerakkody et al. (2007) Kahraman et al., (2007) Sharifi and Manian (2010)
EXTERNAL FACTORS		
Funding arrangements	**Lack of funding of e-government projects** a. Decision about the use of financial resources b. Lack of control mechanisms	Weerakkody et al. (2007) Kahraman et al., (2007)
Infrastructures	**Lack of infrastructure in telecommunications** a. Development infrastructure and development of knowledge b. Poor development of e-Government efforts c. Need to reduce digital divide d. Inefficient access to online services	Picazo-Vela et al. (2012) Maloi and Mutula (2007) Gupta et al., (2008)

Source – The authors.

This lack of support from major public leaders may be reflected in the lack of appropriate government ICT policy formulation [26] to promote the dissemination of information, proper planning for the adoption and diffusion of ICT development network infrastructure, stimulating the improvement of productivity and creativity [31]. These shortcomings and inadequacies policies make ICTs evolve slowly, specifically, Internet does not reach all zones, especially rural areas of difficulty access, so there is no universal access to online services [32], [33]. This poor access to the Internet, along with the high level of illiteracy in the population and low penetration of PC represent a weakness for the start of e-Government [15]. In fact, many public services are primarily offered to vulnerable groups or low income groups, which have less likely to access to technology [34] –see Table 2-. These circumstances force public administration to continue to provide basic services through multiple channels in the short term to avoid excluding those segments of the population without access to the Internet.

This limited access to the Internet is primarily due to the lack of infrastructure in telecommunications implemented in developing countries, hence the high price of Internet access, and the high cost that citizens must endure to access public electronic services [22], [34] –see Table 2-. In this regard, Lin et al. [34] emphasizes that governmental documents are difficult to access for citizens, which must wait hours before browsers to download. In addition to these poor telecommunications infrastructure must be added, that the population lacks education and literacy rates are high, and the dominance of English in certain sectors of the population is zero [15].

To the above, it must be added the problems of security and authentication prevent the development of services and e-business [15], [30]. At this regards, Kahraman et al. [30] affirm that the concern for this issue by the public is important, because personal records have sometimes been found in landfills. These incidents cause distrust, hence the reluctance of citizens to use the Internet and electronic services offered by public administrations [35].

3 Solutions in e-Government Innovation for Developing Counties

The researchers have tried to give solutions to the problems discussed in the previous section, and in some cases guidelines that governments of developing countries must follow if they are to successfully implement e-government. First, give the lack of established strategies and vague objectives of the implementation of this initiative, researchers believe that the governments should establish an organization for programming, supervising, implementing and controlling e-Government development projects [35], and establish a strategic plan for ICT and formulation of appropriate policies [26] –see Table 3-. This will allow the development of e-government is implemented and used successfully.

In this regard, Zhao et al. [23] argue that development requires building an interagency network of systems, networks, software, hardware and organization, which is important in the early stages of implementing e-government element, since the success of e-Government requires a well-defined and well-formulated forward-looking and system-thinking strategy and implementation of the strategy. In addition, it is recommended that government departments and entities development a system thinking mindset to deal with the key issues of e-Government development, such as, e-integration and quality identified in our case study, and conduct strategic planning for a time horizon of three to five years.

With a clear strategy, governments should provide for appropriate coordination and promotion of management structures in e-Government initiatives [24]. It would be advisable to implement a common infrastructure whose services may be used by whole of government entities [32]. The implementation of these initiatives have appropriate agents required from the beginning of project implementation, allowing the definition of the project, consultation with employees to facilitate the careful preparation of the project, the choice of the best contractors qualified, which encourage participation by all in various stages of project implementation [35].

Similarly, the adoption of e-government requires having qualified staff, hence it is necessary to holding training courses, national and foreign professionals and academics [35] and a strategy incorporating national policies and programs for the human capital training [17] –see Table 3-. Furthermore, it is considered that the cooperation with international organizations that have more experience in developing e-government projects has positive effects on the implementation of these initiatives [35], [36].

Alongside this, the involvement of officials is required, especially officials at the highest level [35]. To do this, it is considered that the existence of processes increases the effectiveness of efforts in developing such initiatives. In addition, strong leadership or the existence of a previous network is key components in creating a team project, a good balance of relationships, results and process orientation [25] –see Table 3-.

Due to opposition to the use of ICT by citizens, the government should build confidence by creating Web sites, by providing updated information, and ensure the design Web pages citizen-centered by standardization of Web design [23]. In this regard, analysts and designers must design information systems and ICT services that are easy to use requiring little effort, providing clear guidance on how to navigate the Web, offering a list of steps required to perform a particular transaction [23]. In addition, developing countries citizens with high levels of illiteracy need education and communication programs appropriate for the awareness of citizens, therefore, governments should increase promotion campaigns on the importance of using Internet in everyday life [31].

Finally, governments must build telecommunications infrastructure in the country, favouring the spread of ICT , reducing the price getting cheaper Internet access and access to services for which the liberalization of telecommunications [23], [26], [32] –see Table 3-.

Table 3. Public policies for improving e-government successful implementations in developing countries

National Level Solutions		Specific Recommendations
ORGANIZATIONAL CHANGES		
Institutional Weakness	Clear definition and alignment of ICT goals with organizational goals.	1. Adopting the performance-oriented strategic planning model (BSC) 2. Creativity and modernization of management methods 3. Decentralize administrative system 4.Planning strategies objectives 5. Public policy formulation and partnership between public organizations and private sector
Human Resources	Employees training in IT technological skills. Motivation of employees for positive attitude towards ICT implementations.	1. Workshops and staff training and work organization 2. Specialist in recruitment, education and development 3. Computer training 4. Strong leadership and existence of a previous network
Technology	Global policies of technological systems to be compatible. Investment in efficient measures of privacy and security.	1. Implementation of free software or open source 2. Purchase of only one integrated system 3. Communication and involvement 4. Intervention of experienced international organizations
IMPROVEMENT IN NATIONAL ENVIRONMENT		
Education	Improvement of education grade of citizenry.	1. Online Public Libraries 2. Formation of school-community coalitions 3. Implementation of long-term teacher training programs 4. Establishment educational programs and vocational 5. Literacy campaigns
Infrastructures	Improvement of technological infrastructure in telecommunications.	1. Increase public investment in the ICTs infrastructure 2. Online Kiosk and articulated CRM efforts 3. Telecommunications liberation and lower to price of internet access

Source – The authors.

4 Discussions and Conclusions

This paper has sought to analyse past experiences in the implementation of e-government in developing countries to learn some lessons for improving this implementation in the future, which could help to achieve more transparent, participative and democratic societies. As noted previously, perhaps the main challenge for introducing e-government in developing countries is the lack of strategic planning. Developing countries seem to have understood the implementation of e-government as individual measures and it has given place to raise some inefficiency in the implementation of ICTs in governments.

In this regard, challenging situations require global measures, not individual ones. Challenging situations are challenging because they're dynamically-complex adaptive systems. In this regard, the systemic thinking approach could help developing countries to implement ICTs successfully. This approach would involve viewing "problems" as parts of an overall system, rather than reacting to specific parts, outcomes or events and potentially contributing to further development of unintended consequences.

If we want different outcomes from a situation, we have to change the system that underpins the situation in such a way that it delivers different outputs. It means other measures that are linked to the introduction of ICTs in developing countries such as employees training in IT technological skills, definition of alignment ICTs goals with the organization goals or the positive attitude of personnel in the implementation of these ICTs. In fact, if successful e-government implementation is desired to achieve, politicians in developing countries should wonder if the e-government implementation means an organizational change of their public administrations.

In addition, it seems clear that e-government cannot be effective if stakeholders do not have the needed means to access to government information and services. In this regard, public policies driven to improve technological infrastructures and to make Internet a sure site with efficient measures of privacy and security, as well as to make it accessible for all families and stakeholders are essential for improving transparency, efficiency in public sector services and e-participation, which could have a positive impact on the trust of citizens on their governments. Else, two main problems could be derived. On one hand, the lack of security and privacy could lead to untrusted governments. On the other hand, digital divide could be arisen and it could lead to a loss of trust in governments because e-government implementations could be viewed by citizens as services and information for a specific high social class of the society of the country and it could make bigger the gap between the social classes into the society of that country.

Finally, other public policies must be taken to achieve efficiency in e-government implementation. These public policies should be led to improve the education grade of the citizenry. If citizenry are not trained to use IT, e-government implementations could be inefficient because of the possible low grade of use. In this regard, citizenry must be aware of the possibilities of e-government implementations as well as the use of them in order to obtain efficient public sector services or to have access to government information.

In brief, systemic thinking approach is needed to be applied in developing countries to undertake successful e-government implementation. Indeed, it can therefore provide valuable practical insights to help developing countries define, evaluate and enhance their e-government initiatives. It means to act in three different scopes at the same time: a) organizational structure and processes; b) investment in IT infrastructure and c) investment in education to make citizenry ready to use IT. In order to apply systemic thinking approach, strategic planning in the implementation of e-government applications is essential.

In this regard, financial aids to help developing countries in implementing e-government initiatives should be driven, at least, to four different, but complementary, actions. On one hand, to analyze the current situation of e-government development in the country analyzed using appropriate methodologies that enable to measure this issue. In this regard, guidelines and best practices codes to evaluate e-service, disclosure of online information and e-participation development have been both issued by relevant international bodies [37], [38] and by prior research [39], [40].

Second, international organizations should pilot and monitor projects of IT strategic planning in developing countries with the aim at joining these projects with government goals, increasing the efficiency of IT projects and the achievement of desirable goals. This IT strategic planning should allow developing countries improving information transparency, improving interaction with stakeholders and improving the efficiency of public services delivery.

Third, it is necessary to promote the development a project for training both employees and citizens regarding e-government applications. In this milieu, it would be desirable to finance employee training in IT technical skills and e-government initiatives in order to make them aware of the need of e-government implementation to achieve better social, democratic and economic outcomes. In this regard, prior research has shown that professional training courses using of foreign and domestic professionals and college professors, as well as cooperating with international organizations that have significant experience in e-government development projects could help to successfully implement the e-government projects in developing countries [35]. Therefore, this training should be carefully designed.

In addition, this training could be lead not only to the use of e-government initiatives but also to monitor and to control them. Also, public policies driven to citizenry should be financed to enable them to have access to e-government initiatives and to make them aware of the possibilities of e-government applications to obtaining public services, government information and to participating in public sector management. These funded policies driven to citizenry training could have an effect on an increasing pressure exerted by citizenry to their governments in order to be more efficient, transparent and participative.

Finally, international bodies should finance the creation of an observatory of e-government practices in developing countries in order to monitor and to promote best practices in e-government initiatives. This observatory should undertake timely research regarding the e-government development in developing countries and to issue a specific route for developing countries in order to improve their mature grade of e-government implementation. In this regard, reports about the reforms of governmental structures could be a relevant outcome of this observatory to help developing countries to implement efficient e-government initiatives.

In parallel, governments in developing countries seeking efficient e-government implementation should also introduce official mechanisms to monitor the e-government initiatives and to coordinate all systems involved in these initiatives. The coordination plays a key role in this milieu because it can avoid reduced efficiency and erosion of responsibility in e-government implementation. Indeed, the "individual view" approach of e-government implementation in developing countries may have led these countries to over-fragmentation, self-centred e-government applications, and a lack of cooperation and coordination, hampering effectiveness and efficiency of e-government projects. Instruments for cooperation in e-government projects are therefore essential to optimizing e-government implementation as, for example, the supply of e-services to citizens, the disclosure of government information, or the management of information about citizenry in the delivery of public sector services.

In addition, to make e-government implementation successful, all the structures involved in e-government projects must be perfectly aware of the functions assigned to and executed by each body, and where information flowed among the various bodies in order to detect anomalies in the performance of e-government applications. In this context, as noted previously, strategic planning for e-government implementation is one of the best instruments to be used in order to achieve all these objectives.

In conclusion, our analysis indicates that no specific analysis should be made when e-government implementations are going to be undertaken. It needs a systemic thinking approach, which suggests the use of strategic planning for e-government success. In this regard, successful implementation of e-government is not only linked to the technologies to be introduced in the public sector entities. Political and social changes are required alongside the implementation of electronic mediums [24]. International bodies should fund activities that allow developing countries to achieve all these changes and should monitor e-government efficiency in developing countries with the aim at improving economic, democratic and social development of these countries.

Future research is required to obtain findings regarding the analysis made in this paper. It could be undertaken under different cultural contexts and it should be led to comparing different experiences of successful and unsuccessful implementations of e-government in different developing countries in order to analyse the determinants that influence in the e-government efficiency.

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From Trash to Cash: A Case of Waste Management Business Model Formation

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Abstract. With increased urbanization and the need for environmental sustainability, the issue of efficient waste management is highlighted as one of the many current challenges. In light of this, new solutions for waste management involve moving away from grand-scale, centralized facilities towards more decentralized, smaller facilities supported by novel usage of information technology. It is also important to reduce waste and move the operations towards efficient and interesting services focusing on increased quantities that are re-used, recycled and upcycled. A key prerequisite for this type of solution lies in the creation and maintenance of sustainable business models. This paper explores the formation phase of one such business model for decentralized, local waste management facilities. Through an Action Design Research study conducted in 2013, the research team worked together with representatives from both the public and private sectors within a smart city initiative in Stockholm, Sweden. As the results show, the applied method resulted in a successful business model formation. The contribution of this paper lies in presenting a method for business model formation in a smart city context, along with recommendations related to how this method can be applied to solve the issue of waste management.

Keywords: Waste management, Smart city, Business model.

1 Introduction

By 2050, as forecasted by the United Nations, 70% of the world's population will live in cities [1]. In parallel with this development, the amount of waste generated by citizens in the last century grown dramatically. [2, 3].

According to the World Bank World Bank's Urban Development and Local Government Unit [4], there has been a movement from were 2.9 billion urban residents who generated about 0.64 kg of municipal solid waste (MSW) per person per day (0.68 billion tonnes per year) to today, where the amounts have increased to about 3 billion residents generating 1.2 kg per person per day (1.3 billion tonnes per year). The estimate for 2025 is that this will be increased to 4.3 billion urban residents

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generating about 1.42 kg/capita/day of municipal solid waste (2.2 billion tonnes per year).

In Sweden the trend is that the amount of waste is increasing, moderately, but the environmental impact is actually declining [5]. However, in many other parts of the world, cities have huge challenges to provide easy-to-use systems for re-cycling, and re-use, resulting in that the issue of waste management becoming pertinent to explore.

Most existing solutions for waste management in Scandinavia have been focused on creating economies of scale, with large facilities located outside of densely populated metropolitan areas [6], connected to a collection of nodes within the cities themselves. With transportation being one of the most pressing obstacles for sustainability, this solution has been deemed less than optimal and new solutions have long been sought [7]. These solutions need to address both re- and up-cycle perspectives [8].

Through initiatives related to what is commonly referred to as “smart cities”, information technology (IT) and new types data collection through sensors is regarded as a key factor in creating more environmentally sustainable cities where the “smart” citizen is given the opportunity to follow and adjust his/her own impact. But before it is possible to for grand-scale implementation of smart city solutions, there is a need to formalize scalable collaborative arrangements between involved actors. One way to formalize collaborative arrangements is by business models.

With cities being under the domain of the public sector, smart city solutions have highlighted the need for creating the prerequisites for successful public-private partnerships [9, 14] as a means of solving some of the pressing issues. This involves finding business models for the necessary solutions with enough incentives in the form of both economic (profit, reduced costs et cetera) and non-economic (Corporate Social Responsibility (CSR), brand et cetera) dimensions that will work over time. This involves bridging both the public-private and the intra-inter organizational divides, issues that previously have been largely overlooked in the business model and Public-Private Partnership literature, resulting in a situation where the necessary method support is lacking [10]. The objective of this paper is to add to the field of business models and smart city literature, through the exploration of a case of the business model formation for a decentralized waste management station. This is guided by the following research question:

How can the process of business model formation for waste management be supported?

This is further delimited through the selection and adaptation of a particular type of methodological support for business model formation, the Business model canvas, and the case of a waste management project within a smart city initiative in Stockholm, Sweden.

2 Previous Research

2.1 Smart City

The label smart city is not new. In the early 1990s the phrase "smart city" was established to signal how urban development was turning towards technology, innovation and globalization [11]. It was stressed that the label of smart was connected to the various technologies connected to The Internet. More recent initiatives, like the Centre of regional Science at the Vienna University of Technology, broadens the scope to six dimensions from where cities can be compared in a smart iity context. The dimensions described are: a smart economy, smart mobility, a smart environment, smart people, smart living and smart governance [12]. Forrester defines the smart city as: a “city” that uses information and communications technologies to make the critical infrastructure components and services of a city — administration, education, healthcare, public safety, real estate, transportation, and utilities— more aware, interactive, and efficient [13].

From these multiple perspectives, the smart city concept offers a vision of how to resolve some of the big challenges of the world, by applying ICT to moderate the impacts of continuous and growing urbanization and the associated effects. The idea is that by making cities smarter, we can enhance the opportunities to increase economic growth and yet reduce energy consumption, and the stop the increase of waste in new and possible dramatic ways. [14, 15]. The 1997 World Forum on smart cities suggested that around 50,000 cities and towns around the world would develop smart initiatives over the next decade. [16].

There are a few analyses of smart city discourse from the point of view of more critical urban perspectives, such as ideas surrounding the ‘entrepreneurial city’ [17], the growing domination of neo-liberal urban activities and spaces [18] not to mention the existing literature on urban place marketing [19, 20].

2.2 Business Models

A business model is used to describe the key components of a given business [21, 22]. During most parts of the past decade, authors have suggested frameworks looking to identify and describe the most important parts of a business model, its actors, and how they relate to each other [23, 25]. At a general level the business model has been referred to as a statement [25], a description [26], a representation [27, 28] an architecture (29, 21), a conceptual tool or model [24, 30, 31], a structural template [32]) a method [33], a framework [34], a pattern. [35] and as a set [36]. In this paper, we choose to follow the business model definition advocated by Osterwalder [24]:

‘A business model is a conceptual tool containing a set of objects, concepts and their relationships with the objective to express the business logic of a specific firm. Therefore we must consider which concepts and relationships allow a simplified description and representation of what value is provided to customers, how this is done and with which financial consequences.’

Although the field of business model research being fairly young, dispersed, and by large lacking a solid conceptual base, there is an emerging understanding for the need of a deeper understanding of how value is created and co-created within and between firms [22, 32, 37]. Studies show the facilitating value of business models in business development contexts, specifically when exploring innovative ideas connecting technological potential with economic value [38]. However, there are several challenges that relates to business development and innovation activities, especially when they are based on business models. Amit and Zott [32] describes some challenges related to the conflict between 'the new' and the old existing model, Christensen [39] and Christensen and Raynor [40] highlight the challenges associated with disruptive technology. Prahalad and Bettis [41] describes a different barrier where companies at a certain point of time has a dominant logic how value is created and captured. Chesbrough and Rosenbloom [42] build upon this notion of dominant logic and notes cognitive barriers to business model innovation and business development.

As seen, there seems to be several identified barriers and challenges in the field of business modelling. However, there is a consensus regarding the value of using business models where they can act as a catalyst and a bridge when working in a collaborative manner. Here the models become pedagogical frameworks for mentioned barriers. If managers want to work on overcoming these barriers, they need to adopt tools and techniques to be able to evolve in new ways. [43].

Osterwalder proposes a business model canvas as means to conceptualize business models. The canvas has gained traction within the business community and is widely used [44]. The canvas is comprised of nine categories illustrating how firms create value. In this study we have used the business model canvas, but also other visual tools, to create a basis for alignment concerning the vision and business model design of the future waste management system in the smart city of Scandinavia.

3 Research Approach

In an initiative to build 12 000 new apartments close to the city center, a new "smart city solution" for waste management is required. The solution needs to incorporate recycling and more importantly reuse of material not considered waste, but found in the waste. The city started the project with an overall idea of the business, but not a business model. There were many different views, dreams and opinions as to what it should be. As a way forward, the city enlisted a group of researchers to support the formation of a business model for a Future Waste Management System (FWMS).

With the ambition of bridging the theoretical/practical divide within Information Systems [45], the research was designed following inspiration from the Action Design Research approach as proposed by Sein et al [46]. This particular approach towards linking action research [47] with design science research [48] involves an increased focus on the relevance cycle as proposed by Hevner [49]. Key to this approach is the focus on what Sein et al [44, p. 30] refer to as the "ensemble IT artifacts", i.e. seeing the artifact as something that is socially constructed and part of a context. In our approach towards this, the business model itself is regarded as the ensemble artifact. In Table 1 we present the steps taken in conjunction with Sein et al's [46] model of Action Design Research, along with the empirical material gathered throughout the process. For the analysis, we utilize the Action Design Research methodology and link this to the process of business model formation.

Table 1. Overview of the Action Design Research process and corresponding empirical material

Step	Time	Empirical material
1. Problem formulation	Aug-Sept 2013	Notes from project formation Notes from startup
2. Building, intervention and evaluation	Sept-Nov 2013	-Workshop 1, Vision, Business modelling of recycle entrepreneurs respective business -Workshop 2, Details, merging of business models. Supported by graphical recorder -Interviews with recycle champions from businesses and other innovative recycle stations -Notes from project meetings
3. Reflection and learning	Oct - Nov 2013	Presentation and discussion of project results with city managers
4. Formalization of learning	Nov-Dec 2013	Project report Publication in scientific community

4 Results

The results are structured after the Action Design Research methodology as proposed by Sein et al,[46]. In line with this, the proposed method will be directly interlinked with the Action Design Research methodology, making this part of the actual business model formation process.

4.1 Problem Formulation

1. Reversed literature review, "I learn your stuff, you learn my stuff"
2. Education of each stakeholder from review.
3. Workshop 1 – Understand the positions from each stakeholder. Public, Entrepreneurs/Business and others. Academia moderators. Introduction of Business Model Canvas, document the sessions using Graphical Recorder.
4. Study - Model what works from examples of other similar operations

5. Interviews & Business Modeling - Deeply understand entrepreneurs/business side. How does their respective business work today? What can they imagine would change?
6. Competition and Investigation- What does the public citizen think?

4.2 Building, Intervention and Evaluation

The Process

1. Workshop 2 - Predesigned process. Purpose: Design vision, mission, outer frames and inner frames. Document using Graphical Recorder. End meeting going through the visual recordings.
2. Analysis - Finalization of proposition, business model.

Complementing Methodologies

An artist and professional graphical recorder participated in the workshop, producing visual representations of what was said during the workshop (Figure 1). These were later used as a foundation for discussions.

Fig. 1. Graphical recording

Introducing the Ensemble Artifact: The Business Model

The resulting business model was formalized according to Osterwalder's [24] Business Model Canvas (Figure 2). After a brief illustration of the complete business model, we will devote some time in describing each category in more detail.

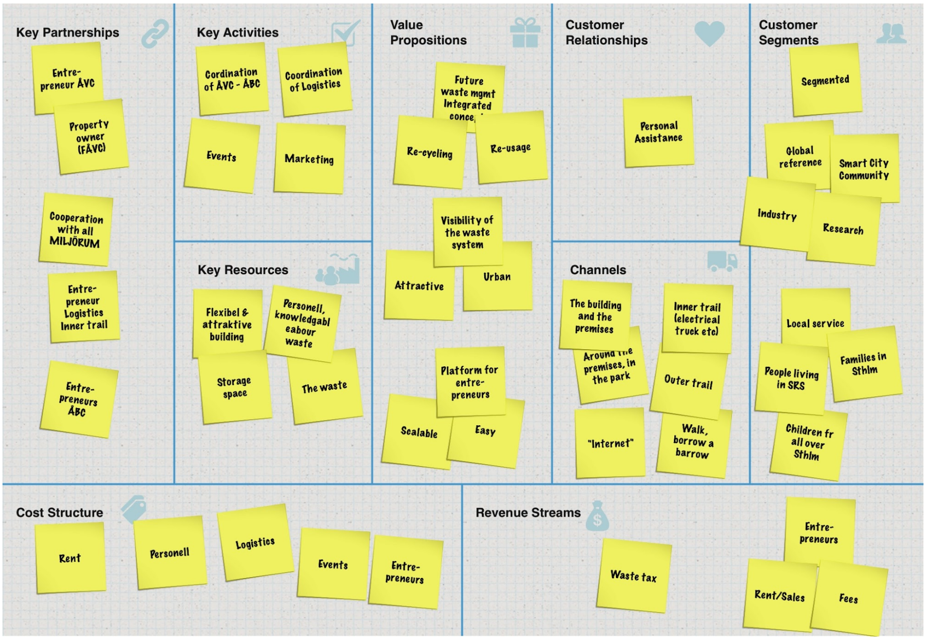

Fig. 2. Business model canvas

The Future Waste Management Station (FWMS)
.. is an attractive building located in a park where citizens (focus on young families with kids) are invited to a hands-on experience of waste management and reuse.
..is grounded in citizens needs for participation, co-creation and understanding of the circulation of materials. This is manifested in a transparent and simple system.
.. is socially, ecologically and economically sustainable.
.. strives to achieve measurable environmental improvements

Value Proposition
FWMS is a platform for recycling of waste and reuse/ "up-cycling" of materials that are nor waste. Further It is also contextualization of the waste system for educational purposes. a visualization/ "experiencing" the waste-system in an attractive urban area. Further, it is also a simple, scalable platform for reuse entrepreneurs to base operations on. The overall value proposition is an increased sustainable approach to waste.

Customer Segments
FWMS has a local-, and a global market. The local market is made up primarily of families living in the area, the global market refers to the private sector related to smart city products and services, and researchers involved in smart city studies

Channels
The channel to the customer is made up of an attractive building within the city, preferably a park. The building is an exciting and safe place for the whole family that

in addition to its main purpose of recycle and reuse also invites to playing and learning. It is not possible to take the care to FWMS, but it is possible to borrow carts and wheelbarrows for transportation of larger materials. Pickup of materials/ “waste” is made in “environmental rooms” located inside the apartment’s buildings supported by an electric truck. There are also extensive information online regarding the site and pickup schedules.

Customer Relations
There is a personal meeting and support onsite for all visitors.

Revenue Streams
Revenue comes from a public waste-fee / tax and recycling of materials, primarily metals. The entrepreneurs’ active at the reuse area pays rent. It is expected to have market rents after a start-up period of 3-5 years of rent subsidiaries.

Key Activities
Key activities include the coordination between the reuse and the recycling as materials are picked up from the recycling to feed the reuse. There is also significant logistical management and marketing of events.

Key Resources
The design and layout of the building is central for FWMS. The building must be flexible and adjustable to changing needs from the reuse entrepreneurs, and attractive enough to draw the attention from the crowd despite the fact that it is not possible to take the car. The building also needs to have a good connection to storage facilities at another location. The personnel must have good knowledge and skills regarding waste and “what to do with it” in order to continually support the visitors with sorting.

Key Partnerships
FWMS needs strong and stable partnerships. The most important is with a competent and committed entrepreneur with an overall responsibility for recycling. In addition, well-functioning partnerships with landlords, the logistics entrepreneur and a set of reuse entrepreneurs are necessary.

Cost Structure
FWMS main costs are related to rent for the building, personnel costs for 3-4 full time, logistics transporting material to- and from the building and costs for events.

4.3 Reflection and Learning

The participants of the project perceived the initial stages of the process as uncomfortable. It was challenging to gain the trust from the participants that the process would lead to a useful result. Many of the stakeholders did not have extensive experience working in research related environments. Another challenge for the researchers was to gain understanding that there were a lot of different views and opinions regarding how the business model should be designed, and that these views was not aligned.

The usage of a graphical recorder was highly appreciated by all team members. The visualizations provided useful graphical representations of the visions that gave fuel and precision to many discussions. It would have been useful to have more individual sessions with stakeholders between workshop 1 and workshop 2. This would have provided an opportunity to not only talk about the individual entrepreneurs' relation to the business model, but also include a reflecting session regarding the process, and how it was perceived. As a way of gaining further acceptance and understanding of the results, and pave the road for implementation of the business model, it would have been useful to have a third workshop presenting the final results supported by the graphical recorder. As a final step, an open discussion with the public would have given us the opportunity to add new perspectives, and to ensure that most needs are covered in the model, and to calibrate details with the end users.

4.4 Summary of Method for Business Model Formation

Based on the experiences and learning from the project, we propose the following (Table 2) action steps in the Action Design Research (ADR) cycle for business model formation in the smart city context:

Table 2. Method summary

Action-design step	Action
1. Problem formulation	1. Double-sided literature review and education of stakeholders 2. Workshop 1: Mapping stakeholder positions 3. On site visit of inspirational example 4. Interviews and business modelling 5. Competition and modelling
2. Building, intervention and evaluation	1. Workshop 2: Vision, mission and framing 2. Analysis: Finalization of business model 3. Workshop 3: Discussion and acceptance
3. Reflection and learning	1. Adjust business model and vision from WS2 and WS3. 2. Present to the public, feedback from the Public.
4. Formalization of learning	1. Formalize learning through publication(s)

5 Discussions and Conclusions

This study highlights the challenges associated with business model formation in a smart city context and adds to previous knowledge through a proposed method for said process. Through an open and collaborative approach, the research initiative took the first steps towards the formation of an accepted business model. The process was structured as a step-by-step process, where various visual tools, ie. Business Model Canvas and Visual recording, were found to offer support in creating a business model accepted by the involved stakeholders. The business model will now provide a foundation for future work related to the collaborative arrangements among stakeholders.

This study adds to previous knowledge surrounding business models in general and business model formation in particular. As noted in previous research, there has so far been a lack of research targeting methods for working with business model formation, particularly in contexts where the said business model involves multiple stakeholders from both the public and private sector [10, 22, 32, 37].

This facet of the findings presented in this paper, i.e. the inter-organizational and the crossing of the public-private divide are deemed valuable for issues related to environmental sustainability in general and waste management in particular. With these issues often being handled at a societal level, or through the involvement of both public and private actors [10, 14, 15], we believe that additional knowledge in terms of how to create business models that balance the wants and needs of multiple stakeholders is one important piece of the puzzle. Hopefully, this first attempt at proposing a model for business model formation will be able to act as an inspiration for both research and practice.

Albeit this study being merely the first step towards a working method for business model formation within public-private partnerships, we argue that it could function as a basis for further research devoted to testing and further developing the method. At the same time, we believe that the applied methodology in terms of action design research as proposed by Sein et al [46] has been proven to be fruitful for this particular type of research. Future research conducted within this particular empirical context will hopefully take heed of this and continue down the same path.

In steps to come, the implementation of the business model presented in this paper, it will require extensive usage of information technology for the capture, storage and facilitation of “waste related data”, from the apartments, through the waste rooms in the apartment buildings to the recycle station sorting and into the reuse and up-cycle entrepreneurs businesses all the way to the storefront of up-cycled material. Although the Business Model does not define the requirements for such an IT solution, it gives a direction for what it could be. We believe that it points in the direction of the necessity for an IT-platform with functionalities aimed to stimulate waste entrepreneurs and smart city inhabitants to co-create new types of services. This area, defining in more detail what requirements this platform needs to meet, is in need of research attention. Following this line of thought, it is our intention to further investigate how business models and the presented process can enhance and add important details in the IT industry, especially where business modelling and visual recording could improve early process steps, such as the requirements or design phases.

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Ontological Modeling Applied to Engineering and Governance Processes of Customer Complaints

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Abstract. By selecting and adopting best practices organizations expect to benefit from the experience of other organizations and avoid common mistakes that these organizations have committed in the past. However, the adoption of best practices is not a trivial step due to several reasons. One reason is the fact that, to implement best practices, organizations need to migrate from an *as-is* state (before the adoption) to a *to-be* state (after the adoption), and the current best practices do not provide methods based on strong conceptual foundations to support this transition. Our proposal is a method supported by the Enterprise Ontology to align the current organizations' processes with the industries best practices. We applied the proposed method in a Portuguese Telco and aligned a process of customer complaints with The Information Technology Infrastructure Library (ITIL) best practices. As result the organization found several improvements to the mentioned process based on the ITIL best practices.

Keywords: Enterprise Government, Enterprise Ontology, DEMO, Best Practices, ITIL, Incident Management.

1 Introduction

Adopting best practices involves changing the state of an organization from an *as-is* state to a state that is aligned with the best practices processes. This implicates that the accountable organization for this transition must have awareness of what the *as-is* state is and what the *to-be* state looks like. This awareness requires the existence of a connection between the organizations' and the best practices processes, so the changes can be made. The problem is that current best practices do not provide methods based on strong conceptual foundations to support this connection. In other words, the best practices only focus on what should be implement and not on how organizations should change their processes in order to achieve what is proposed.

For example, despite The Capability Maturity Model Integration for Services (CMMI-SVC) recommends that when using its model, we should use professional

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judgment and common sense to interpret it for each organization [1], this solution does not specify how it should be implemented.

Another obstacle to a smooth transition is the fact that processes often rely on "knowledge workers" who know how to overcome the situations and who ultimately ensure the "normal" operation of the company [1]. The problem is that the knowledge they have, usually is only in their minds, and they cannot model that knowledge since most of them are not familiar with modelling techniques.

Therefore, the specific problem addressed in this paper can be described in the following research question:

How to take advantage of the Enterprise Ontology and DEMO to align the organizations' business processes with the industry's best practices?

DEMO (Design & Engineering Methodology for Organizations) is a methodology for modelling, (re)designing and (re)engineering organizations and networks of organizations. The theory that underlies this methodology is called Enterprise Ontology (EO) that by itself is based on the speech act theory [2]. We decided to use EO and DEMO methodology, since EO and DEMO illustrate the way to profoundly understand, (re)design, and (re)engineer organizations. Additionally, DEMO has proved to be efficient in extracting the knowledge from the "knowledge workers", due to the potential of the universal transaction patterns.

In order to solve the mentioned problem, we propose a method that allows organizations to have processes aligned with the best practices. This method is composed by the following steps: produce business models and their respective best practices models in such a way they are coherent, comprehensive, consistent, and concise; compare the process models versus the best practices models; reengineer the process being studied according to the analyses from the previous steps.

We applied the proposed method in a Telco organization in which we focused in the incidents of the mobile portability process.

This remaining of this paper is structured as follows. In Section 2, we present a brief overview of the literature on the research problem area. Afterwards, we present our proposal, namely the proposed method (Section 3). In Section 4, we explain the demonstration of the proposal. In Section 5, we show the evaluation process, and finally, we conclude the paper by reinforcing the main conclusions of this research (Section 6).

Our study was conducted using the Design Science Research Methodology (DSRM) that aims at creating and evaluating IT artefacts intended to solve identified organizational problems [3]. This section corresponds to the problem identification and motivation phase of DSRM. It also corresponds to the objectives definition phase.

2 Related Work

In this section we present the related work that is divided in three subsections. First, we describe the solution from the best practices that we used in this research (ITIL, namely the incident management process). Afterwards, we describe the Enterprise

Ontology and respective modelling methodology DEMO. Finally, we conclude this section with an analysis of the current solutions that used DEMO to improve processes.

2.1 ITIL – Incident Management

In ITIL terminology, followed in the official book of ITIL [4], an incident is defined as an unplanned interruption or reduction in the quality of an IT service.

Incident management is the process responsible for managing the lifecycle of all incidents. Incidents may be recognized by technical staff, detected and reported by event monitoring tools, communications from users (usually via telephone call to the service desk), or reported by third-party suppliers and partners.

The process activities to be followed during the management of an incident are: Incident Identification, Incident Logging, Incident Categorization, Incident Prioritization, Initial Diagnosis, Incident Escalation (Functional and Hierarchic Escalation), Investigation and Diagnosis, Resolution and Recovery, and Incident Closure.

2.2 Enterprise Ontology – DEMO

Enterprise Ontology [2] is based on four axioms – operation, transaction, composition and distinction – and the organization theorem. The operation axiom states that the operation of an enterprise is constituted by the activities of actor roles that are elementary chunks of authority and responsibility, fulfilled by subjects. In doing so, these subjects perform two kinds of acts: production acts (p-acts) and coordination acts (c-acts). These acts have definite results: production facts and coordination facts, respectively. P-acts contribute to bringing about the goods and/or services that are delivered to the environment of the enterprise. C-acts represent commitments regarding the performance of production acts.

The transaction axiom states that coordination acts are performed as steps in universal patterns. These patterns (or transactions), always involve two actor roles (initiator and executer) and are aimed at achieving a particular result. A transaction develops in three phases: the order phase (O-phase), the execution phase (E-phase), and the result phase (R-phase). In the O-phase the two actors agree on the expected result of the transaction; in the E-phase the executer executes the production act needed to create the expected result; and in the R-phase the two actors discuss if the transaction result is equal to the expected result.

The composition axiom establishes the relationships between transactions. This axiom states that every transaction is either a) enclosed in another transaction, b) is a customer transaction of another transaction, or c) is a self-activation transaction.

The distinction axiom states there are three distinct human abilities playing a role in the operation of actors, called performa, informa, and forma. An ontological act (performa) is an act in which new original things are brought about. An infological act is an act in which one is not concerned about the form but, instead, about the content of the information. Datalogical acts are related to copying, storing, and transmitting data.

2.3 DEMO Based Solutions to Improves Processes

We analyzed three solutions that contribute to the state of art of DEMO based solutions that allow to improve processes.

In 2010 the potential of bringing together the notions of Enterprise Governance (EG) and Enterprise Ontology was evaluated in [5]. This research developed a set of conceptual models and an underlying reference method to support the EG in designing a set of normative outputs. This method uses the notions of competence, responsibility and authority designed at the ontological level within DEMO to address: how to restrict the undesirable freedom of the process of detailing the ontological models by addressing how actor' acts should be supported at the infological, datalogical and technological levels [5].

In 2012 another research presented a method to analyze the consistency of a process model according to business transactions [6]. The method makes possible assessing the consistency of a business process in terms of the business transactions that can be inferred from it. To do so, it takes as input a process model that is converted to a transactional model. The transactional model is then analyzed and revised so that all transactions become consistent according to the patterns of DEMO. Finally, the original process model is revised to comply with the transactional model. As a result, the revised business process becomes consistent with the corresponding transactional model [6].

Additionally in 2012, a method for improving healthcare management using Enterprise Ontology [2] and Lean Thinking [7] was proposed in [8]. The proposed method, illustrated in Fig 1, identifies innovations to improve the healthcare management.

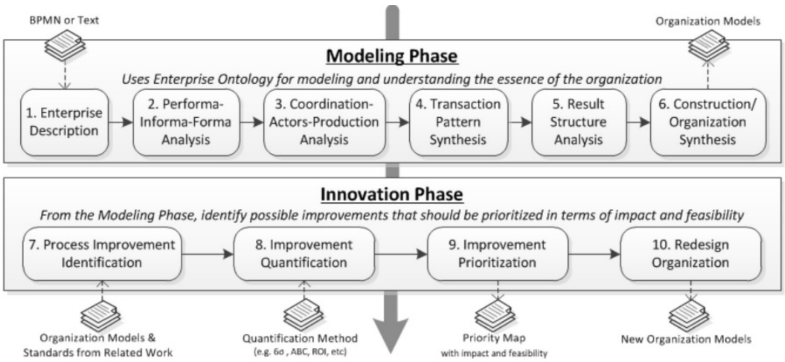

Fig. 1. Graphical Representation of the method

The method starts with the *Modeling Phase*, which uses EO to study the organization and its processes. As result, this phase provides a structured working approach by layering the organization into three parts, and focusing only on the one that directly refers to the complete knowledge of the organization and independent of the implementation. Then it continues with the *Innovation Phase*. In this phase identifies possible improvements from the previous models, prioritizes them in terms of impact and feasibility, and then proposes redesigned models for the organization. As result, this phase gives the appropriate tackle to handle the transformation process, and helps to choose the most profitable improvements first.

This method identifies possible improvements in which it is necessary to use some kind of partial judgment to identify transactions that do not seem essential and may be removed, changed, or automated. Whereas, our proposed method uses EO and DEMO for both the business process and the best practices in order to master their diversity and their complexity by the use of the same ontological models of DEMO. In that way, we can have the essence not only for the business process but also for the best practices and make a proper and impartial judgment about their similarities and differences.

3 Proposal

This section corresponds to the design and development step of DSRM. **We propose a method that relies on DEMO to align the organizations' processes with the industry's best practices**. The proposed method is intended to be used as a tool to make comparable what is now incomparable.

The method encompasses the following four steps:

1. Model the current state of a process to be optimized in DEMO;
2. Model the chosen best practices in DEMO;
3. Compare the DEMO models from the current process and best practices;
4. Reengineer the process according to the previous steps.

The **first step** is to model the current state of the process to be optimized in DEMO, using for that purpose the methodology proposed in [2]. In this step the "knowledge workers" involved in the process should be interviewed. The interviewers should prepare the interviews by collecting documentation about the process. As result, a white-box model of the organization being studied is obtained. A white-box model is a direct conceptualization of the ontological system definition and captures the construction and the operation of a system, while abstracting from implementation details. This white-box model is composed by four models: Construction Model (CM), Process Model (PM), Action Model (AM), and State Model (SM) [2]. If necessary, some information regarding the infological and datalogical layers (see Section 2.2) should be included. This information can be useful when the chosen best practices are rich in implementation details.

The **second step** focuses on modelling the chosen best practices in DEMO. Once more, the methodology proposed in [2] should be followed. As result, a white-box model of the chosen best practices is obtained. Since in this step there is no specific organization being modelled it may be useful to first model the best practices in The Business Process Modeling Notation (BPMN) and use the BPMN models as input to the methodology that produces the DEMO models. BPMN has been chosen because it is a standard of the industry with a well-known nomenclature. Both BPMN and DEMO models should be validated with experts of the related best practices.

The **third step** compares the two white-box models identified in the previous steps. This analysis compares the two ontological models (current process and best practices) by identifying their differences concerning mainly activities flow, actor roles, and complete transactions. Three components from DEMO can be used in this comparison: Result Structure Chart (RSC), Actor Transaction Diagram (ATD), and Process Structure Diagram (PSD). RSC can be useful to easily compare the two ontological models regarding the number of transactions, since the RSC only contains the transactions results and respective connections. In that way, we expect the two RSCs to be similar, and if it is not the case, we propose to identify the missing transactions from the best practices and add them to the ontological model of the organization. The ATD can be used to identify missing actor roles from the current process, since this diagram details two elements: actor roles and transactions. Additionally, ATD shows the boundary of the organization, as well as the interface transactions with actor roles in the environment. Finally, the PSD can be useful to identify different process flows between the process in study and the best practices. This analysis is possible since the PSD contains, for every transaction type in the ATD, the specific transaction pattern of the transaction type. The PSD also contains the causal and conditional relationships between transactions [2].

The **fourth step** bases the reengineer suggestions on the previous three steps and on the basics of Enterprise Governance [5]. From the first two steps one can identify missing atomic acts (such as missing promises) and inconsistent ones, just by developing the PSD, since this diagram imposes the specification of the complete transaction pattern for each transaction. The work from [6] can be used in this step. These improvements can be proposed also to the best practices and not only to the process in study, but this is out of this research context. Finally, from the comparison made in the third step of the proposed method, one can suggest improvements regarding activities flow, actor roles, and complete transactions.

4 Demonstration

This section corresponds to the design and development steps of the Design Science Research Methodology (DSRM). The demonstration was performed in a private company, leader in the telecommunications industry in Portugal, which we will call from now on ACME. In 2006, ACME had 1150 employees, 1518,5 millions € in revenues, and 215,6 millions € in profit.

We applied the proposed method to the ACME's customer complaints process and to the ITIL incident management. ACME did not have ITIL implemented. In order to model the customer complaints process in DEMO, **first step** of the method, we interviewed three "knowledge workers" from ACME. In order to exemplify the flow of this process, we describe a situation in which Alice (an ACME's customer) could not use her simcard on her phone. After some time, she decided to call her Telco operator, ACME, to ask for help with this matter. Throughout some interactions with the call center, she continued to not be able to use her simcard. Later, with a lot of trial and error, ACME finally found that Alice's number has been exported to another Telco company without request from Alice. Once the company identified this, they requested the other Telco operator to return the number. Once Alice's number was returned, she was finally able to use her simcard again.

The Actor Transaction Diagram of this customer complains process is illustrated in Fig. 2.

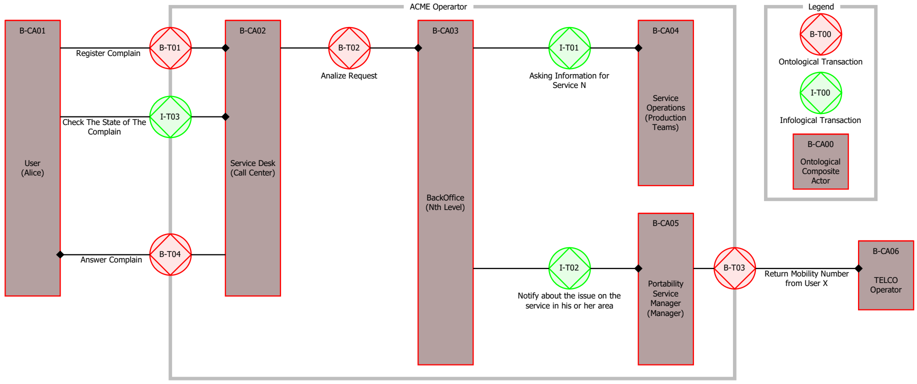

Fig. 2. Method – Step1 ATD of ACME's customer complaints process

We identified the existence of 4 ontological transactions, 3 infological transactions, and 6 actor roles. The ontological transactions are B-T01 Register Complain, B-T02 Analyze Request, B-T03 Return mobility number, and B-T04 Answer Complain. The infological transactions are I-T01 Asking information for Service, I-T02 Notify About the issue on the Service, and I-T03 Check the State of the Complaint.

In the application of the **second step** of the proposal (modelling of the best practices in DEMO), we used the Incident Management of ITIL. We based this modelling on the official literature of ITIL [4] and on two interviews with ITIL experts. The resulting diagram is depicted in Fig. 3. For the sake of readability only part of the diagram is presented.

We identified the existence of 29 ontological transactions, 23 infological transactions, 27 elementary actor role, and 13 composite actor roles.

With the ontological models of the ACME's process and the best practices, we identified the key transactions that were missing on ACME's customer complaints process (**third step** of the proposal). In order to do that, we used the Result Structure Chart (RSC) of DEMO for both ontological models from ACME and ITIL best practices.

Comparing these two figures, we identified the following transactions of ITIL best practices that were missing on the ontological model of ACME and that were suitable of being implemented in ACME: T02 - Recognize Suspicious Incident, T05 - Incident Identification, T13 - Incident Resolution, T06 - Incident Categorization, T07 - Incident Prioritization, and T20 - Incident Closure.

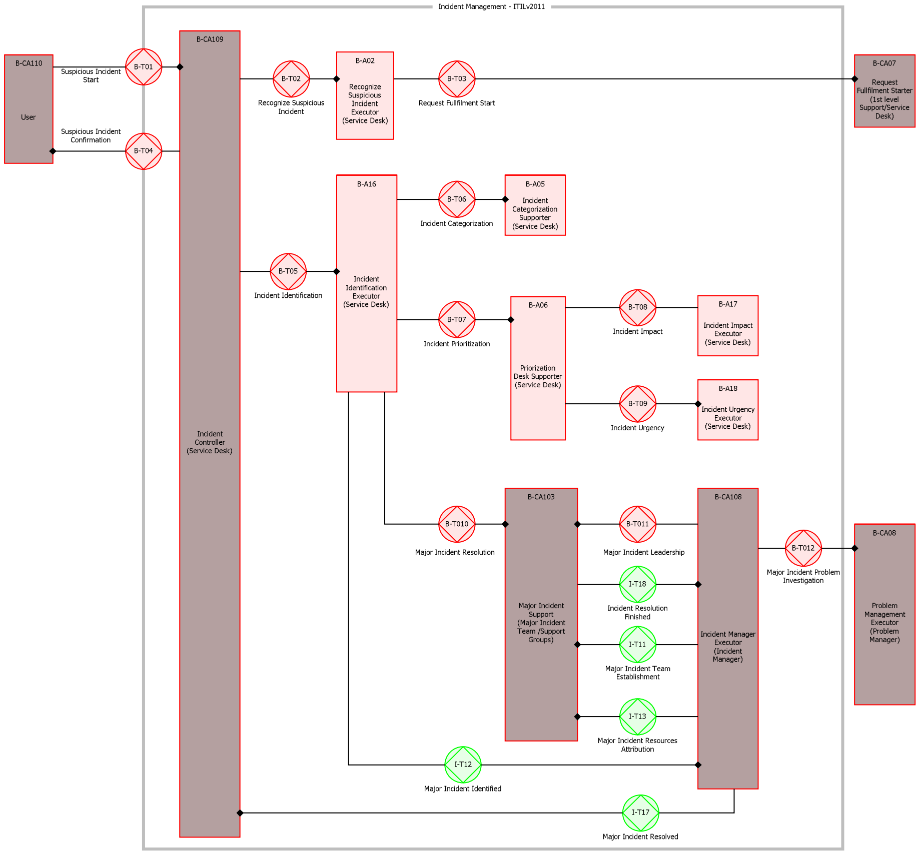

Fig. 3. Partial ATD of ITIL Incident Management

Finally, in the **fourth step** of the proposal, we proposed some reengineer improvements to the customer complaints process, based on the analyses from the previous three steps. Therefore, from steps 1 and 2 we found some improvements related with missing activities (mainly promises) and from step 3 we proposed the inclusion of the complete transactions already mentioned.

5 Evaluation

This section corresponds to the evaluation phase of DSRM and in order to explain the evaluation we use the framework proposed in [9]. This framework identifies what is actually evaluated, how it is evaluated and when the evaluation takes place:

- **What is actually evaluated?** The artifact evaluated is the proposed set of steps of Section 4 (a design process) and the results of applying these steps to the ACME (process improvements; a design product);

- **How is it evaluated?** We used ACME employees' (knowledge workers) and ITIL specialists' feedback to evaluate the proposed artifact and respective results. They were interviewed in semi-structured interviews that took 2 hours each and were structured as follows: first, the researchers explained the proposed method and the ACME demonstration including the identified improvements. Then, they were asked to comment on the usefulness of each improvement. This represents a naturalistic evaluation since it was conducted using a real artifact in a real organization facing real problems.
- **When was it evaluated?** It was evaluated ex post (after the design artifact was developed).

Overall, the four principles from [10] were accomplished:

- **Abstraction:** the artifact can be applied to any organization. As the proposal focuses on DEMO and by consequence not considering the implementation details, it can be applied to organizations in different contexts, as demonstrated in other works [11] [12];
- **Originality:** the proposed artifact is not present in the body of knowledge of the domain since it was designed by relating independent subjects, such as best practices and DEMO;
- **Justification:** the artifact is supported by the related work, described by textual and graphical representations, and justified and validated in different ways;
- **Benefit:** the artifact provides a structured working approach for aligning the organizations processes with the corresponding best practices. The feedback from the ACME's employee was positive since he agreed with all the suggested improvements. He mentioned that after the application of this proposal it was possible to have a big picture of the studied process and its (mis)alignment with the ITIL best practices.

Despite these positive results, we also found some limitations. The most relevant is the fact that we only interviewed three "knowledge worker" from ACME involved in the customer complaint process. Although, being a crucial elements of the ACME team accountable for answering the customers' complaints, their feedback may not be representable of the entire team.

6 Conclusion

This research offers an alternative for the diagnosis and resolution of organizational problems with scientific bases, through Enterprise Ontology, DEMO and best practices. We seek to leverage the capability of organizations to align their operations with industry standards and frameworks. This is not trivial since current best practices do not provide methods based on strong conceptual foundations to support this alignment.

In this context, this research proposes a method that, by using a common language (DEMO) to describe organizations' processes and best practices, allows to compare both and propose specific changes to the organizations' processes, so these can be aligned with the best practices. Therefore, the main contributions of this paper are: (1) leverage the use of best practices in organizations, and (2) create ontological models considered standard for a particular industry. These contributions promote the potential of applying Enterprise Ontology and DEMO in organizations.

As future work, we intend to apply our proposal in a different organization from the same industry in order to improve the ITIL ontological models. Additionally, we intend to evaluate the applicability of the method in different industries (health, bank, and public administration) and with different best practices (COBIT and CMMI).

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Converging the Streams: Information Systems Governance Unifying Framework

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Abstract. Information Systems Governance has been studied by scholars and practitioners under different angles. Various research streams have been enrolled in these researches. Despite their richness, there has been no study that really considers the IS governance in a holistic way and that covers all the angles of view. This paper is an attempt to address this gap and to propose a model that provides a unifying holistic view of the IS governance based: GUMM "Governance Unified Meta Model".

Keywords: Information System, Governance, Global, Unified Model.

1 Introduction

Companies are competing on the basis of unique resources that are valuable, rare, difficult to imitate, and non-substitutable by other resources (Bharadwaj, 2000). Information systems are not only part of these resources, but are also considered as valuable and strategic (Silva & Hirsheim, 2007) and significantly associated with the performance of the organization (Sathanam & Hartono, 2003). Moreover, the empirical research showed the link between the effectiveness of the governance of information systems and organizational performance (Weil, 2004). This link gives the information systems governance a particular importance in the governance of the company with which it is greatly overlapped (Wilson & Pollard, 2009). Indeed, good IS governance relies on the principles of corporate governance in order to manage and use information systems as a leverage to achieve the performance objectives of the company (Weil 2004).

The importance of IS governance has made that practitioners and researchers continue to fight in order to determine what the IS governance is, who is responsible for it in research and in practice, and how IS governance can be recognized, implemented and managed over time (Jacobson, 2009). This confusion is due to the fact that IS governance is a transversal phenomenon not only for the research disciplines but also for the organizational functions.

This explains the diversity of angles of sight and aspects under which the IS governance has been considered and studied by academics and practitioners as well. However, these studies were done in different ways and no study has been made considering the IS governance in its entirety. It is this gap in the IS governance research that our research wish to fill.

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This paper is structured as follows: first, we present a review of the literature concerning IS governance. Then, we present the unifying framework of the governance that we deduce from this literature. And we conclude our research by a discussion on the contributions and limitations of this unifying framework, as well as directions for future research.

2 Review of the Literature

Before detailing the aspects studied concerning the IS governance. Let us try to reach an agreement on a definition of the IS governance, even if there is no consensus on a single definition (Wilson & Pollard, 2009). Indeed, trying to obtain a common definition from the existing IS governance literature can quickly turn into a difficult exercise (Brown & Grant, 2005).

To integrate diversity in the number of definitions of IS governance, Webb & all (2006) suggest following "IT Governance is the strategic alignment of IT with the business such that maximum business value is achieved through the development and maintenance of effective IT control and accountability, performance management and risk management".

This definition incorporates many of the aspects studied by IS governance researchers. But the literature on this topic is much richer and more diverse. Therefore, in order to consider all the aspects studied by IS governance researchers; we classified this literature into five categories. The granularity of the studied aspects is headed gradually towards the finest operational details concerning IS governance. The first four categories are derived from the academic literature, while the fifth category is much more derived from the professional literature rather than from the academic literature (see fig.1).

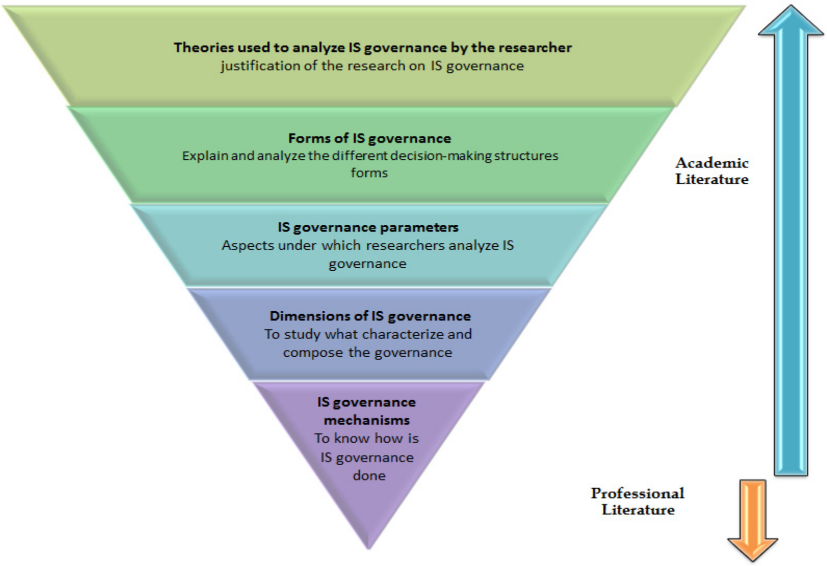

Fig. 1. Pyramid of the literature on IS governance

The first category concerns the theories used to analyze IS governance by the researchers and to give a justification for the research on IS governance. These theories allowed identifying all issues concerning governance. The four most used theories are:

- The Contingency theory (Olson & Chervany, 1980; Ein - Dor & Segev, 1982; Tavakolian, 1989) was used to determine the reasons of IS governance, and therefore to answer the question "why do we need IS governance? ". It was also used to study the IS governance decision-making structures, and so to answer the question "who makes and who is responsible of IS governance? ". And finally it has been used to study the question concerning the centralization / decentralization and integration / differentiation of the IS governance, and so to answer the question "where the IS governance is made? ".
- The Transaction Cost theory (Ang & Straub, 1998; Aubert et al., 2004) has been used in the studies concerning the cost of implementation of IS governance, and therefore to answer the question "how much costs IS governance? ". It has also been used to study information systems outsourcing, and so to answer the question "where the governance is made? ".
- The Agency theory (Loh, 1994; Oh, 2005) has been used for the understanding of the IS governance, and so to answer the question "what is IS governance? ".
- And finally the Institutional theory (Jacobson, 2009; Ang & Cummings, 1997; Pardo et al. 2008) has been used in the research concerning the manners IS governance is actually done and the IS governance practical approaches. It was therefore used in answering the question "how the IS governance is made".

The second category concerns the forms of IS governance (Brown & Grant, 2005; Lawrence & Lorsch 1994; Garrity, 1963; Brown and Magill, 1994; Schwarz and Hirschheim, 2003) to explain and analyze the different decision-making structures forms: centralization/decentralization and integration/differentiation. The researchers in this category followed two streams (Brown & Grant, 2005):

- Location of IS decision-making: research on the traditional IT organizational structures (Thompson, 1957, Jelinek, 1977, Burlingame, 1961, Golub, 1975, Olson & Chervany, 1980, Keen, 1981, Jenkins and Santos, 1982, Wetherbe, 1988, Von Simson, 1990)
- Expansion of the IT decision-making structures: research on vertical and horizontal expansion traditional organizational structures of the IS: (Ein - Dor and Segev, 1978, Rockart et al., 1978, King, 1983, Zmud et al. 1986, Boynton and Zmud, 1987)

Table 1. Theories used in the research on IS governance and their contributions

Theory	Main research	Significant research on IS governance	Inputs	Question answered
Institutional theory	Meyer & Rowan(1977), DiMaggio & Powell (1983) Scott (1987) Scott (2001)	Jacobson (2009) Ang and Cummings (1997), Pardo and colleagues (2008)	Method of IS governance (how). Links between IS governance and performance.	**How**
Contingency theory	Thompson (1967) Lawrence & Lorsch (1967) Galbraith (1973)	Olson & Chervany (1980) Ein - Dor & Segev (1982) Tavakolian (1989)	Strategic alignment. No best solution. Alignment leads to better performance. The reasons for the governance (why). Decision structures of the governance (who). Centralization / decentralization - Integration / differentiation (where).	**Why Who Where**
Transaction Cost theory	Coase (1937) Williamson (1987)	Ang and Straub (1998) Aubert, et al..(2004)	Opportunism. Transaction costs can be measured. IS governance cost (how much). Outsourcing of the IS (where).	**Where How much**
Agency theory	Jensen & Meckling (1976) Eisenhardt (1989)	LOH (1994) Oh (2005)	Asymmetric information. IS risk aversion. Understanding governance (what). IS Control and Audit.	**What**

Rather than the traditional models centralized, decentralized and federal, Weil and Ross (2004) propose six classifications of IS governance based on political archetypes. These archetypes are:

- Business Monarchy: IT decisions are made by the Executive
- IT Monarchy: IT teams take the IT decision
- Feudal: decisions are taken by the autonomous business units
- Federal: hybrid decision
- Duopoly: decisions are taken by IT managers and a business group
- Anarchy: Each small group makes its decisions

The third category concerns the governance parameters (Weill & Ross, 2004; Brown & Grant, 2005; Wilson & Pollard, 2009) under which researchers analyze IS governance, i.e. the context parameters for the decision structure and factors impacting IS governance.

The context parameters for the decision structure that researchers have determined are: business, size, structure, and strategy (for the strategy, the parameters are: vision, strategic objectives, and strategic role of information systems).

To find out these parameters, the researchers followed three different directions:

- Individual and multiple contingencies affecting the traditional uniform governance decision structure (Olson and Chervany, 1980) Ein - Dor and Segev, 1982; Tavakolian, 1987; Dixon and John, 1989; Allen & Boynton, 1991; Boynton et al.. 1992; Henderson and Venkatraman, 1992; Clark, 1992; Venkatraman, 1997).
- Complex analysis of individual and multiple contingencies affecting the extended (horizontally and vertically) non-uniform governance decisions structures: (Brown, 1997; Brown and Magill, 1998; Brown, 1999; Sambamurthy and Zmud, 1999).
- Joint contingency combining governance forms and decisions structures contingency parameters (Weill and Ross, 2004).

And the IS governance impacting factors (Wilson & Pollard2009; Peterson and al. 2002; Musson & Jordan, 2005; Kingsford and al. 2003; Peterson and al. 2002; Haes and Van Grembergen, 2005; Bai and Lee 2003; McGinnis, and recent;Martin and al. 2005; Sohal & Fitzpatrick 2002) are: the management (communication, coordination and involvement of management and leadership), actors (awareness, skills, knowledge, understanding and experience of IS governance, relationships, values, and culture).

The fourth category concerns the dimensions of the governance. It is used to study what characterize and compose the governance. The majority of researchers characterized IS governance with these five basic principle (strategic alignment, value management, performance management, resource management and risk management). The relevance of these five dimensions is supported by several researchers (Gellings, 2007; Guzman, 2007; ISACA, 2008; Wilkin & Chenhal, 2010; Florescu & Dumitru, 2008).

Other researchers are interested in two other dimensions, namely the management responsibilities and controls (Broadbent, 2003; Ross & Weill, 2002; Keyes - Pearce, 2002) and the management of the capacity (Peppard & Ward, 2004; Wilson & Pollard, 2009).

Below is a description of the seven dimensions that characterize the governance:

- Strategic alignment: it concerns the alignment of the business strategy with the IS strategy (Henderson & Venkatraman, 1993). Strategic alignment is widely recognized as a key success factor for companies (Bodnar, 2003) and the most important issue for the IS governance (Luftman & Kampaiah, 2008). It aims is to provide strategic orientations to different management processes. Auregan & colleagues (2008), consider that the strategy is seen as a process of generation, selection and coordination of projects. Strategic alignment, in the IS governance scope, means that the information systems strategy is no more only developed in response to plans of business, but rather dynamically in the context of their developments (Wilkin & Chenhal, 2010).

- Value creation: this point concerns the company's services value improvement through IS (Corbel et al. 2004). It implies the use of processes to provide the requested services. The creation of business value through IS is a recurring theme in the literature (Peterson, 2004a; Lin & Shao, 2006; Heier et al, 2007). Weill (2004) says that companies with IS performance above average, enjoy higher investment than other companies.
- Performance management: it concerns the analysis of practices in steering, IS management control, dashboards, reporting, etc. (Florescu & Dumitru, 2008). Each business process is accountable for the achievement of its objectives, monitoring the smooth running of the process and improving it, if necessary, by setting new guidelines. Performance management is not a one-dimensional concept and can be interpreted in several ways, including managing the organization performance according to IS decisions (Wilson & Pollard, 2009). In this context, it could be expanded to include the measurement of benefits achieved through investment in IT (Dhillon, 2000).
- Resources management: it concerns the hardware and software resources and the human resources management, (Bharadwaj, 2000; Sathanam & Hartono, 2003; Barney, 1991; Wade & Hulland, 2004) and the policy of subcontracting and outsourcing.
- Risk management: it concerns the analysis of the knowledge of the risk taken by the company through its IS in terms of impacts on business (Florescu & Dumitru, 2008). Discussions on IT risks management are very common in the IS governance literature (Ask and al. 2007;) Gellings, 2007; Korac-Kakabadse & Kakabadse, 2001; Van Grembergen et al., 2004). Risk management also includes financial, operational, systemic and technological risks (Guldentops, 2004; ISACA, 2008).
- Responsibilities and controls management: three types of control are common: the organizational level, the results level and the behavior (Eisenhardt, 1985). The establishment of an accountability framework to identify the roles and responsibilities regarding the return on investment of IT expenditures is one the objectives of the IS governance (Broadbent, 2003; Ross & Weill, 2002). However, the management of responsibilities is still a cause of frustration for managers and often generates confusion within organizations (Keyes-Pearce, 2002).
- Capacity management: the development of skills in information systems is essential to have an effective IS governance (Korac-Kakabadse & Kakabadse, 2001). An important element in the IS success is the organization's ability to develop and efficiently manage IT capabilities (Peppard and Ward, 2004). The capacity management could be interpreted as the organization's managers' actions to increase the organization's information systems ability (Wilson & Pollard, 2009).

Finally, the fifth category concerns the IS governance mechanisms that allow to know how is this governance done. That is to say processes, IS governance frameworks or process approaches (COBIT, ITIL, Val IT, PMBOK, COSO, etc.).

Indeed, IS governance frameworks illustrated by the professional and academic literature are processes approaches that take into account viewpoint of IS governance and provide a set of processes for the governance of this viewpoint. So, ITIL or 'IT Infrastructure Library' (Cater-Steel & Pollard, 2008;Chamfrault, 2006) is a process approach that provides five books of best practices in the form of control process used for setting up an IT service management strategy and guide professionals in the effective management of IT resources and IT services quality. "Control objectives for information and related technology" or CobiT (Cater-Steel et al., 2006; Ridley et al. 2004 ; Moisand, 2009) is a process approach that provides good practices in the form of 34 processes to guide practitioners in the implementation of internal controls and to assist risks management (security, reliability and compliance) and investment. It focuses on what the company has to do, not how it should do it. COSO (Moeller, 2007) is a method of risk management and aims to guide practitioners in identifying risks related to the performance and growth objectives. It defines internal control as a process implemented by the managers. And Val IT offers a framework for the IT investments performance analysis. PMBOK or "Project Management Body of Knowledge" (PMI, 2010) is a set of practices that define 42 process for the management of projects.

These IS governance frameworks have proven their advantages for the professional community. Furthermore, they interest academic community. Indeed, even though very little researches were made on the IS governance meta-modeling, and literature on this subject is almost non-existent, some researchers proposed meta-models of IS governance based on some of these frameworks. Among the few researchers who have proposed a meta-model, Goeken & Alter (2009) proposed a meta-model of COBIT and Sienou (2007) proposed a formalization of the concepts of the COSO.

3 Research Gap

As we have seen in this literature review, the IS governance is studied under several angles and points of view. Indeed, several theories have been mobilized to justify, understand and implement the IS governance. Several searches were conducted to answer the questions "what, why, who, where, how and how much" concerning the IS governance. So, some researchers have been working on the determination of the forms of the IS governance, others have worked on the IS governance parameters (context parameters for the structure of decision or impacting factors) and others focused on the dimensions of the governance. Professionals are rather oriented towards developing mechanisms of governance (IS governance frameworks and processes approaches). Some academic researchers have also worked on these frameworks, and focused on the meta-modeling of IS governance basing on these frameworks. Thus, several process approaches or framework of IS governance have emerged. Indeed, there as many approaches as angles of views of IS governance. Some of these frameworks are very successful both in the academic and professional community.

However, this diversity of research on the IS governance is not simply a diversity of IS governance studied aspects, but rather a variety of research streams. Indeed, researches conducted on each of these aspects were generally conducted by different researchers. And researchers tend to enroll, unconsciously, in one or another of these research streams. There are few researchers who have worked on more than one of these aspects and in more than one of these streams. Nevertheless, despite the richness of research and the very large number of articles that can be found in the literature, academic as well as professional, and despite the abundance of process approaches or frameworks of IS governance, no research considers the governance in its entirety and covers all angles of views.

Moreover, Kiraka and Manning (2005) confirm the need of researches on a theoretical framework that integrates the following components: organizational processes, the internal organization context and external environment, and the assessment of how processes are determined and influenced by these contexts.

This overview of the current state of research on IS governance shows that, despite the richness of research that can be found in the literature, there is a lack of a unifying framework of IS governance research covering all aspects of the governance.

4 GUMM: Unifying Framework of Governance of Information Systems

The literature review allowed us to determine all the aspects of IS governance. Through this literature, and using these aspects we are able to provide a framework with unified vision of the governance of information systems.

Our model represents the governance of information systems with:

- Contingency parameters: they are the determinants and the moderators of the IS governance :
    - Determinants: They are the IS governance impacting factors. Namely:
        - The management (communication, coordination, involvement of managers, and leadership).
        - And the actors (awareness, skills, knowledge, understanding and experience in governance, relationships, values and culture).
    - Moderators: They are the control variables that give the governance context parameters. Namely: business, size, structure, and strategy (vision, strategic objectives, and strategic role of information systems).
    - Facilitators: They are the mechanisms used to implement IS governance, i.e., the frameworks and processes approaches of IS governance.
    - Dimensions: They are the elements that compose the IS governance and allow to characterize it. Namely, strategic alignment, performance management, risk management, value management, resources management, capacity management, and responsibilities and controls management.

From this model arises the following definition of IS governance:

"Information systems governance is a set of mechanisms that transforms the information system into success, taking into consideration the organization's environment"

Below is the IS governance unifying framework, GUMM (Governance Unified Meta Model):

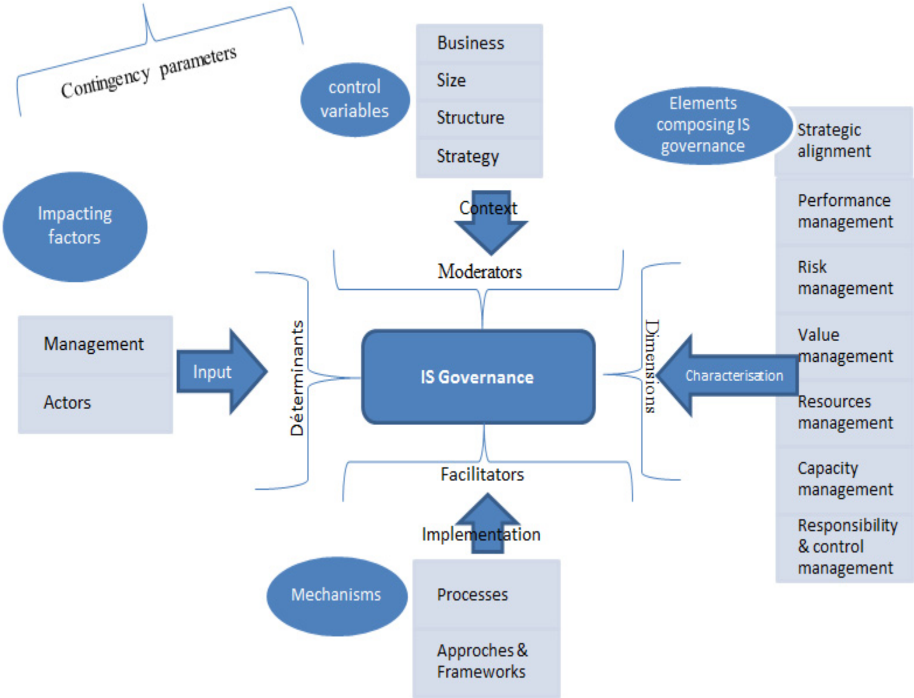

Fig. 2. GUMM: IS governance unifying meta-model

5 Discussions and Conclusion

This research contributes to the information systems researches, and especially to IS governance researches, both in the management science field as well as in the computer science field. Indeed, it enriches the research knowledge base with a new unifying framework of IS governance. As a matter of fact, it assumes that none of the IS governance approaches is frozen. Furthermore, it considers that each approach will necessarily evolve, voluntarily or involuntarily, more or less noticeably, and even incrementally. Therefore, this unifying framework is totally open. Besides, it allows making revisions, addition or deletion of principles. Hence, this unifying model provides a support for the research on IS governance.

From an operational and managerial viewpoint, GUMM ensures the coherency of the IS governance mechanisms, taking into account the organization's environment.

This unifying model, based on an in-depth study of the IS governance literature, could be the first brick in the literature gap. Furthermore, it brings value to the community of practitioners, and allows extending and improving the information systems research knowledge base.

We used rigorous methods for the development of this model. Indeed, we relied on the available knowledge bases both at the level of theories as well as methodologies.

This research axis may be very promoting. Indeed, it allows putting the first brick in an emerging field of research on IS governance, i.e., the unification of the aspects of research on IS governance as a research stream.

We propose for future research to explore in depth the track of the unification of IS governance with field studies, and successive investigation round-trips between field and theories.

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The Key Project Managers' Competences for Different Types of Projects

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Abstract. This paper describes a quantitative research approach for identifying key project managers' competences for different types of projects. By identifying the perceived most valuable project manager competences, as having the most potential for increased contribution to project management (PM) performance, practitioners and organizations can select their priorities when developing their PM practices. The 46 competences (technical, behavioural and contextual) provided by IPMA (International Project Management Association) were surveyed through an online questionnaire. Three dimensions to distinguish project types were used: application area, innovation and complexity. Completed questionnaires were received from 96 project managers from Portugal. The results showed that 13 key competences (20%) were common to the majority of the projects. Most of these are behavioural competences, such as: ethics, reliability, engagement, openness, and leadership. It was also observed a clear correlation between technical competences and project complexity.

Keywords: Project management (PM), PM success, Project types, PM competences.

1 Introduction

Nowadays we witness an incredible growth of the interest in project management. However, projects continue to fail at a large rate. At the same time, complexity and uncertainty grow in project environments. So, it is time to reflect about how project managers should be educated to deal with projects' complexity and uncertainty growth [10], [16], [23].

The development of project managers' competences in organizations is an important factor to enhance the project management performance and consequently the organization performance [1], [22], [24]. The extent of this impact depends on other factors like the organization context and maturity, or the type of projects [18]. Project types and characteristics were the focus of this research with the objective to associate each type of project to a different group of project managers' competences.

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This challenge came with the knowledge that project managers do their job better and obtain better results when their characteristics and personal competences match with the requirements and needs of the project [9], [14].

Over the years, different Project Management (PM) standards have been developed around the world attempting to codify what is been observed in research and practice [7], [18]. The majority of PM literature continues assuming that all projects are alike, advising organizations to adopt a project management general approach [17], [20].

Different studies showed that a universal approach assuming all projects are the same may not be appropriate to project management [2], [5], [6], [25]. Different types of projects should be managed in different ways. This would suggest that different project managers' competence profiles would be appropriate for different types of projects [11].

Two studies made by Müller & Turner served as a support for many decisions made in this study and to compare results. A summary of each study is presented next [11], [14].

"Matching the Project Manager's Leadership Style to Project Type" by Müller & Turner (2007)

The aim of this research was to show that different leadership styles are more appropriate to reach PM success in different types of projects. To identify the different leadership styles, 15 competences were used (7 emotional, 5 management, and 3 intellectual). To distinguish the different types of projects 6 dimensions were used, two of them were the complexity and the application area. A world wide web-based questionnaire that asked about the type of project, the leadership competences and the project management success, was distributed to project managers.

"Leadership Competency Profiles of Successful Project Managers" by Müller & Turner (2010)

Three years later the same authors used the same group of 15 competences to analyse leadership competence profiles of successful project managers in the different types of projects. This time they used 4 dimensions instead of 6 to distinguish the projects by types. The complexity and the application area are again included in these 4 dimensions. The data collection was conducted through a digital questionnaire send to PM professionals around the world.

2 Research Objectives

The constant search for the growth of the PM success rate is the base of this study. We believe that project managers' competences influence directly the PM success, and project types affect the degree of that influence. In other words, the importance of each competence in PM success depends on the type of the project [18]. Therefore, the research questions were: *What are the key competences of PM that the project managers should have? These competences are different depending on the type of the project?* To answer these questions the present research had two objectives:

A- Find the project managers key competences considering the three dimensions: technical, behavioural and contextual.

B- Check if there is any correlation between a group of project managers' key competences and the different types of projects.

3 Literature Review

3.1 Project Management Success

The IPMA defines project success as "the appreciation of the various interested parties of the project outcomes". This definition goes far beyond the production of project deliverables within time and budget, considered only a part of the project success [7].

Müller e Turner (2007, 2010) use a list of ten project success criteria, extracted from interviews made to managers responsible to assign project managers to projects, with the goal of identifying some correlation between project success and the project managers leadership competences: a) End-user satisfaction with the project product or service; b) Supplier satisfaction; c) Project team satisfaction; d) Other stakeholders' satisfaction; e) Performance in terms of time, cost, quality; f) Meeting user requirements; g) Achieving project purpose; h) Customer satisfaction with the project results; i) Reoccurring business with the client; j) Meeting the respondents' self-defined success factors.

It becomes evident that to consider a project successful it is necessary to satisfy a number of requirements that vary from project to project.

In spite of the terms "PM performance" and "project performance" are frequently used indistinctively, the objectives of both PM and project performance are different. PM performance emphasis is towards achieving specific and short-term targets compared to the wider aims of a project [3]. For example, important parameters to project performance will be the return on investment, profitability, competition and market ability, while to project management performance the focus is usually given to the triple constraints, control of time, cost and quality [8], [15]. So, in this study, three dimensions were considered in evaluating the project success: **time**, **budget** and **client satisfaction**.

3.2 Project Management Competences

Competence is "a cluster of related knowledge, attitudes, skills, and other personal characteristics that affects a major part of one's job; correlates with performance on the job; can be measured against well-accepted standards; can be improved via training and development; can be down into dimensions of competence." [18]. The three different dimensions of competence defined by PMI in PMBoK are knowledge, performance, and personal characteristics [19].

The third version of ICB (International Competence Baseline) developed by IPMA (International Project Management Association) defines competence as "one collection of knowledge, personal attitudes, skills and relevant experience needed to be successful in a certain function." [7]. The ICB presents, like PMBoK, a division of the competences in three different groups: technical competences, contextual competences, and behavioural competences.

This study uses the list of 46 competences provided by ICB: 20 are technical, 11 are contextual, and 15 are behavioural competences (see table 1).

Table 1. Overview of ICB competences

1. Technical competences	2. Behavioural competences	3. Contextual competences
1.01 Project management success	2.01 Leadership	3.01 Project orientation
1.02 Interested parties	2.02 Engagement	3.02 Programme orientation
1.03 Project requirements & objectives	2.03 Self-control	3.03 Portfolio orientation
1.04 Risk & opportunity	2.04 Assertiveness	3.04 Project, programme & portfolio implementation (PPP implementation)
1.05 Quality	2.05 Relaxation	3.05 Permanent organisation
1.06 Project organisation	2.06 Openness	3.06 Business
1.07 Teamwork	2.07 Creativity	3.07 Systems, products & technology
1.08 Problem resolution	2.08 Results orientation	3.08 Personnel management
1.09 Project structures	2.09 Efficiency	3.09 Health, security, safety & environment
1.10 Scope & deliverables	2.10 Consultation	3.10 Finance
1.11 Time & project phases	2.11 Negotiation	3.11 Legal
1.12 Resources	2.12 Conflict & crisis	
1.13 Cost & finance	2.13 Reliability	
1.14 Procurement & contract	2.14 Values appreciation	
1.15 Changes	2.15 Ethics	
1.16 Control & reports		
1.17 Information & documentation		
1.18 Communication		
1.19 Start-up		
1.20 Close-out		

3.3 Project Types

In 1978 Blake has suggested a distinction between the minor chance projects (alfa) and major chance projects (beta) [20]. Wheelwright and Clark (1992) differentiated product development projects according to the degree of change in product portfolio. Some have made the distinction between radical and incremental projects [20]. In the work of Turner and Cochrane (1993) is possible to find an increasing understanding of the projects' goals and the methods needed to achieve these goals [20]. The matrices developed by Shennar (2001) use two dimensions, technical uncertainty and project scope [20].

Shennar has several contributions to projects' categorization, some of them with Wideman and others with Dvir. First, they identified three dimensions to distinguish projects: technological uncertainty, complexity and pace [5], [6], [20], [21]. After this identification, they developed the TCP (Technology, Complexity and Pace) model, which had a structure that allowed selecting the best way to manage one project with one certain level of technology, complexity and pace. Some subsequent studies on the validation of the model, proposed one new dimension, the novelty, which defines how new is the product to the potential users, giving rise to a new model with four dimensions: Novelty, Technology, Complexity and Pace (NTCP). Each one of these dimensions is divided in three or four levels, depending on the degree of intensity. In that way, the more complex the project is, the higher will be the level of intensity in the dimension considered. This principle is applied to the four dimensions which are presented in a four axis model. The NTCP model works like a guide to select the project manager, the team members, the structure, the processes and the tools to use in different types of projects [6].

In this particular study, projects were distinguished using three different dimensions: application area, complexity, and innovation. Each one of these dimensions has three different levels. The three dimensions and their levels are listed in table 2. The application area was selected because it was found in the two studies of Müller & Turner presented in the introduction [11], [14], in two other studies by the same authors [12], [13] and in the work by Crawford in 2005 [4]. The complexity was selected because is part of the dimensions used in the two studies, presented in the introduction, by Müller & Turner, and is part of the NTCP model. Innovation was selected because is one of the dimensions of the NTCP model and because nowadays it is considered important given the continued reduction of product life cycles.

Table 2. Project categorization model used in this study

Dimension	Level/type	Reference example
Application area	- Engineering & construction; - Information, communication & technology; - Organizational change.	Crawford, 2005; Müller & Turner, 2007, 2010
Innovation	- Breakthrough projects; - Next generation projects; - Derivative projects.	Dvir, 2006
Complexity	- Low; - Medium; - High.	Dvir, 2006; Müller & Turner, 2007, 2010; Shennar, 2001

4 Methodology

It was conducted a web-based survey distributed through the snowball method. This methodology has been found in some similar studies [4], [13], [14]. The target population for this study were the Portuguese project managers. In terms of structure, the questionnaire is divided into four sections:

Project Type. The respondents were asked to categorize the majority of their projects using the three dimensions, choosing only one level in each dimension.

Competence Questions. The 46 competences (Table 1) were listed and project managers were asked to select all the competences they used most in their projects.

PM Success. After a short definition of success that included the three dimensions presented before: time, cost and client requirements, the respondents were asked to judge the majority of their projects as successful or unsuccessful. If the answer was "unsuccessful" another question appeared asking in which of the three dimensions they think they had failed.

Demographic Questions. At the end of the questionnaire the respondents were also asked about the industry sector they worked, their age and gender, how many years they worked in PM, dimension of the company and if they had or not certification in PM.

The questionnaire release was on July 29, 2013 and the access to the questionnaire was blocked on October 10, 2013. A total of 265 answers were obtained, but only 96 were considered valid (complete answers).

To analyse the existence of some correlation between each of the three types of competences (technical, behavioural and contextual) and each dimension that distinguish projects, three new variables that represent the sum of the competences selected in each group were generated. Then, a non-parametric test (Kruskal Wallis) was conducted, analysing the three new variables in the three dimensions that distinguish projects. For a better comprehension of the results, the following hypotheses were created: H0 (the null hypothesis) – The distribution of the competences (technical, behavioural or contextual) is the same across the categories of each dimension (application area, innovation, or complexity);

H1 (rejection of null hypothesis) – There is a significant difference in the distribution of one or more types of competences (technical, behavioural, or contextual) across the categories of one or more dimension (application area, innovation, or complexity).

A chi-square test of independence was used to verify the existence of an association between the use of the competences and the dimension of the projects considered.

5 Results

The respondents were predominantly male (76.3%), aged between 22 and 70 years, and there were more than 50% with 38 years or less. They had between 1 and 40 years of experience in PM, and almost 59% had 10 years or less of experience.

Concerning the companies' size, 15.2% worked in companies with less than 10 employers, 30.4% in companies with 10 to 49 employers, 35.9% in companies with 50 to 250 employers and 18.5% in companies with more than 250 employers. About 12% of the respondents had some kind of PM certification. Just one of the 96 inquired judged his projects as unsuccessful, pointing the time as the dimension that has failed. In what concerns to project types, relatively to application area, 40% were engineering and construction projects, 34% organizational change projects, and 26% information, communication and technological projects. As for innovation, it was found that 46.6% were derivative projects, 34.4% next generation projects, and about 19% breakthrough projects. In terms of projects complexity, almost 65% of the projects had medium level of complexity, about 19% were low complex project and, at last, 16% of projects had high complexity.

5.1 Key-Competences for All Projects

For the evaluation to the most frequent competences used in projects, thirteen competences were found with frequencies higher than 60% (see table 3).

Table 3. Key-competences for all projects

Technical	Behavioural	Contextual
1. Project management success (87.5%); 2. Project requirements and objectives (82.3%); 3. Problem resolution (63.5%); 4. Resources (64.6%); 5. Cost and Finance (64.6%).	1. Leadership (74%); 2. Engagement (61.5%); 3. Openness (76%); 4. Results orientation (69.8%); 5. Conflict and crisis (68.8%); 6. Reliability (61.5%); 7. Ethics (76%).	1. Programme orientation (65.6%).

5.2 Competences Types vs. Project Types

The results of the Kruscal Wallis test, and considering a decision rule of 5% (significance level equal to 5%), just one rejection of the null hypothesis was found. It happened in the technical competences relatively to the complexity of the projects. So, it was possible to conclude that, at least for this sample, there is a difference in the technical competences due to the projects complexity, or, the projects complexity level has different influence in the utilization of the technical competences.

5.3 Competences Presence in the Different Project Types

A chi-square test of independence was used to verify the existence of an association between the use of the competences and the dimension of the projects considered.

Relatively to the application area, five competences with significant differences were found. Three of them were technical and the other two were contextual competences. In organizational change projects, the three technical competences are not very used, on the other hand the two contextual competences seem to be more frequently used by the project managers inquired, that worked in this type of projects, than the project managers that worked in the rest of the application areas.

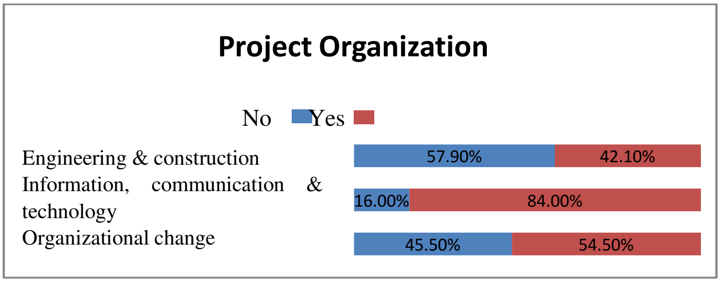

Fig. 1. Distribution of project organization competence responses by application area

Concerning the innovation, the chi-square test reveals that only two competences were found with significant differences, one is technical (close-out) and the other is contextual (programme orientation).

Competences with significant differences were found in the complexity dimension. And, as expected by the results of the Kruskal Wallis test, the higher number of detected differences was in the technical competences (6) in contrast with just one in the behavioural competences.

6 Conclusions and Future Research

6.1 Conclusions

The results of this study are discussed comparing its findings with the two similar studies presented before [11], [14].

As explained before, the size of the sample of this study was not enough to allow statistics inferences. However, some of the results of the studies made by Müller and Turner (2007, 2010) coincide with some results of this study [11], [14]. The conclusions of that coincidence results are:

1. About 20% of all PM competences are more important to reach PM success (see table 3);
2. Most of these competences are behavioural, like: Ethics, reliability, engagement, openness, and leadership;
3. The competence of quality is more important to reach the PM success in engineering and construction projects than in other application area projects;
4. The interested parties and the project organization have more influence in PM success in information, communication and technological projects than in the other application area projects;
5. The two contextual competences of programme orientation and business seem to be more important to organizational change projects than to other application area projects;
6. Concerning the medium level complexity projects, three technical competences were identified as the more important ones to the PM success, relatively to the other complexity levels: time and project phases, resources and communication;
7. Analysing projects with high complexity, and comparatively with the other complexity levels, two technical competences stand out: risk and opportunity, and team work;
8. Points 6 and 7 validate the result that sustains the existence of a correlation between the projects' complexity and the technical project managers' competences.

6.2 Theoretical and Practical Contributions

Independently of the project type, this study suggests that the development of PM competences, for example through training, should focus more on the behavioural competences than on technical competences, because behavioural competences have a higher influence on PM success.

The present research and its results have more interest to organizations with different project types. Managers that allocate the project managers to projects have to be aware of the importance of the PM competences that the different project types require of their project managers.

Using the three dimensions that distinguish the different project types presented in this study or using other appropriate dimensions, we suggest that organizations identify, in the first place, the types of projects the organization undertakes. Then the organizations should recognize the PM competences needed in each of the project types identified. With a good PM competences assessment, it would be easier to allocate the appropriate project managers to the different projects and to identify which competences should be developed.

6.3 Limitations and Future Research

The main limitations of this study are related with the sample size and the PM success data collection process, a sample with 96 project managers in one population clearly larger than 1500 Portuguese project managers, is not enough to allow generalizations.

In what concerns to the PM success data collection process, an inaccuracy was made in attempting to reduce the time spent by the respondents answering the questionnaire. Respondents had to indicate whether they considered successful or unsuccessful the majority of their projects. In that way, only 1 out of 96 respondents admitted the majority of his projects to be unsuccessful. If this question has been made in a different way, one association of the competences to the PM success would be possible or better supported.

The suggestions made above lead to the need of future work to develop a PM competences assessment model and identify the best way to develop each competence or type of competence.

Considering the possibility of repeating a similar study, and taking into consideration the limitations presented before, the main suggestion is about the way to collect the data related to the PM success. One good way would be, as was found in the studies made by Müller and Turner (2007, 2010), to present some PM success criteria to the respondents, and he would have to judge their projects, for each criteria, in a Lickert scale with five points [11], [14]. This process would be repeated so project managers could judge each PM success criteria in terms of importance to achieve the PM success. In that way, the association between the PM success and the PM competences would be much more supported. It would also be possible to associate one specific PM competence to the success of one project type and to the failure of other project types.

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Modeling Data Integration for Dynamic Allocation and Intelligent Scheduling of Airport Terminal Resources

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Abstract. Dynamic allocation and intelligent scheduling of terminal passenger service resources (TPSR) is a focus in the field of the international civil aviation. To address the issue of data integration for dynamic allocation and intelligent scheduling of airport terminal resources, a geodatabase-based spatial data model of airport terminal Layout and a multidimensional data model of on-line analytical processing(OLAP) of airport terminal operation are presented. The models can efficiently organize data from airport terminal layout design, manual survey for passenger service processes(PSP), passenger flow detector, departure control system, management information system for airport security and global distribution system, and assure logical rationality and efficiency of data query for dynamic allocation and intelligent scheduling of airport terminal resources, and then, support passenger flow prediction and simulation and optimizing for passenger service process. The proposed models have reference value to data integration for dynamic allocation and intelligent scheduling of airport terminal resources.

Keywords: Data model, Airport terminal resources, Dynamic allocation and scheduling.

1 Introduction

It is a basic requirement to guarantee safety and punctuality of flight in civil aviation transportation. The United States has established a clear development goal in the new generation of civil aviation transportation system (N-GAS)[1]: After arriving at the airport, passengers can depart within 30 minutes. There are two ways to reduce passengers' waiting time for departure. One is to increase service resources for passengers, and the other is to allocate and schedule service resources intelligently (automatically adjust resource allocation and scheduling strategies as passenger flow changes). Under current conditions, the latter is an effective way to solve passenger stranding problem[2].

Some researches on intelligent allocation and scheduling of airport terminal resources have been done[3][4][5], but extensive manner of resource allocation and scheduling based on the frequency of flights are still employed in almost all the terminals in the world. Adjustments to resource allocation and scheduling plans are just based on the frequency of flights. It is very common that service resources are

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very busy in peak hours, and are idle or in low utilization in slack hours. The fundamental cause of this is the lack of accurate and real-time mastering of passenger flow, as well as requisite scientific grounds and technological means of resource allocation and schedulin[2] The specific embodiments are as followings:

Without quantitative prediction methods of the terminal passenger flow, it is difficult to allocate and schedule TPSR according to changes of passenger flow.

Without a complete theory system on terminal passenger service resource allocation and scheduling, it is hard to realize intelligent allocation and scheduling of TPSR.

Intelligent allocation and scheduling of TPSR is an innovative idea for airport terminal management. According to this idea, allocation and scheduling of terminal passenger service resource is dynamically optimized by integrating data obtained from the airport operation system, the terminal passenger counting system and manual survey of passenger service process, and predicting the terminal passenger flow based on the modern computational theory, as well as applying process simulation technology into terminal passenger service resource dynamic allocation and scheduling, to dynamically response to passenger flow change, to improve the service level of the terminal operation and to get more benefit. Data integration is the basis to realize the dynamic allocation and scheduling of TPSR.

Currently, the researches on technology of airport information system integration mainly include the guidelines of airport information system development[6], the multi-tiered distributed architecture of the integrated operating database based on Web Service and message queue[7], and the technology of data-exchange platform under the condition of distributed heterogeneous environment[8]. The above-mentioned researches focus on the framework of airport information system integration, the architecture of the airport operating database and the technology of airport information system integration, but no researches address data integration model for dynamic terminal resource allocation and scheduling ,and therefore the logic rationality and query efficiency of data integration cannot be guaranteed.

Aimed on the data integration demand for dynamic allocation and intelligent scheduling of TPSR, in this paper, a data integration model is put forward. In the following sections, three issues are addressed: the data integration sources, the spatial data model of airport terminal plan layout, and the multi-dimensional data model of airport terminal OLAP.

2 Data Source

As shown in Fig.1,the data sources for dynamic allocation and intelligent scheduling of airport terminal resource include: manual survey for passenger service process, airport terminal plane layout designs, detectors for passenger flow, departure control systems, airport security management information systems and global distribution systems.

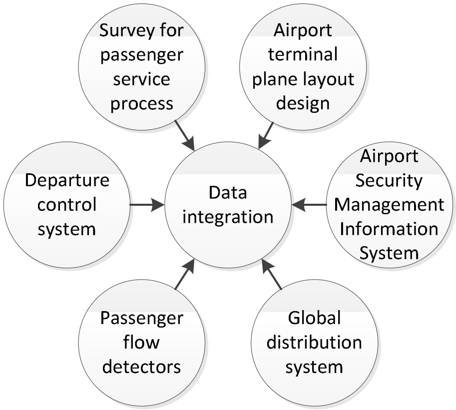

Fig. 1. Data sources for dynamic allocation and intelligent scheduling of airport terminal resources

Airport terminal plane layout's spatial data is used to associate attribute data (such as check-in counters' queue length, average service time for each passenger, etc.) of airport terminal space objects (such as check-in counters, security check channel, etc.), visualize airport terminal plane layout and query spatial object’s attributes. The airport terminal plane layout’s spatial data can be obtained by digitizing the airport terminal layout plan or importing computer-aid design files into geographical information systems.

Airport terminal PSP fall into two catalogs: arrival PSP and departure PSP. Survey of PSP can provide data for PSP modeling, model validation , simulation and optimization. The manual survey contents of PSP includes: activities and their logical relationship, information transmission of between activities, the resources involved in activities and duration of activities.

The global distribution system of civil aviation evolved from the airline reservation system and the agent distribution system. It is a distribution system which provides travelers a full range of service on a global scale such as the trip planning, ticket booking, hotel reservation and online payment. Among them, the ticket booking information in the agent distribution system is one of the key factors to impact on time-sharing passenger flow of the airport terminal.

Departure control system is a large real-time computer system to provide the functions such as check-in, flight control, flight load balance and comprehensive information service. The final departure time from the flight control subsystem is another key factor to impact on passenger’s arrival time at an airport terminal. The boarding gate allocation information from the flight control subsystem impacts on direction and volume of passenger flow at airport terminal.

Airport security management information system is an information system that can provide information ports among some functions like passenger safety verification, baggage delivery, boarding review, check-in information extraction, equipment monitoring functions and some related systems such as computer-departure system, airport surveillance systems. Also, it can locate and track the whole departure process of passengers. Among them, the baggage delivery information of passengers is the basis to allocate and schedule the baggage sorting systems.

The passenger flow detectors of the airport terminal use the technologies such as the infrared scanning, video detection and microwave to monitor real-time passenger flow or queue length at the various functional areas of the airport terminal. With regression analysis technology, passenger flow information, ticket booking information and flight take-off /landing time can be used to forecast the passenger flow's spatial distribution on the functional areas of the airport terminal. The spatial distribution pattern of the passenger flow can be regarded as a reference to allocate and schedule passenger service resources of the airport terminal [2].

3 Spatial Data Model of Airport Terminal Plane Layout

Passenger service resources of the airport terminal are allocated to the spatial objects in the airport terminal. For example, at the present, how many staff should be allocated to the manual check-in counters, how many self-service check-in counters should be open, and etc. , Therefore, it is necessary to address the spatial data model of airport terminal plane layout.

Geodatabase is a relational data mode which is introduced by ESRI[9]. In the Geodatabase data model, spatial data is stored in the form relational schema, and accessed in the form of objects. The model benefits both client program's access to spatial data and the server's management of spatial data.

Spatial objects associated with the departure service include self-service check-in counters, manual check-in counters, domestic security check area (security line, public security treatment room, local police station, comprehensive information room, search room, person detained room, goods detained room), quarantine area(inspection room, disinfection room, inoculate preparation and observation room, etc.), customs workplace(drug examination room, physical inspection room, customs declaring room, etc.), frontier inspection area(certificate identification room, vehicle formalities handling room, temporary examine room, etc.), international security check area (local police station, liquid tester, security check channel, etc.), transit lounge, waiting hall.

Space objects associated with the arrival service include quarantine area (inspection room, inoculation preparation and observation room, prophylactic immunization room, etc.) frontier inspection area(certificate identification room, temporary examine room, etc.), international/domestic baggage sorting hall(baggage sorting table, exit of big luggage), international/domestic baggage claim hall(baggage carousel, quarantine dog workplace), customs workplace(customs channel (red, green, work passage), drug inspection room, animal inspection room, surveillance room, etc.), international/domestic transit hall.

As an example, a Geodatabase model of the spatial objects associated with the domestic departure services is shown in Fig. 2 and Fig. 3.

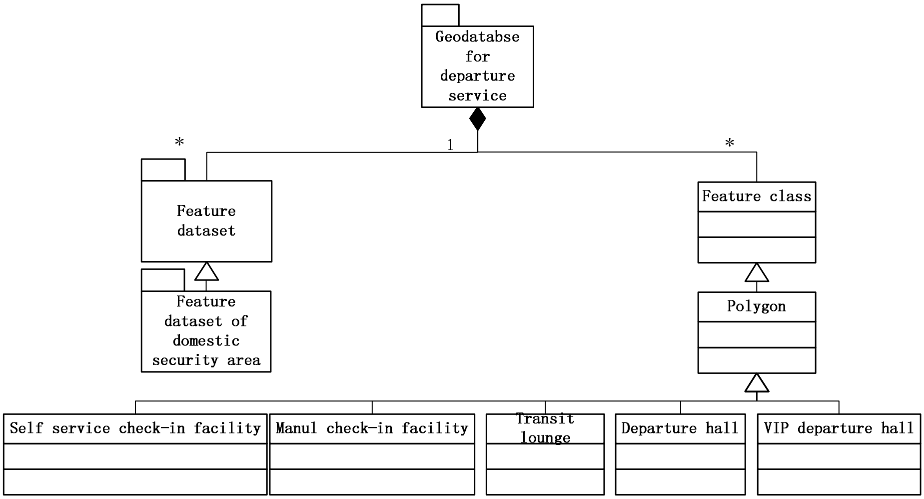

Fig. 2. Geodatabase model of airport terminal departure service

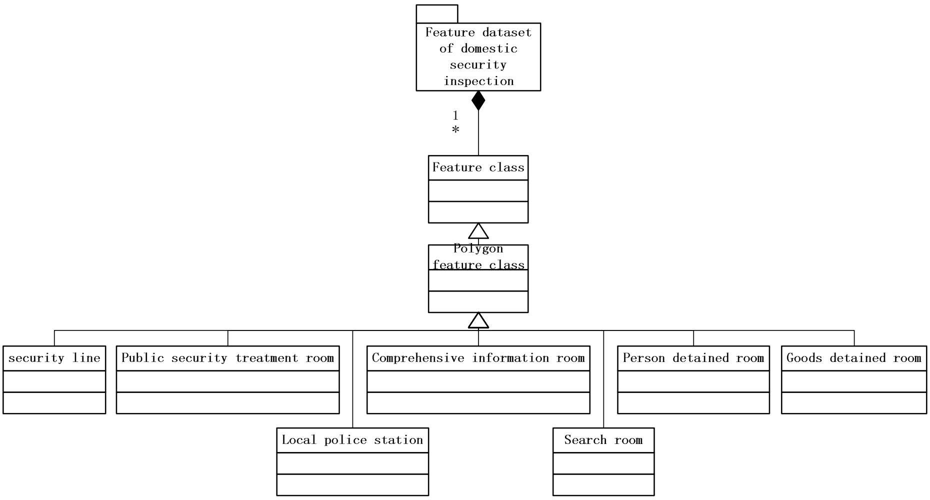

Fig. 3. Feature dataset model of domestic security inspection area

4 Multidimensional Data Model of Airport Terminal OLAP

Airport terminal OLAP data model should support the following topics:

- Support OLAP for the arrival /departure service processes
- Support OLAP for the arrival /departure flights
- Support OLAP for the arrival /departure baggage delivery
- Support OLAP for service resource utilization rate

- Support OLAP for passenger time-spatial distributed patterns on functional areas of the airport terminals.
- Support forecasting the airport terminal the passenger flow
- Support modeling, simulation and optimization of the arrival/departure passenger process

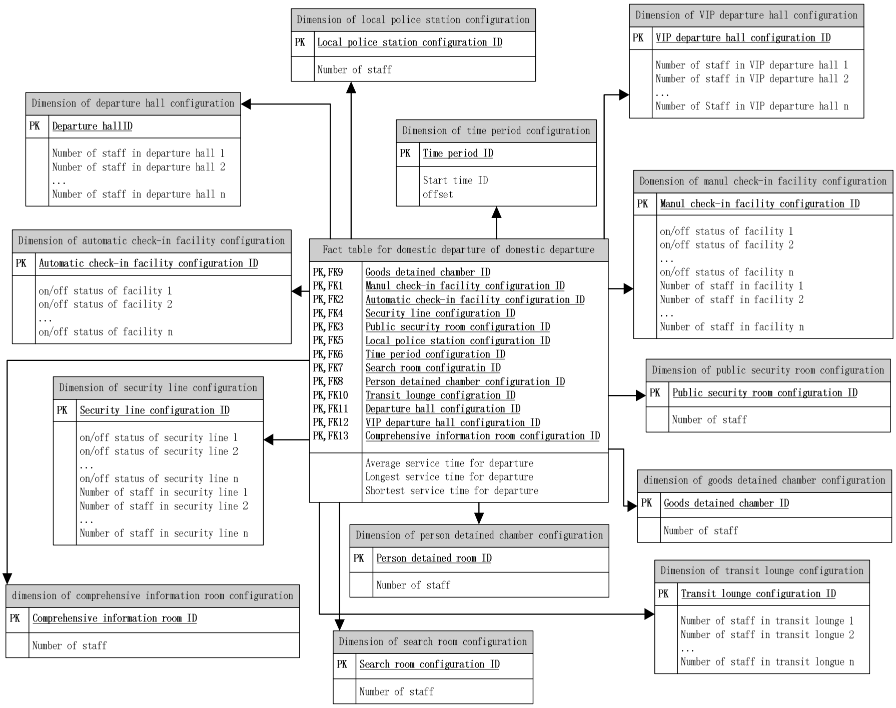

Fig. 4. Multidimensional data model of airport terminal OLAP

As an example, the domestic departure level of service OLAP data model is a star structure of multidimensional data model (as shown in Fig. 4). The departure service time depends on allocation and scheduling of service resources related to the departure process, therefore, the departure flights and resources allocation related to the departure process are used as dimensions to analyze departure service level (dimensions of multidimensional data model), and the time for the passengers to spend on departure process is used to measure departure service level, to establish the multidimensional data model of domestic departing service level OLAP. Among them, every group of key attribute values in the fact table uniquely determines one scheduling, and this scheduling decides the departure service level of airport terminal. Similarly, the OLAP data models of other topics can be designed.

5 Conclusion

Data integration is foundation of dynamic allocation and intelligent scheduling of airport terminal resources. A well-designed data models can assure logical rationality of data integration and efficiency of data query. The proposed data model can support passenger flow prediction of airport terminals and simulation-based optimizing of PSP, and enable allocation and scheduling of passenger service resources to dynamically response to passenger flow fluctuation, and then, improve passenger service level and operation efficiency of airport terminals.

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Toward an Ethical Framework for Web-Based Collective Intelligence

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Abstract. Web-based collective intelligence deserves and intends to become a full discipline with its formal framework, tools, measuring instruments, practical applications, and ethical field. As of yet, little attention has been paid to study the ethical dimension of harvesting the collective intelligence via Web-based collaborative systems. The present study aims to develop an ethical framework for the Web-based collective intelligence in business organizations. Based on a combination of previous ethical frameworks that regulate the ethical behavior in the age of information societies, moral intelligent theories, and ethical theories of collaborative business environments, five layers of ethical principles were identified. These include the morality of collective decisions, compliance with laws and regulations, the collective truthfulness, the collective transparency and responsibility, and the greatest benefits for the greatest number of stakeholders.

Keywords: Web-based collective intelligence, ethical theories, business organizations, decision making.

1 Introduction

The constantly changing in the business environment of todays' organizations are come at an ever-increasing pace and more rapidly than ever before with a range of highly complex, dynamic, and multi-faced challenges. These controversial changes and challenges have a critical impact on the businesses' ability to remain competitive and even to survive. Business organizations, government agencies, and other organizations constantly have to innovate in new areas, make complex decisions, originate creative solutions, adapt and behave as human beings to serve its survival, prosperity and superiority. In this context, business organizations have to be recognized as complex adaptive systems [1], [2], [3], [4]. More specifically, it can be recognized as human systems formed with the basic objective of pooling different human abilities and expertise together to create certain synergetic effects in finding emergent and sustainable solutions to the complex problems and challenges faced by organizations, communities and society [4], [5]. They must learn, self-organize, adapt, compete and evolve getting rid of its mechanic and procedural life to behave and think as human beings. From this perspective, intelligence is the prized asset of an organization [2], [4], [5], where organizations must grow far more intelligence to deal

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with the diverse and simultaneous challenges encountered on a daily basis [6].This new awareness are establishing for beginning of a new approach to re-examined organizations as an evolving intelligent beings, in the same manner as biological entities are competing for survival in an ecological system using its intelligence [2].

Clearly, intelligence and information are two closely associated entities with mutually reinforcing relationships [2]. The new Information and Communication Technologies (ICTs) are now making it possible to organize groups in very new ways that have never been possible before in the history of humanity [7]. The internet empowers people to collaborate in new ways, which were not imaginable before [8], [9]. In his work on the classification of collective intelligence systems, Lykourentzou et al. [10] described collective intelligence as an emerging field that seeks to merge human and machine intelligence, with an aim to achieve results unattainable by either one of these entities alone. The increasing capabilities of collaborative Information Technology (IT) has played a vital role in giving the support and facilities to harvest, use, and sharing of the collective intelligence. According to Gruber [11], collective intelligence has been the goal of visionaries throughout the history of the Internet. Malone et al. [7] purport that the widespread adoption of the internet, which has spawned all of these crowd harnessing mechanisms, has effectively changed the way intelligence is collectively developed.

Studying the synergy between IT and collective intelligence is still in its early stages and many important issues are still unexplored or under discussion and open for research. Kapetanios [12] clarified that the transition from personalized data, knowledge, and contents towards collectively intelligent forms of synergies in an amalgamation of humans and technology is at its infancy and raises many questions. This may explain why most of previous research was theoretical and technical oriented focusing on identifying requirements, analysis, design, tools, modeling prototypes, and developing algorithms of different types of systems to harvest the collective intelligent.

Web-based collective intelligence intends and deserves to become a full discipline, with its formal framework, tools, measuring instruments, practical applications, and ethical field [10], [11], [12] by virtue of the advances in collaborative Internet applications. Ethical ramifications and social responsibility are becoming an increasingly important area of concern in the contemporary Internet and digital technologies taking into consideration its impact on the ethical business and ethical decisions making in particular [13], [14], [15], [16]. On the other hand, Ethics are a major characteristic of collective intelligence [12], [17], [18], [19]. While IT revolution and its role in harvesting the collective intelligent is growing continuously, as of yet, a little attention has been paid to study the ethical dimension of web-based collaborative systems in harvesting the collective intelligence. Given that, this study contributes to the ongoing stream of research on through developing an ethical framework for the Web-based collective intelligence in business organizations.

2 An Overview of Web-Based Collective Intelligence

There are many definitions of collective intelligence that has been built around the idea of intelligence. For example, Hiltz et al. [20] and Heylighen [1] defined collective intelligence as the ability of a group to arrive at a solution that is better than any of the members achieved individually. Steinbock et al. [21] defined collective Intelligence as the ability of a group to exhibit greater intelligence than its individual members. According to Gan and Zhu [19], collective intelligence is the ability of a group, a team, an organization, a community and the whole society to learn, to solve problems, to plan the future, to understand and to adapt to the internal environment and the external world, with the convergence of individual or distributed intelligence. Scarlat and Maries [3] described it as a shared intelligence that emerges from the collaboration of individuals. Lévy [22] defined collective intelligence as the capacity of human communities to co-operate intellectually in creation, innovation and invention. Lykourentzou et al. [10] asserted that it is based on the concept that large groups of cooperating individuals can produce higher-order intelligence, solutions and innovation and come to function as a single entity.

The roots of the human-technology models of collective intelligence can be traced back to the early 1960's when computing pioneer Douglas Engelbart has envisioned the grand challenge of boosting the collective IQ of organizations and society for coping with complex, urgent, and large-scale problems [22]. However, in spite of that early Engelbart's vision, the collective intelligence through IT and Web-based collaborative systems in more specifically, is considered an emerging field of study [4], [10], [22]. The tremendous advances in Internet applications bring impetus to collaboration development as the most recent IT-supported collaborative tool. Collaborative Web-based systems are the most recent path discovered for opening up the possibilities of improving the collective intelligence that were simply unconceivable even few years ago [7], [10]. Lykourentzou et al. [10] asserted that through the combination of the best aspects of human and machine intelligence, the collective intelligence of the community will be facilitated to emerge. Malone et al. [7] purport that the widespread adoption of the internet, which has spawned all of these crowd harnessing mechanisms, has effectively changed the way intelligence is collectively developed. These systems leverage the combined efforts of very large groups of people to solve complex problems, and often referred to as collective intelligence systems [7], [10].

As a collaborative platform, the Web-based systems provide a single point for integrating all the company's information, applications and services that are used by employees, business partners, and customers [23]. It enables people from remote locations to meet each other and to share information, using specific tools in order to achieve common goals, facilitating knowledge delivery and creation of more efficient functional relationship between groups of people in an open and distributed intelligent environment via networks [22]. Intelligence techniques are rapidly emerging as new tools in information management systems. The literature (e.g. [23], [24]) provides a great deal of evidences that the rise of collaborative Web-based systems accompanied with the advances of intelligence mechanisms, techniques, and tools. Therefore, it can be inferred that Web-based collaborative systems are built on a combination of collaboration technologies and intelligence tools that can be embedded in these systems as enabler of collaboration, facilitating the human-human and human-computer relationships. In the context of technological utilization for knowledge management, Olszak and Ziemba [23] demonstrated that intelligent technologies include such tools as data warehousing, data-mining, Knowledge directories, Knowledge-based systems, and intelligent support systems.

The key of collective intelligence, as the visionaries have seen, is a synergy between human and machines [10], [11]. According to Lykourentzou et al. [10] collective intelligence is an emerging field that seeks to merge human and machine intelligence, with an aim to achieve results unattainable by either one of these entities alone. The advances in ICTs have given impetus to the emergence, dissemination, and applying the collective intelligence [25]. Lévy [22] asserted that one axiom of collective intelligence is coordination in real time through cyberspace. An important aspect of organizational intelligence is using the Business Intelligence (BI) [6]. The concept of BI was put forwarded by Gartner Group in 1996 [24]. BI solutions enable an intelligent usage and analysis of company's business data [26]. It provides a large functionality with a vast collection of applications and tools that enables delivery of consistent and high quality information through gathering, providing access to, and analyzing data for the purpose of helping organization to make effective business decisions.

3 The Ethical Dimension of Web-Based Collective Intelligence

Organizations are increasingly facing ethical implications and responsibilities in the age of Internet and digital technologies, especially in the field of decisions making [14], [16]. Ethical decision making in today's organization is not only the right thing to do but is vital to its survival [27]. According to Crane and Matten [28], business ethics is the study of business situation, activities, and decisions where issues of right and wrong are addressed. Sinha and Mishra [29] defined business ethics as a set of rules, standards, codes, principles, and philosophy to be followed for ethical decision making in business. In collaborative business environments, the normative ethical theories, including stockholder theory, stakeholder theory, and social contract theory determine whether business decisions are ethical or not [16].

Collective intelligence deserves to become a full discipline, with its formal framework, its tools, its measuring instruments, its practical applications, and its ethical field [12]. The Ethical dimension is gaining more attention as a main characteristic of collective Intelligence [17], [18], [19]. According to Zembylas and Vrasidas [18], the notion of collective intelligence deepens a sense of ethics in navigating and acting in cyberspace. Gan and Zhu [19] demonstrated that collective intelligence may lead to collective wisdom that includes the ability to apply knowledge into practice, and fulfill needs in harmony with environment to comprehend ethics and morality. Collective intelligence needs a new social contract bringing about a change in behavior and thus a change in values toward an ethic of collaboration [17].

4 The Ethical Model of Web-Based Collective Intelligence

Despite the increasing importance of ethical issues, there is disagreement about the theory and practice of ethical conduct in business organizations [16]. Therefore, the modeling approach of the present research is based on a combination of previous ethical frameworks that regulate the ethical behavior in the age of information societies, moral intelligent theories, and ethical theories of collaborative business environments. Figure (1) represents the ethical model of Web-based collective intelligence. Based on the analysis of society, stockholders and stakeholder's rights and obligations, the Web-based collective intelligence system will work under five ethical constraints. The proposed model posits that the society needs and rights, stockholders and stakeholders' rights and obligations should be taken care to develop an ethical Web-based collective intelligence.

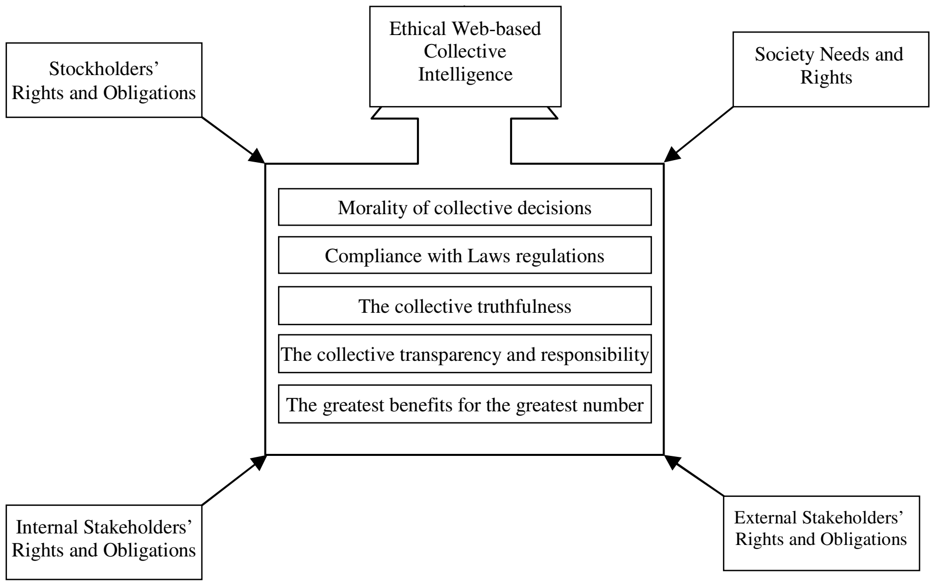

Fig. 1. The Ethical Model of Web-based Collective Intelligence

Many research efforts have intended to focus on developing ethical frameworks for developing and using ITC. For example, Spinello [30] presents a model describing six environmental constraints that regulate the ethical behavior of cyberspace activities, including government and laws, work environment, professional environment, private environment, and the Personal environment. Walstrom [31] explained these constraints to study the ethical decision-making processes regarding information ethics, as following: The social environment, with religious, cultural, and social values; the government or legal environment, including legislation, administrative agencies, and judicial systems; personal environment, comprising individual attributes, such as personal goals, motivation, position, demography; private environment, containing peer group, family, and their influences; professional environment, including code of conduct, professional meetings, and licensing; and finally, work environment, comprising corporate goals, stated policy, corporate culture. In the context of using ITC, Haines and Leonard [32] suggested a framework includes four characteristics of the ethical decision making process, namely; recognizing moral issue, making moral judgment, establishing moral intent, and engaging in moral behavior. Davidrajuh [33] proposed a model that can be used to develop computer software to help solving the problems associated with ethical decision-making, such as the ambiguous of decision making process, the cognitive moral development, uncertainty in problem identification, and dealing with environmental influences.

The theory of multiple intelligences, posits that individuals possess a number of autonomous intelligences. Individuals draw on these intelligences, individually and corporately, to create products and solve problems that are relevant to the societies in which they live [34]. One of these intelligences includes the moral intelligent as an important component of human society, where intelligence can be put to either moral or immoral uses in society [34], [35], [36]. According to Rahimi [37], a manager with high moral intelligence is the executive of organizational intelligence. Lennick and Kiel [36] identified four competencies of moral intelligence consisting of acting consistently with principles, values, and beliefs; telling the truth; standing up for what is right; and keeping promises. Rahimi [37] demonstrated seven main traits exhibited by moral beings and coincides with one's level of moral intelligence. These traits include inhibitory control, empathy, consistency, fairness, responsibility, cooperation, and logic.

There is a growing stream of research (e.g. [38], [39], [40]) examining the ethical dimension in Web-based collaborative technology environments. More specifically, Davidrajuh [16], [33], and Bose [41] developed an ethical framework for ICT that can be applied in collaborative business environments based on three theories, including stockholder theory, stakeholder theory, and social contract theory. These theories and their explanations are given below:

Stockholder Theory

According to the Stockholder Theory, the social responsibility of business and hence the managers, is to use the resources to participate in business activities to increase returns of investment for the stockholders, where revenue must be done by open and free competition, without deception.

Stakeholder Theory

Stakeholders include any individual who can affect or is affected by the survival, success, and accomplishment of the organization's objectives. According to this theory, managers are responsible for taking care of the interests of all the stakeholders, such as employees, suppliers, distributors, customers and whose interest the corporation vitally affects.

Social Contract Theory (SCT)

SCT theory proposes that managers are responsible for taking care of a society needs beyond the complex business organization arrangements. This theory forces the organization to interact in a way that provides benefits to the society as whole. This theory also allows organization to exist and demands that managers pay their efforts to add more values to the society than they consume for the business interactions their narrow interests.

Based on the after mention discussion, the present research identifies six ethical principles that should guide the efforts of developing the Web-based collective intelligence system. These principles include:

- Provide mechanisms to support the moral aspects of collective decisions, actions, judgments, and behaviors.
- Support the compliance with Laws, regulations, and standards imposed or agreed to by the government, industry associations or stockholders.
- Support acceptable decisions that take into account the rights, benefits and interests of stakeholders (i.e. stockholders, customers, suppliers, wholesalers, retailers…)
- Support the investigation of decisions truthfulness that confirms with facts and reality.
- Provide mechanisms to support the transparency and responsibility for the consequences of decisions.
- Support the decisions that do the greatest of benefits for the greatest number of stakeholders

5 Conclusions

The new ICTs are now making it possible to organize groups in very new ways that have never been possible before in the history of humanity. The increasing capabilities of collaborative IT has played a vital role in giving the support and facilities to harvest, use and sharing of the collective intelligence. Web-based collective intelligence intends and deserves to become a full discipline, with its formal framework, tools, measuring instruments, practical applications, and ethical field. The Ethical dimension is gaining more attention as a main characteristic of collective intelligence.

The present study contributes to the ongoing stream of research on through developing an ethical framework for the Web-based collective intelligence in business organizations. Based on a combination of previous ethical frameworks that regulate the ethical behavior in the age of information societies, moral intelligent theories, and ethical theories of collaborative business environments, five layers of ethical principles were identified. These include the morality of collective decisions, compliance with laws and regulations, the collective truthfulness, the collective transparency and responsibility, and the greatest benefits for the greatest number of stakeholders. There are some limitations which, at the same time, can serve as directions for future research. First of all, the findings of the study are presented in the form of a conceptual framework that will need to be tested empirically in future research. Furthermore, the scope of this study is limited to the ethical dimension for the Web-based collective intelligence apart from the prevailing ethical and cultural values that may have possible impact on achieving a unified ethical framework.

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Use of a Game Theory Model to Simulate Competition in Next Generation Networks

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Abstract. With game theory, we want to understand the effects of the interaction between the different players defined in our business case - Next generation access networks (NGNs). In the proposed games, the profit (outcome) of each operator (player) will be dependent not only on their actions, but also on the actions of the other operators in the market. This paper analyzes the impact of the price (retail and wholesale) variations on several output results: players' profit, consumer surplus, welfare, costs, service adoption, and so on. For that, two price-setting games are played. Players' profits and Net Present Value (NPV) are used as the payoff for the players in the games analyzed. We assume that two competing Fiber to the home networks (incumbent operator and new entrant) are deployed in two different areas. For the game-theoretic model, we also propose an adoption model use in a way that reflects the competition between players and that the variation of the services prices of one player has an influence on the market share of all players. In our model we also use the Nash equilibrium to find equilibrium - Proposed tools include a module to search the Nash equilibrium in the game.

Keywords: Access Networks, NGNs, Game Theory, Techno-economic Model.

1 Introduction

In a real competitive market situation, competitors need to adapt their strategy to face/react the strategies from other players. The interaction between the several market players can be modeled using game theory. The main objective of a game-theory model is providing a mathematical description of a social situation in which two or more players interact, and every player can choose from different strategies. [1] define game theory as a collection of mathematical models formulated to study situations of conflict and cooperation, and concerned with finding the best actions for individual decision makers. [2] argue that game theory is a theory of decision making under conditions of uncertainty and interdependence.

To better understand the effects of interaction (interaction between players can consist of competition or cooperation) between different players, we build a new model, in which the outcome for each player will be depending on his own actions but also on the actions of the other players. The players compete for some good or

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reward, and often in business cases, the customer will be the aim of the competition [3, 4]. The object of study in game theory is the game, where there are at least two players, and each player can choose amongst different actions (often referred to as strategies). The strategies chosen by each player determine the outcome of the game - the collection of numerical payoffs (one to each player). So, the game has three main key parts [5]: a) a set of participants; b) each player has a set of options for how to behave; we will refer to these as the player's possible strategies; and c) for each choice of strategies, each player receives a payoff that can depend on the strategies selected by everyone (in our model, the payoff to each player is the profit each provider gets).

After the calculation of the several payoffs, game theoretic concepts can be used for retrieving the most likely (set of) interactions between the players [4]. There are several different equilibrium-definitions of which probably the Nash equilibrium is the most commonly known - A broad class of games is characterized by the Nash equilibrium solution. In 1950, John Nash demonstrated that finite games always have a Nash equilibrium, also called a strategic equilibrium [1]. A Nash equilibrium is a list of strategies, one for each player, which has the property that no player can unilaterally change his strategy and get a better payoff - each player's strategy is an optimal response to the other players' strategies. Even when there are no dominant strategies, it should be expected that players use strategies that are the best responses to each other. This is the central concept of noncooperative game theory and has been a focal point of analysis since then. For example, if player 1 chooses strategy S1 and player 2 chooses S2, the pair of strategies (S1 and S2) is a Nash equilibrium if S1 is the best response to S2, and S2 is the best response to S1. So, if the players choose strategies that are best responses to each other, then no player has an incentive to turn to an alternative strategy, and the system is in a kind of equilibrium, with no force pushing it toward a different outcome [5].

2 Model Overview

One of the main goals of regulated access is to prevent the incumbent from abusing a dominant market position [6]. It is necessary to make sure that alternative operators can compete effectively. It is fundamental that incumbent operators give access to the civil works infrastructure, including its ducts, and to give wholesale broadband access (bitstream) to the local loop (be it based on copper, new fiber, etc.). However, at the same time, alternative operators should be able to compete on the basis of the wholesale broadband input while they progressively roll out their own NGAN infrastructure. In some areas, especially with higher density, alternative operators have rolled out their own infrastructure and broadband competition has developed. This would result in more innovation and better prices to consumers [7].

Many European incumbents and some alternative operators are starting to plan and in some cases deploy large-scale fiber investments, which has resulted in important changes for European fixed-line markets [8]. Many Europeans incumbents and some alternative operators are starting to plan and in some cases deploy large scale fiber investments, which results in important changes for European fixed line markets [8]. The risk of alternative operators will take longer to deploy their own infrastructure and will give to incumbents the possibility to create new monopolies at the access level. The technologies used and the pace of development vary from country to country according to existing networks and local factors. Based on the different underlying cost conditions of entry and presence of alternative platforms, it may be more appropriate to geographically differentiate the access regulatory regime.

This work focuses the development of a tool that simulates the impact of retail and wholesale price variation on provider's profit, welfare, consumer surplus, costs, market served, network size, etc.

In the proposed model, "Retail Prices" represents the set of retail prices charged by providers for each service to consumers in a given region/area. We assume that retail providers cannot price discriminate in the retail market. "Wholesale Prices" represents the prices that one provider charges to other provider to allow the later to use the infrastructure to reach consumers. We assume that wholesale price can be different in each area. Also, we assume that when a provider buys infrastructure access in the wholesale market, it cannot resell to another provider. The shared infrastructure consists of: conduit and collocation facilities; cable leasing (dark fiber requires active equipment to illuminate the fiber – for example repeaters); and bit stream.

For example, one or several wholesaler providers can sell Layer 0 access (conduit and collocation facilities) and/or Layer 1 access (cable leasing) or Layer 2 access (bitstream – network layer unbundling – UNE loop) only to retail providers and not directly to consumers. UNE loop is defined as the local loop network element that is a transmission facility between the central office and the point of demarcation at an end-user's premises. Table 1:shows an example of a scenario with two regions, two providers, two services, and one infrastructure layers.

Table 1. Structure of a scenario

									Results						
	Provider 1				Provider 2				Market Served	Size of Network	Total Costs	Total Revenues	Total Profit	Consumer Surplus	Welfare
	Retail price		Wholesale price		Retail price		Wholesale price								
	Serv. 1	Serv. 2	Reg. 1	Reg. 2	Serv. 1	Serv. 2	Reg. 1	Reg. 2							
			Layer 0	Layer 0			Layer 0	Layer 0							
St_1	$P^{r}_{(S1,V1)}$	$P^{r}_{(S2,V1)}$	$P^{w}_{(L0,V1)}$	$P^{w}_{(L0,V1)}$)	$P^{r}_{(S1,V1)}$	$P^{r}_{(S2,V1)}$	$P^{w}_{(L0,V1)}$	$P^{w}_{(L0,V1)}$)							
St_2	$P^{r}_{(S1,V1)}$	$P^{r}_{(S2,V1)}$)	$P^{w}_{(L0,V1)}$	$P^{w}_{(L0,V1)}$	$P^{r}_{(S1,V1)}$	$P^{r}_{(S2,V1)}$)	$P^{w}_{(L0,V1)}$	$\mathbf{P^{w}_{(L0,V2)}}$							
St_n	…														

Each line corresponds to a strategy of prices (St1, St2, Stn), and for each strategy the tool calculates the results (columns at the right side of the previous table). To calculate the number of strategies required, we use the following formula:

$$TS = TVS^{(TProv*(TServ+(TReg*TLay)))} \quad (1)$$

Where: TS – Total strategies; TVS – Total values to simulate; TProv – Total providers; TServ – Total services; TReg – Total regions; TLay – Total layers

3 Input Parameter Assumptions

As we can see in Figure 1: , our tool has several input parameters, computes several results and finds the strategies that are Nash equilibrium. The results are represented in tables and graphics.

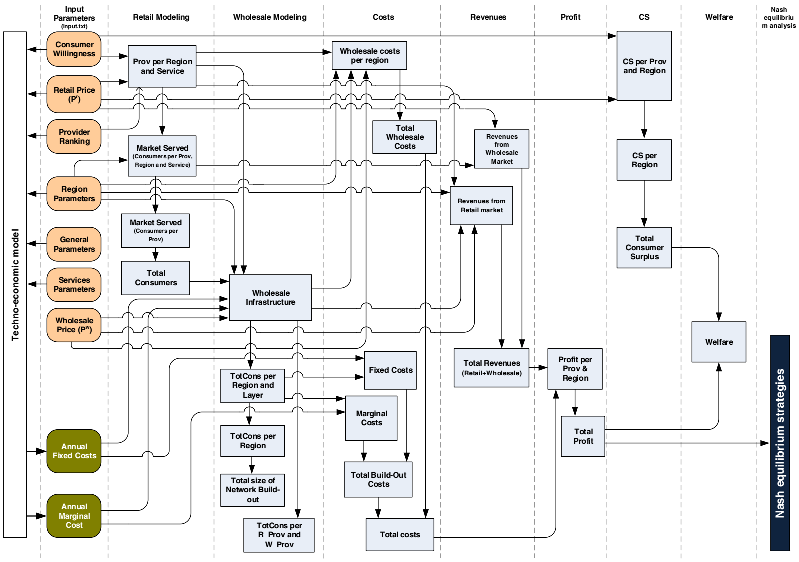

Fig. 1. Game-theoretic model structure

3.1 Fixed and Marginal Costs

In our model, we assume that providers incur in fixed costs to build network infrastructure to provide access to a region and in marginal costs to connect each consumer separately.

The fixed costs are detailed by provider, region and infrastructure layer (see Table 2:). So, we assume that the fixed costs of each provider can be different in different regions - for example, if a provider has part of the infrastructure deployed in a region, and in the other is required all the infrastructure, the costs are different [6].

Table 2. Structure of fixed costs input parameter

	Region1			Region2			…	Region r		
	Layer 0	Layer 1	Layer 2	Layer 0	Layer 1	Layer 2	…	Layer 0	Layer 1	Layer 2
Provider 1	$C^f_{(P1,R1,L0)}$	$C^f_{(P1,R1,L1)}$	$C^f_{(P1,R1,L2)}$	$C^f_{(P1,R2,L0)}$	$C^f_{(P1,R2,L1)}$	$C^f_{(P1,R2,L2)}$	…			
Provider 2	$C^f_{(P2,R1,L0)}$	$C^f_{(P2,R1,L1)}$	$C^f_{(P2,R1,L2)}$	$C^f_{(P2,R2,L0)}$	$C^f_{(P2,R2,L1)}$	$C^f_{(P2,R2,L2)}$	…			
…	…	…	…	…	…	…	…	…	…	…
Provider p							…			

For marginal costs, we assume that each provider has different costs for deployment in each infrastructure layer. In each region, the marginal cost could be different for each provider depending of the total number of subscribers – scale economies. This means that the marginal cost can decrease when a specific provider buys higher quantities of equipment, cable, etc. (see Table 3:).

Table 3. Structure of marginal costs input parameter

		Region 1				Region 2				…
Total Consumers		TotCons1	TotCons2	TotCons3	TotCons4	TotCons1	TotCons2	TotCons3	TotCons4	…
Provider 1	L0	$C^m_{(P1,R1,L0,V1)}$	$C^m_{(P1,R1,L0,V2)}$	$C^m_{(P1,R1,L0,V3)}$	$C^m_{(P1,R1,L0,V4)}$	$C^m_{(P1,R2,L0,V1)}$	$C^m_{(P1,R2,L0,V2)}$	$C^m_{(P1,R2,L0,V3)}$	$C^m_{(P1,R2,L0,V4)}$	
	L1	$C^m_{(P1,R1,L1,V1)}$	$C^m_{(P1,R1,L1,V2)}$	$C^m_{(P1,R1,L1,V3)}$	$C^m_{(P1,R1,L1,V4)}$	$C^m_{(P1,R2,L1,V1)}$	$C^m_{(P1,R2,L1,V2)}$	$C^m_{(P1,R2,L1,V3)}$	$C^m_{(P1,R2,L1,V4)}$	
	L2	$C^m_{(P1,R1,L2,V1)}$	$C^m_{(P1,R1,L2,V2)}$	$C^m_{(P1,R1,L2,V3)}$	$C^m_{(P1,R1,L2,V4)}$	$C^m_{(P1,R2,L2,V1)}$	$C^m_{(P1,R2,L2,V2)}$	$C^m_{(P1,R2,L2,V3)}$	$C^m_{(P1,R2,L2,V4)}$	
Provider 2	L0	$C^m_{(P2,R1,L0,V1)}$	$C^m_{(P2,R1,L0,V2)}$	$C^m_{(P2,R1,L0,V3)}$	$C^m_{(P2,R1,L0,V4)}$	$C^m_{(P2,R2,L0,V1)}$	$C^m_{(P2,R2,L0,V2)}$	$C^m_{(P2,R2,L0,V3)}$	$C^m_{(P2,R2,L0,V4)}$	
	L1	$C^m_{(P2,R1,L1,V1)}$	$C^m_{(P2,R1,L1,V2)}$	$C^m_{(P2,R1,L1,V3)}$	$C^m_{(P2,R1,L1,V4)}$	$C^m_{(P2,R2,L1,V1)}$	$C^m_{(P2,R2,L1,V2)}$	$C^m_{(P2,R2,L1,V3)}$	$C^m_{(P2,R2,L1,V4)}$	
	L2	$C^m_{(P2,R1,L2,V1)}$	$C^m_{(P2,R1,L2,V2)}$	$C^m_{(P2,R1,L2,V3)}$	$C^m_{(P2,R1,L2,V4)}$	$C^m_{(P2,R2,L2,V1)}$	$C^m_{(P2,R2,L2,V2)}$	$C^m_{(P2,R2,L2,V3)}$	$C^m_{(P2,R2,L2,V4)}$	
…	…	…	…	…	…	…	…	…	…	…

3.2 Pricing Strategy

Both suppliers and consumers aim at maximizing the benefit or surplus they receive [9]. The suppliers aim at maximizing the profit, which is the difference between revenue and cost. The consumers aim at maximizing the consumer surplus, which is the difference between consumer value (also known as utility or maximum willingness to pay) and price. As discussed, some of the factors that are important in the design of pricing scheme include technology risks, availability of resources, competition, supplier and consumer behavior, price discrimination and regulation.

3.2.1 Definition of the Variation in Retail Prices

The definition of retail prices and trend was explained previously. For the game-theoretic tool, we need to define the variation in retail prices which we want to simulate. So, for each service, we define the price values we wish to simulate - the tool gives the possibility to simulate n values. In the example presented in the next table, the tool simulates the results obtained when the value of service 1 is Pr S1,Value1, Pr S1,Value1, Pr S1,Value1, and Pr S1,Value1 for all players (providers).

Table 4. Variation values for retail prices

	Value 1	Value 2	Value 3	Value 4	…
Value for Service 1	Pr S1, Value1	Pr S1, Value2	Pr S1, Value3	Pr S1, Value4	
Value for Service 2	Pr S2, Value1	Pr S2, Value2	Pr S2, Value3	Pr S2, Value4	
…					

3.3 Definition of the Variation in Wholesale Prices

For wholesale prices, we define the variation in wholesale price layers that we want to simulate. Similarly, for retail price, for each layer we define the price values we wish to simulate—the tool gives the possibility to simulate n values.

Table 5. Variation values for wholesale prices

	Value 1	Value 2	Value 3	Value 4	…
Value for Layer 0	$P^{w}_{L0,\ Value1}$	$P^{w}_{L0,\ Value2}$	$P^{w}_{L0,\ Value3}$	$P^{w}_{L0,\ Value4}$	
Value for Layer 1	$P^{w}_{L1,\ Value1}$	$P^{w}_{L1,\ Value2}$	$P^{w}_{L1,\ Value3}$	$P^{w}_{L1,\ Value4}$	
Value for Layer 2	$P^{w}_{L2,\ Value1}$	$P^{w}_{L2,\ Value2}$	$P^{w}_{L2\ ,Value3}$	$P^{w}_{L2,\ Value4}$	

For infrastructure, the definition of which layer or combination of layers we would like to simulate is also required: conduit, cable or Bit-Stream (Conduit + Cable + Equipment).

4 Simulation Model (Modeling Competition)

The simulation model can be sub-divided into seven main parts: retail and wholesale modeling, calculate total costs (build and lease infrastructure), calculate revenues (retail and wholesale market), calculate profit, calculate consumer surplus, and calculate welfare.

In retail modeling, we assume that consumers choose the service from the provider with the lowest price. However, consumers only buy a service if the price is less than their willingness to pay. This means that if there are two or more providers, consumers choose the service from the provider with the lowest price. Moreover, if several providers have the same price, we use the provider ranking. We also assume that consumers have a different willingness to pay for each service. First, the tool identify the retail provider for each service in the regions in study using information from providers, retail prices, consumer willingness to pay, and provider rank. Next, as we know which provider will provide each service, we can compute the total subscribers per region, service, and provider (market segment).

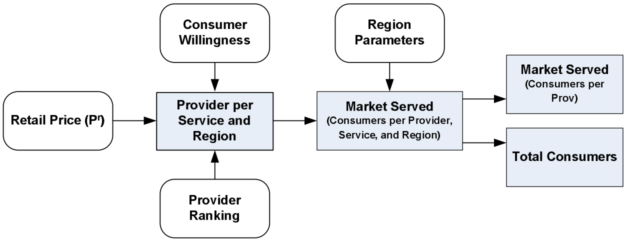

Fig. 2. Retail market modeling

In wholesale modeling, we determine the infrastructure chosen by each provider to reach consumers. To model the wholesale market, we assume that if a provider does not have infrastructure, it uses the infrastructure (or part of the infrastructure, such as a conduit cable) of another provider if the price charged to access it is lower than the cost to build an infrastructure. To achieve that goal, the algorithm uses information about wholesale prices, fixed costs, and marginal costs to identify the best solution (lease or build infrastructure) for each region and service.

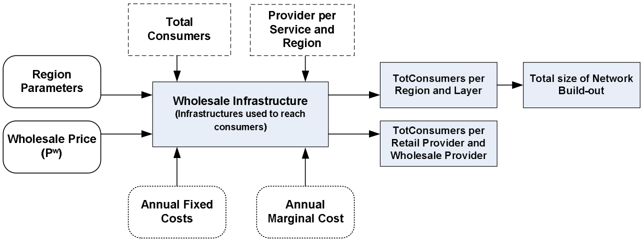

Fig. 3. Wholesale market modeling

4.1 Calculate Total Costs (Build and Lease Infrastructures)

The calculation of the total costs incurred by each provider is divided in two main parts: wholesale costs and build-out costs. As sees in next figure, we use the wholesale infrastructure design computed previously and the wholesale prices charged by the infrastructure owners (i.e., payments that a specific provider gives to the infrastructure owner to buy wholesale access in order to reach consumers). We assume that the network owner charges the same wholesale price to all providers.

To calculate the build-out costs, the algorithm uses the fixed and marginal costs parameters with region parameters to compute the total costs required to deploy an entire or part of an infrastructure. The total number of consumers per region and per provider is also used to add the effect of economies of scale. When a provider buys a large quantity of equipment, the probability of attaining better prices is higher.

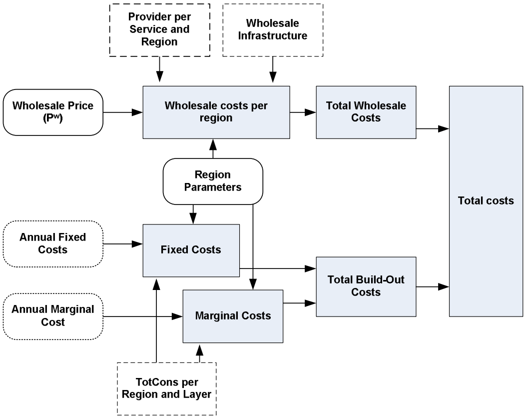

Fig. 4. Total costs calculation

4.2 Calculate Revenues, Profit, Consumer Surplus and Total Welfare

To compute the total revenues per provider, we first calculate the revenues from the retail market.

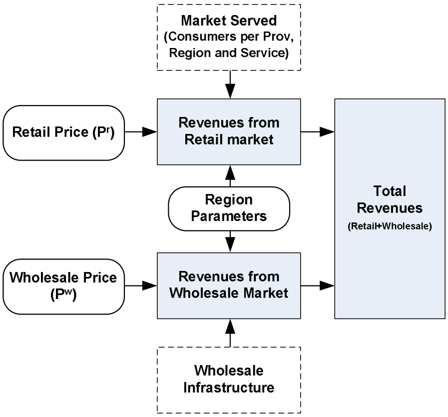

Fig. 5. Revenues calculation

These are primarily based on the retail prices charged by providers and the total number of consumers per provider and services computed in the retail modeling. Revenues from the retail market are equal to the product of the retail price of each service and the total customers of the service.

Next, we calculate the revenues from the wholesale market. The wholesale infrastructure provides information about the number of access leased. The revenues of a provider are the sum of all payments received from other providers that use its infrastructure to reach consumers. Finally, the total revenues of a given provider are the sum of the revenues from the retail and the wholesale market. After computing the total costs and revenues in the previous algorithms, the formula we use to calculate total profit is the difference between total revenues and total profit. The total profit is also used in the identification of the Nash equilibrium strategies.

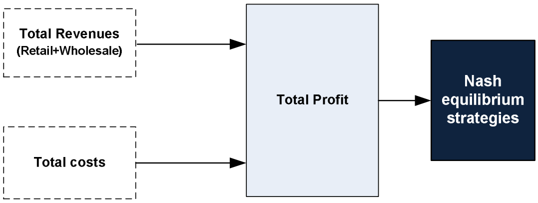

Fig. 6. Profit calculation

Consumer surplus (CS) is the difference between the total amount that consumers are willing and able to pay for each service and the total amount that they actually pay (i.e., the retail price). So, the CS of a specific market is the sum of the individual consumer surpluses of all those customers in the market who actually bought the service at the going retail price [10]. To compute CS, we need information about consumer willingness to pay and retail prices for each service.

Total welfare is computed on base of the formula: welfare = consumer surplus + total profit. Like the previously calculations, the CS and the profit are computed in the algorithms presented above.

5 Results

Based on the numerous input parameters described, our tool computes several results, including profit, consumer surplus, welfare, market served, network size, costs, and revenues, and finds the strategies that are Nash equilibriums. The results are saved in text files (see Figure 7:).

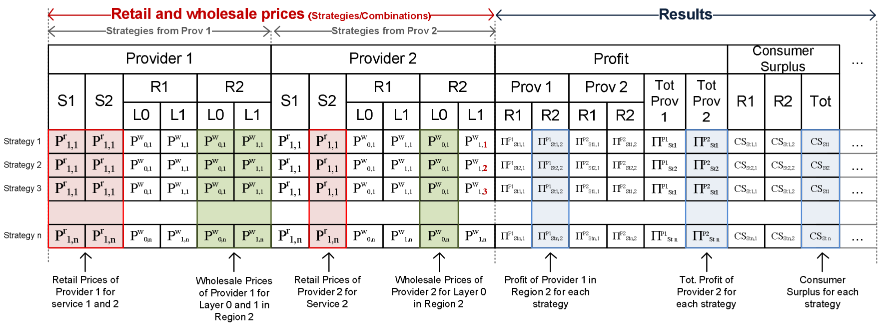

Fig. 7. Structure of the results produced (output from tool)

Figure 7: show the structure of the results that correspond to a scenario of two providers, two retail services, two infrastructure layers, and two regions. Each line is a strategy. We consider a strategy to be a set of retail and wholesale prices. For each combination of prices, the tool calculates profit, CS, welfare, market served, network size, and total costs.

In addition to the results presented in the tables, the tool creates several types of graphs. Next figures show two examples of the graphs produced. The graph shows the impact on profit of both providers and variation in wholesale and retail prices. This representation gives users a tool to gain a better perspective of the results.

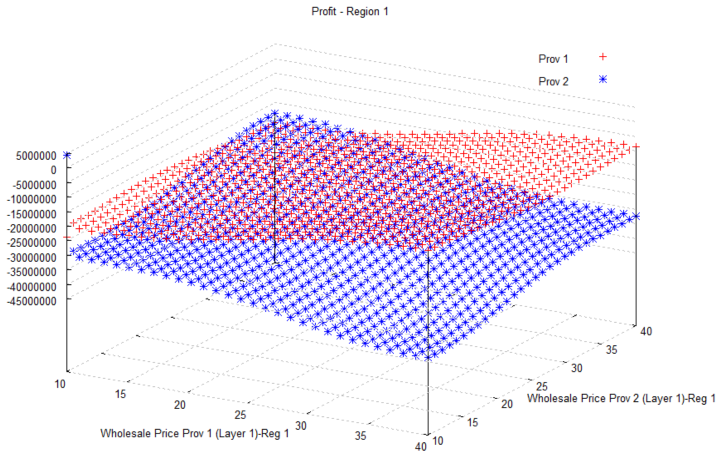

Fig. 8. Profit region 1 (retail price) - example

6 Conclusion

Sensitivity analysis shows the impact that changes in a certain parameter will have on the model's outcome. As the interaction between all the players is important, we put the competition component in the business case. With game theory, we want to understand the effects of the interaction between the different players defined in our business case. In the proposed games, the profit (outcome) of each operator (player) will be dependent not only on their actions, but also on the actions of the other operators in the market.

The impact of the price (retail and wholesale) variations on several output results: players' profit, consumer surplus, welfare, costs, service adoption, and so on. For that, two price-setting games are played. Players' profits and NPV are used as the payoff for the players in the games analyzed.

In our model we also use the Nash equilibrium to find equilibrium. Proposed tools include a module to search the Nash equilibrium in the game. One strategy is a Nash equilibrium when both competitors play their best strategy related to the other strategies selected (players know each other's strategy in advance).

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Using a Multi-Criteria Approach in Early Warning Information Systems (MCEWIS)

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Abstract. A great deal of research has been conducted and numerous software programs have been created around the world in order to monitor events that cause threats. Such efforts had sought to predict possible disastrous events and help minimize their adverse effects on human life and property. The authors have developed a multi-criteria early warning information system (MCEWIS) to detect risks or expected hazards in the law enforcement sector. The distinguishing feature is using the EWS with a multi-factor/ multi-criteria approach to select the most important factors affecting the risk or even stimulating it. The EWS will automatically calculate the weight of each criterion/indicator and compare all criteria according to this weight. If one criterion has more weight than the others; this reflects the importance of this criterion in stimulating or increasing the risk. The paper describes the new approach and demonstrates the proof-of-concept.

Keywords: Early Warning, Multi-criteria, Decision Support, Forecasting, Indicator.

1 Introduction

Early warning information systems (EWIS) in any sector are capable of predicting future crises and preventing them or reducing their negative effects. Early warning information systems not only save lives but also help protect livelihoods and national development gains [1]. Early warning systems are widely recognized as worthwhile and necessary investments. However in many cases, early warning systems do not exist, are ineffective, or break down at critical points – risking devastation, death, and destitution [2]. The goal of this paper is twofold. Firstly, it provides guidelines for professionals involved in implementing an effective EWIS. Secondly, it presents a new approach to comparing the different criteria, evaluating their importance, and ranking them according to their critical effect on crises. This approach can also be used in crisis preparedness, especially in creating crisis prevention plans. In the following sections we will review the definition of early warning, its importance and its main phases. Subsequently, we will explore the multi-criteria method, its uses, importance and drawbacks. Moreover, we will suggest a certain methodology that

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solves the drawbacks of the traditional method (multi-criteria) by assigning a relative weight to each value that represents its importance compared to the other values. Finally, the paper describes a case study in the law enforcement sector as a proof-of-concept. The proposed tool provides a new method to express the ranking of the criteria by applying weight to each value according to a certain technique, which is proposed by the authors. The system will compare criteria (indicators) according to the net weight. If one criterion gets a higher net weight than others, this means that this criterion has a greater effect on stimulating the risk and hence the system will rank it first.

2 Related Work

A number of methods and computer-based systems have been developed [3]. They are mainly studied in the framework of decision support systems [4,5,6], operations research and management sciences, decision theory [7] or decision analysis [8]. A multi-criteria technique is expressed as one of the important techniques that are widely used by decision makers. The basic aim of the multi-criteria (MC) technique is 'to investigate a number of choice possibilities in the light of multiple criteria and conflicting objectives' [9]. In doing so it is possible to generate compromise alternatives and rankings of alternatives according to their attractiveness [10]. Guozhong et al. (2012) used in their paper the fuzzy analytic hierarchy process method to evaluate work safety in hot and humid environments. A safety evaluation framework containing three factors (work, environment, and workers) and ten sub-factors was established. The weights of the factors and sub-factors were calculated based on pair-wise comparisons. Decision makers evaluated this data according to their experience [11]. Moreover, Krasimira et al. (2004) presented in their paper a multi-criteria analysis decision support system called MultiChoice, which was designed to support decision makers in solving different multi-criteria analysis problems. In order to solve multi-criteria analysis problems, several criteria were simultaneously optimized in a feasible set of a finite number of explicitly given alternatives. The information that the decision maker gives, reflects his/her preferences with respect to the quality of the alternative sought [12,13]. A study by Xiang (1993) employed a multi-objective linear programming technique. In many practical situations, it would be desirable to achieve a solution that is "best" with respect to multiple criteria rather than one criterion as in Chuvieco (1993) [14,15]. Based on the literature review, we have concluded that the MC technique has proved useful in situations that require the selection of the best alternative from a number of feasible choices in the presence of multiple decision criteria and diverse criterion priorities. MC methods can be used to reduce complex problems to a singular basis for selection of a preferred alternative. However, the major drawbacks of these methods are: that they require decision makers to formulate the model by specifying the weight of each variable and to quantify the priorities in advance, which is difficult in reality. In addition, they do not necessarily weigh the relative importance of criteria and combine the different criteria to produce an aggregate score for each alternative. The suggested approach is more accurate because it is performed automatically without any intervention from decision makers, unlike the old traditional method where each decision maker places a value for each variable according to his/her experience and manually calculates the results.The new approach introduced in this paper will also help the EWIS compare the different criteria and will shed light on the criteria that have major effects on increasing the danger or risk.

3 Early Warning Information Systems (EWIS)

The idea of early warning emerged in the fifties of the past century, and was used for the first time in military domains to predict risks and potential attacks before they occur. Until the early eighties; the concept of early warning had not evolved noticeably due to a number of reasons; such as the difficulty of creating its applications and its high cost [16]. The expression 'Early Warning' is used in many fields to mean the provision of information on an emerging dangerous circumstance where that information can enable action in advance to reduce the risks involved [17]. A universally accepted definition of an EWS does not yet exist and most probably never will [18]. There are many definitions of an EWS that are used to guide the actions of individuals, groups, and governments. An EWS can be defined as "a social process for generating maximally accurate information about possible future harm and for ensuring that this information reaches the people threatened by this harm, as well as others disposed to protect them from the harm" [2,19,20]. An 'Early Warning Information System (EWIS)' can be understood as a set of institutional and technical solutions designed and implemented in a coherent way to make available, to a wide range of users and more particularly to decision makers, information useful to carry out vulnerability analyses, to evaluate and manage the risk of a hazard that can become a disaster, and to manage disasters from prevention to recovery and rehabilitation [21,22,23]. The objective of EWIS is to generate accurate information to empower individuals and communities threatened by hazards to act in sufficient time and in an appropriate manner so as to reduce the possibility of personal injury, loss of life and damage to property or the environment. The term EWIS can be used for any information system that collects, shares, analyzes data, produces future predictions about potential crises and gives recommendations or warnings for those involved [24,25,26]. Saad Eldin et al. (2013) suggested that an EWIS framework combines 4 major models (see Fig. 1.) The first model (detecting the risk) includes functions that capture and analyze the event/crisis information; while the second model (analyzing the risk) determines the set of mathematical indicators (criteria) that should be measured frequently. Any indicator is expressed as a criterion that contributes with other criteria to evaluate the level of a threat: each criterion has a certain effect on increasing the risk. Meanwhile,

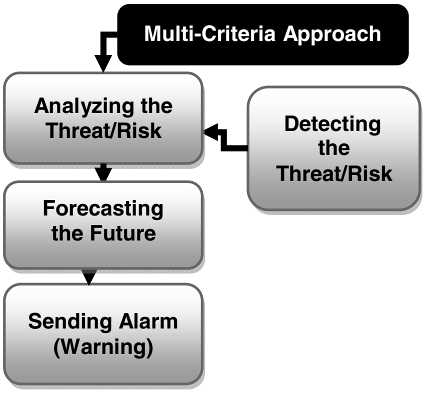

Fig. 1. EWIS Phases

the third model (Future Forecasting) provides future forecasts depending on the data calculated from the previous step, and finally the fourth model (Issuance of Warnings) is concerned with sending warnings (alerts) to users [27]. This paper will focus on the second model (analyzing the risk). Most of the time each indicator (criterion) in this model has a set of values, these values are conflicting. Indicators are often evaluated by a number of individuals (decision-makers, managers, stakeholders, etc.), but using our proposed tool, the system will do the evaluation of each criterion automaically without any interference from the users**.** The system analyzes the risk by evaluating all of the values associated with each indicator, each value is then compared with other values and accordingly the system puts a relative weight to each value according to the specific methodology proposed by the authors. Next, the system ranks the indicators according to the net weight they got; which reflects the importance of this indicator in stimulating the crisis.

4 Multi-Criteria Technique

Exploratory data analysis involves the use of statistical techniques to identify patterns that may be hidden in a group of numbers. One of these techniques is the "multi-criteria approach", which is used to visually summarize and compare groups of data. The words "criterion" and "attribute" are often used synonymously in the literature on MCA, which is indeed sometimes referred to as multi-attribute analysis. The word "attribute" is also sometimes used to refer to a measurable criterion. The development of multicriteria decision making techniques (MCDM), also known in the literature as multicriteria analysis (MCA) or multicriteria evaluation (MCE), is actually relatively recent. Over the past 20 years there has been a plethora of tools and techniques developed for solving these problems. These methods are designed to clarify the decision problem, help generate useful alternative solutions, and help evaluate the alternatives based on a decision maker's values and preferences [28]. The general objective of MCDM is to assist the decision-maker (DM) in selecting the best alternative from the number of feasible choice alternatives under the presence of multiple choice criteria and diverse criterion priorities [29]. A number of approaches to structuring MCDM problems have been suggested in the decision analysis literature. Within MCDA, almost all methodologies share similar steps of organization and decision matrix construction, but each methodology synthesizes information differently [30]. Different methods require diverse types of value information and follow various optimization algorithms. Some techniques rank options, some identify a single optimal alternative, some provide an incomplete ranking, and others differentiate between acceptable and unacceptable alternatives. In this paper, the authors use a new methodolgy that is based on many of the previous techniques. This methodology depends on using the EWIS to rank indicators and give weight to each inicator according to its importance. The methodology also compares the different indicators and selects the most influential ones (the indicators which have a greater effect on increasing or stimulating the risk).

5 Criteria Weighting Method

The main element in the weighting method is determining the weights of the criteria. Many methods for criteria weighting have been developed. A value tradeoff method is proposed in [31]. A direct ranking and rating method is proposed in [32], in which the decision makers first rank all the criteria according to their importance. Next, the criteria weights are obtained on this basis and under certain assumptions, while defining their relative importance. A mathematical programming model with sensitivity analysis is used in [33] to determine the intervals of weights, within which the same ranking result is produced. The weighting methods use a decision maker's preference model, which does not allow the existence of incomparable alternatives and the preference information obtained by the decision maker is sufficient to determine whether one of the alternatives must be preferred or whether the two alternatives are equal for the decision maker. Using the procedure presented in this paper, the weight of each value can be calculated through the position of the value of the indicator in the range and hence the importance of any criterion (indicator) is determined by the total weight of all the values of this indicator. If the net weight of any indicator is higher than the others then this indicator has a higher importance in increasing or stimlulating the risk/phenomena. The new Method proposed by the authors is as follows:

1. Inputting the time-series data of the indicator (1)
2. Calculating the total number of values of the indicator (n)
3. Determining the lowest value (L) and the highest value (H).
4. Subtracting the lowest value from the highest value (D) = H - L
5. Number of interval (I) (from 0.1 to 1) = 10
6. Calculating the increment = D / I
7. Determining the ranges.
8. Setting the weight according to the range and values
9. Repeating the above process for indicator (2)…to indicator (n)
10. Calculating the weights for all indicators
11. Normalizing the weight values by calculating the following formula:
    Weight of indicator 1 / total weights (weight of indicator 1 + weight of indicator 2+….weight of indicator n).
12. Ranking the Indicators (1…n), the top indicators have a higher weight and will affect stimulating the risk.
13. Building a prevention plan with priorities that depend on the ranking table.

6 Case Study

In order to demonstrate some of the key concepts introduced in the model described above, we have implemented a proof-of-concept purely in software to show how the theoretical concept can be implemented practically against data from the law enforcement sector. The authors have designed and implemented a multi-user software based on Windows system. The database is designed by SQL database management software and the logical model is created by a data modeling software tool. The EWIS forecasting models have been tested by comparing their results with other forecasting packages such as Minitab to ensure the efficiency and accuracy for EWIS models. The new method used short and long time intervals data from the law enforcement sector. The forecasting models have also been tested by verifying the forecasted data produced by the EWIS against the real data for the years (2011, 2012, 2013). The next few sections will explain the case study in more detail.

6.1 Detecting the Threat/Risk

- Event data is collected from different data sources.
- The number of occurrences is calculated in a specific time frame.
- The EWIS selected the most frequent event; "widespread drug abuse among youth" (see Table 1.), because this event has the highest number of occurrences. The data is collected from multiple sources (from Jan. 2000 to Dec. 2010)

Table 1. Event Occurrences (2010)

Event /Phenomena	No. of Occurrences
Drug abuse (youth)	64
Spinsterhood	24
The collapse of buildings	22
Hooliganism	21
Child molestation	20
Train accidents	18
Trafficking in Persons	12

6.2 Analyzing the Threat/Risk

- Determining the indicators that best describe the event: The EWIS uses from 3 (minimum) to 10 (maximum) indicators for each event/phenomena to work efficiently, the number of indicators varies from one event/phenomenon to another. The process of determining the indicators is implemented by a group of experts specialized in designing law enforcement indicators and these indicators are:
  - Indicator (A): Total number of drug users in the country.
  - Indicator (B): Total number of drug cases.
  - Indicator (C): The percentage of people arrested to the total population.
  - Indicator (D): The percentage of local people arrested to the total of arrests.
- Applying the methodology in section (4) which is proposed by the authors as follows:

Indicator A

1. Input the time-series data for indicator (A) (see table 2.)
2. Calculate the total number of values for indicator (A)= 11
3. Determine the lowest value = 85 and the highest value = 322
4. Subtract the lowest value from highest value = 322-85=237

5. Number of intervals (from 0.1 to 1) = 10
6. Calculate the increment = difference between highest and lowest value / number of intervals = 237/10= 23.7
7. Determine the ranges (see Table 3.)
8. Set the weight according to the range and values
9. Calculate the weights for all time-series values (see table 4.)

Table 2. Indicator (A) Time-Series Data

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Value	85	88	92	120	100	80	140	160	222	280	322

Table 3. Indicator (A) Range Values

Value + Increment	Range	Weight
85+23.7= 108.7	>=85 to less than or equal 108.7	0.1
108.7 +23.7= 132.4	> 108.7 to less than or equal 132.4	0.2
132.4+23.7= 156.1	> 132.4 to less than or equal 156.1	0.3
156.1+23.7= 179.8	> 156.1 to less than or equal 179.8	0.4
179.8+23.7= 203.5	>179.8 to less than or equal 203.5	0.5
203.5+23.7=227.2	> 203.5 to less than or equal 227.2	0.6
227.2 +23.7= 250.9	> 227.2 to less than or equal 250.9	0.7
250.9+23.7=274.6	> 250.9 to less than or equal 274.6	0.8
274.6+23.7= 298.3	> 274.6 to less than or equal 298.3	0.9
298.3+23.7=322	> 298.3 to less than or equal 322	1

Table 4. Indicator (A) Weights

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total Weight
Value	85	88	92	120	100	80	140	160	222	280	322	
Weight	0.1	0.1	0.1	0.2	0.1	0.1	0.3	0.4	0.6	0.9	1	3.9

Indicator B

1. Input the time-series data for indicator (B) (see Table 5.)
2. Calculate the total number of values for indicator (A)= 11
3. Determine the lowest value = 127 and the highest value = 290
4. Subtract the lowest value from the highest value = 290-127=163
5. Number of intervals (from 0.1 to 1) = 10
6. Calculate the increment = (difference between highest and lowest value) / number of intervals = 163/10= 16.3
7. Determine the ranges (see Table 6.)
8. Set the weight according to the range and values
9. Calculate the weights for all time-series values (see Table 7.)

Table 5. Indicator (B) Time-Series Data

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Value	132	136	139	140	127	143	143	150	186	210	290

Table 6. Indicator (B) Range Values

Value + Increment	Range	Weight
127+16.3= 143.3	>= 127 to less than or equal 143.3	0.1
143.3+16.3 =159.6	> 143.3 to less than or equal 159.6	0.2
159.6+16.3 = 175.9	> 159.6 to less than or equal 175.9	0.3
175.9+16.3=192.2	> 175.9 to less than or equal 192.2	0.4
192.2+16.3 =208.5	>192.2 to less than or equal 208.5	0.5
208.5+16.3=224.8	> 208.5 to less than or equal 224.8	0.6
224.8+16.3=241.1	> 224.8 to less than or equal 241.1	0.7
241.1+16.3=257.4	> 241.1 to less than or equal 257.4	0.8
257.4+16.3=273.7	> 257.4 to less than or equal 273.7	0.9
273.7+16.3=290	> 273.7 to less than or equal 290	1

Table 7. Indicator (B) Weights

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total Weight
Value	132	136	139	140	127	143	143	150	186	210	290	
Weight	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.4	0.6	1	2.9

Indicator C & Indicator D

The system will carry out the same previous processes as indicators (A and B).

Final Results

1. Calculate the total weight = total weight for indicator (A)+ total weight for indicator (B) + total weight for indicator (C) + total weight for indicator (D).
2. Calculate the optimized weights = Weight for Indicator (n) / Total Weight.
3. The next table (Table 8.) shows that the Indicator (D) needs more attention from decision and policy makers than other indicators in their future plans.
4. The EWIS will automatically carry out the procedure in section 5 as in (Fig. 2.)

Table 8. Indicators Ranking

Indicator	Weight	Optimized Weight	Rank
Indicator D	4.8	0.30	1
Indicator C	4.2	0.27	2
Indicator A	3.9	0.25	3
Indicator B	2.9	0.18	4
Total		1	

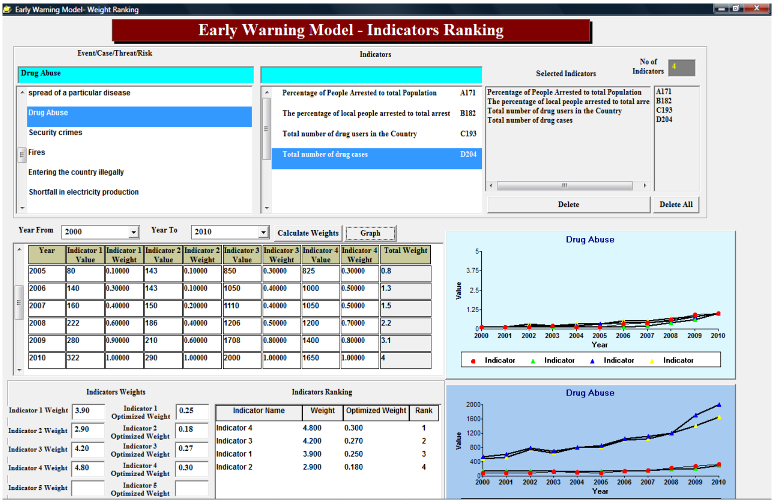

Fig. 2. Indicators Ranking

6.3 Forecasting the Future

1. Creating Forecasts for Each Indicator. The EWIS will use four forecasting models (Linear, Exponential, Moving Avergae and Cubic Models). After analyzing and validating the data, the EWIS will choose the best forecasting model depending on the following criteria: lowest MAPE (Mean Absolute Error) and highest correlation between variables.

6.4 Sending Warning Messages

1. Calculating the probability of each indicator by setting a range for each one. The probabilities will have values between 0.1 and 1 as shown in (Table 9).
2. Determining the level of danger (see Table 10., Fig. 3.), the level of danger equation will be: [(Probability of indicator A + Probability of indicator B + Probability of indicator C + Probability of indicator D) / total Number of indicators] * 100.

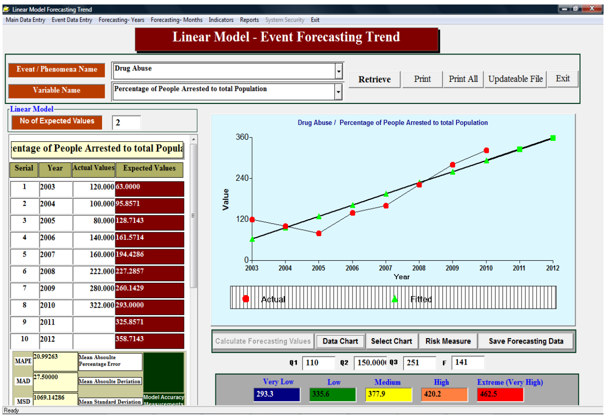

Fig. 3. Level of Danger

3. Converting the result into the following description:
   1. ***Dangerous*** (Red Color) = Probability at or above 90%.
   2. ***High*** (Orange Color) = Probability at or above 70% but below 90%.
   3. ***Medium*** (Yellow Color) = Probability above 55% but below 70%.
   4. ***Low*** (Green Color) = Probability above 20% but at or below 55%.
   5. ***Nil*** (Blue Color) = Probability at or below 20%.
4. Calculating the Length of Time Remaining to the Emergence of the Threat. The system can estimate the year in which the detected event will reach a dangerous level .The system found that in the year 2015 the detected event will reach a dangerous level (level of danger =100%).

Table 9. Probability Table

Indicator A		Indicator B		Indicator C		Indicator D	
Range	Probability	Range	Probability	range	Probability	range	Probability
<100	0.1	<100	0.1	<500	0.1	<450	0.1
101-150	0.2	101-130	0.2	501-800	0.2	451-680	0.2
151-200	0.3	131-160	0.3	801-1100	0.3	681-910	0.3
200-250	0.4	161-190	0.4	1101-1400	0.4	911-1140	0.4
251-300	0.5	191-220	0.5	1401-1700	0.5	1141-1370	0.5
301-350	0.6	221-250	0.6	1701-2000	0.6	1371-1600	0.6
351-400	0.7	251-280	0.7	2001-2300	0.7	1601-1830	0.7
401-450	0.8	281-310	0.8	2301-2600	0.8	1831-2060	0.8
451-500	0.9	310-340	0.9	2601-2900	0.9	2061-2290	0.9
> 500	1	>341	1	>2900	1	>2290	1

Table 10. Level of Danger

Year	Indicator A	Probability	Indicator B	Probability	Indicator C	Probability	Indicator D	Probability	Level of Danger (%)	Description
2000	85	0.1	132	0.3	540	0.2	480	0.2	20 %	Very Low
2001	88	0.1	136	0.3	616	0.2	530	0.2	20%	Very Low
2002	92	0.1	139	0.3	780	0.2	745	0.3	22.5%	Low
2003	120	0.2	140	0.3	700	0.2	650	0.2	22.5%	Low
2004	100	0.1	127	0.2	800	0.2	800	0.3	20%	Very Low
2005	80	0.1	143	0.3	850	0.3	825	0.3	25%	Very Low
2006	140	0.2	143	0.3	1050	0.3	1000	0.4	30%	Very Low
2007	160	0.3	150	0.3	1110	0.4	1050	0.4	35%	Very Low
2008	222	0.4	186	0.4	1206	0.4	1200	0.5	42.5%	Low
2009	280	0.5	210	0.5	1708	0.6	1400	0.6	55%	Low
2010	322	0.6	290	0.8	2000	0.6	1650	0.7	67.5%	Medium
…..	…..	…..	…..	…..	…..	…..	…..	…..	…..	…..
2015									100%	Dangerous

7 Conclusion

In this paper, we have proposed a new approach using the integration of multi-criteria and EWIS. We have also presented the tool designed by the authors as a case study to prove the concept. A list of issues related to the multi-criteria and EWIS were also presented. Based on our literature review, we have concluded that the integration of the multi-criteria approach and EWIS is necessary when the organization needs to evaluate certain criteria (Indicators) and define their relative importance in increasing the threat. Using the integrated approach is beneficial due to number of reasons. Firstly, it will help EWIS users decide which criteria or indicators are more important and require more attention and focus from policy makers and the government. Secondly, the ranking of the criteria will also help decision makers to design a prevention plan with certain priorities to prevent the threat or risk from increasing in the future. Thirdly, the system will automatically calculate the relative importance of each value and set the weight for each one without any interference from users. And finally, it will strengthen the ability of the organization to prevent disasters and crises before they occur. This versatile idea can be implemented in many other sectors in addition to the law enforcement sector. It is expected to be applied in the Education sector and on data from the Construction sector before the end of 2014. Moreover, the proposed model can be enhanced by adding new forecasting models to the existing ones to increase the accuracy and efficiency of the EWIS.

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University Application Process – Decision Support Models

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Abstract. After a study made in Portugal it was possible conclude that 5 months before application date, 51 % of the students did not know concretely which course to select at University. Meanwhile, 25% of the students attending Portuguese Public Higher Education has changed or ever thought of changing their course. In order to support the university application process it was designed a solution based in decision models. This solution will identify for a user what are the best alternatives to apply for. Decision models consider variables from various contexts (e.g. social, economic, personal, and psychological). These variables were defined according to scientific studies or in real facts. The generated model contemplates the introduction of a weighting system for these variables that can be set by the user, being the model able to adapt to the intrinsic characteristics of each student. As result it is always presented a set of possible choices adequate to the student profile.

Keywords: Higher Education, University application process, Decision Models, Decision Support.

1 Introduction

The main objective of this work is the development of a Decision Model based on a comprehensive study of the Portuguese higher education application process After a first study was introduced a Decision Support System (DSS) called COURSE (Universal Centre Collection Tips Oriented) which assists the students who are in transition year between secondary and higher education, in order to choose the most suitable course for them according to their profile.

Based on a number of variables provided from a questionnaire, the decision model uses information about the courses of public higher education in Portugal and present to the student a list of courses that best fit the profile. The student can scrutinize what are the most relevant questions for him defining the weighting that each question (variable) has in the final solution. The model processes the information taking into account some variables (social, economic, fitness) for a particular area and returns as output an ordered list of the most suitable courses for the user.

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The success of the first version motivated the research team to improve the decision models. A second phase was then started. In order to evaluate the viability of the solution a questionnaire has been submitted to possible users (students attending both systems Secondary Education and Higher Education). Two separate questionnaires were developed. This exercise took place during the month of February 2013 from the two segments mentioned above (Students of High and Higher Education) in order to prove that there is a large number of secondary school students who do not know yet which course to choose, and that there is a large number of higher education students, who, despite having entered a course, after some time eventually changed the course thus proving that their initial expectation was wrong [1].

This paper addresses the development of decision models, in particular the stages processed to gather information to develop the model, the variables to be included in the model and the relational model to store information.

This work is divided into seven chapters: in chapter two is dealt the background that defines the scope of this work, similar services, techniques used to portray information about the target audience and also the description of the development methodology that will be used. In chapter three the problem that motivated this work is discussed and the variables studied were analyzed, in particular their explanation and association with the model and their data source. Later, in chapter four the relational model prevenient from the variables treatment is presented. Finally, in chapters five, six and seven, the results were discussed and some conclusions and future actions were drawn.

2 Background

As a starting point of this work was performed a search for some similar services and defined a methodology to support the development of the decision models process.

2.1 Similar Services

After an exhaustive survey, no system has been found with similar characteristics in terms of the decision models considered. Two online services have been found in Portugal allowing for searching courses of higher education (research) establishing a set of criteria. These services correspond to the site of the Directorate General of Higher Education (DGES) and the Office of Higher Education. In both cases the user can survey courses in higher education and filter the results by location, type of institution, field of study and the specific prove to ingress therein. Also in Portugal there are some punctual events about this thematic as is “Salão Virtual - Fórum Estudante”. This is based on an application that has as main goal the elicitation of the existing courses and some related informations.

Out of Portugal similar systems can be found. In addition, in some systems the user fills out the variables of a short questionnaire and then the best options for their profile are presented. Table 1 present the services found in association to each one of the types of service (search and form).

Table 1. Similar Services

Institution	Country	Search	Form
Empresário	México		X
Univafu	México		X
Universidades.com	Argentina	X	
UK *Course Finder*	United Kingdom	X	
Go2Uni	United States	X	
Guia do Estudante	Brazil	X	
Good Universities Guide	Australia	X	
Guia da Carreira	Brazil		X
Gabinete do Ensino Superior	Portugal	X	
DGES	Portugal	X	

2.2 Psychometric Tests

Alternative tools should also be considered, being the most common psychometric tests. Through a series of questions and mental exercises, with the help of a psychologist, the students are related to a number of areas of professions, in order to find what area they feel more adequate.

2.3 RIASEC (Holland Codes)

RIASEC characterized by a specific action within the psychometric tests are performed in a completely different way from the traditional approach, namely in terms of how the user is involved in the way the results are presented [2].

In these tests the user is faced with a number of situations where he has to indicate whether or not identify with them. At the end, the result points to the six areas of exercise: Realistic (R), Investigative (I), Artistic (A), Social (S), Enterprising (E) and Conventional (C).

2.4 Methodology for the Development of Decision Models

The development of this project was based on three of the most respected researchers in this area, Herbert A. Turban, Sharda and Simon [3]. Simon was the first to carry out extensive studies in the framework of Decision Models and established a methodology for their development. Decision models are based on changes made by Turban [4] to the model developed by Simon. Currently the model is divided into 5 stages / phases

1) Intelligence: Gathering the information inherent in the process for expectations about the answers that the model will represent.
2) Design: Drawing of the decision model, consisting of flow charts, decision trees and other tools for structuring the model.
3) Choice: Configuration of the data structure that will go in the Model.
4) Implementation: Conception of the implementation of Decision Models in a platform and the best way to present it to their users.
5) Monitoring: Monitoring of the system after its implementation [5].

3 Intelligence Phase

3.1 Problem

To understand the problem and to support the work in the context of which the study was conducted, some questionnaires were submitted among possible users of the system (both students attending high education as higher education). Two separate questionnaires were established.

The questionnaires were developed after the introduction of the first phase of C.U.R.S.O application and were based in feedback received from the users that tried the system. They were distributed and analysed through a specialized online tool for this kind of situations. The questionnaire was sent by email to all Secondary Schools and Public Higher Education Establishments of Portugal, to disclose that they make for their students. The two questionnaires yielded over 2,000 responses from various locations.

This phase was fundamental to understanding the behaviour of those who will use the Decision Model, namely analyse the feasibility of creating a platform of this nature and understand which specific variables should be used. Table 2 describes the survey sample results, i.e. the characterization of the individuals group surveyed.

Table 2. Questionnaire results

High School	
Nº of respondents	381
Sex	Male 35% Female 65%
Average age	17,2 years
Scholar Year	10^{th} – 17% 11^{th} – 20% 12^{th} –73%
Districts	18 in 20
“Do you know what area you will choose when you apply to Higher Education?”	Yes – 68% No – 29% Won’t attend – 3%
"And the course in concrete, you know what you’re going to choose to apply to Higher Education?”	Yes – 45% No – 53% Won’t attend – 2%
"Do you consider useful one (web or smartphone) tool to help you (through a series of questions) to choose(s) course(s) best suited(s) to you or to ensure that the course you'll choose is even as indicated "	Yes – 93% No – 7%

Table 2. (*continued*)

Higher School	
Nº of respondents	1699
Sex	Male 33% Female 67%
Average age	23,03 years
Scholar Cycle	1^{st} – 56% 2^{nd} – 28% 3^{rd} – 16%
Districts	20 in 20
“In your academic career, you've changed some time of course?”	No – 75% Yes – 16% No, but I tried/thought about it–9%
“Did you know that the course you 'd apply at the time of application "	18% - Do not know which course to choose and I applied depending on my average 82% - knew what course to choose in advance
"Do you consider useful one (web or smartphone) tool to help you (through a series of questions) to choose(s) course(s) best suited(s) to you or to ensure that the course you'll choose is even as indicated "	Yes – 86% No – 14%

The questions of this survey focused mainly on two points: i) if the student had difficulty finding the courses listed to put in their applications for access to Higher Education; and ii) if he known existent tools to help finding information on courses.

Analysing the results was possible identify the problem and prove the necessity to develop a tool that can support the decision process. The results show that there are a large number of secondary school students who don’t know yet which course to choose, and that there is a large number of higher education students, who despite having entered a course, after some time changed the course [1].

3.2 Data Collection

All variables represented in Decision Model are based on a comprehensive study to justify its inclusion as part of the system, i.e., to ensure the reliability of data that make up the model. It was necessary collect data from reliable and scientific sources. This point was essential to find information corresponding to each variable to be treated. Table 3 shows all the variables and corresponding data source from which the information was collected.

Table 3. Data Sources

Variable	Data Source
Admission exams	Public Guide for College Admission[1] - DGES website
High School Areas	DGES website
Scholarship assignment importance	Direção Geral de Estatísticas da Educação e Ciência (DGEEC) entitled "Inscritos no ano letivo 2011-2012 por NUTs"[2]; DGES website
City life quality importance	"Os Municípios e a qualidade de vida", dos autores José Pires Manso, António de Matos e Fátima Gonçalves no ano de 2012 (Manso & Simões, 2012)
Academic life importance	Institutional Websites of Colleges and Student Associations
Cultural life importance	Institutional Websites of Colleges and Student Associations
Sports prestige importance	Federação Académica de Desporto Universitário (FADU)
Rankings	Webometrics[3]
College courses areas	DGES website

For some of these variables, the study of their sources has led to the development of indicators allowing for responding to prescribed assumptions. Table 4 presents these indicators.

Table 4. Variables Indicators

Variable	Indicator
Scholarship assignment importance	(total of assigned scholarships / total of submitted scholarships) per establishment
City life quality importance	Association of the quality of life of municipalities index here there are establishments of higher education to the same
Academic life importance	Percentage of activities related to the academic life occurring in a particular establishment
Cultural life importance	Percentage of activities related to the cultural life occurring in a particular establishment
Sports prestige importance	(total medals won / total modalities practiced) per establishment
Rankings	Division of 5 variables for 5 distinct rankings
DGES areas	Relation with high school areas through a comprehensive analysis of curricular plans

In parallel, other study was made with the objective to cross the RIASEC codes with the DGES areas. This study was performed in cooperation between two distinct

[1] http://www.dges.mctes.pt/NR/rdonlyres/C17C6105-9379-40E9-AEF1 -470F0DEF08E6/7074 /GuiadasProvasdeIngressoPC3BAblico2013_20130520.pdf

[2] http://www.dgeec.mec.pt/np4/84

[3] www.webometrics.info

areas: information systems and psychology. As a result was possible convert the RIASEC areas into variables of vocation. Those variables also are used as input variables of the model. For example, the vocational variable Social (S) is characterized by activities and environments that involve often, preference for working with people. Involving communication and interaction with others, and the provision of services in order to help, support, educate and advice, allowing for realizing life values related, for example, to altruism, ethics and equality.

Finally, and after made this study for all the six vocational variables it was possible identify the DGES area and respective course. The use of the model and this pertinent information allow for understanding which areas / courses the students have more vocation.

3.3 Data Transformation

In this step it was necessary found the indicators that best represent each variable. It was performed a statistical analysis in order to map the variables of higher education

Table 5. Model Variables (blocks)

Id	Name	Description	Variables
1	High School	Logic component for user variables corresponding to High School	School, Conclusion Average, Studies Area, If still attending High School, Required Exams
2	College	Logic component for user variables corresponding to all College courses	Average, Duration, Regime
3	DGES Areas	Logic component for user variables corresponding to DGES Areas	All the 10 institutional areas created by DGES
4	Social	Logic component for user variables corresponding to all Social details	Scholarships, City quality of life
5	Academic	Component logic that treats all variables corresponding to the user's academic oriented responses	8 Academic Events
6	Cultural	Component logic that treats all variables corresponding to the user's cultural oriented responses	7 Cultural Entities
7	Sports	Component logic that treats all variables corresponding to the user's sports oriented responses	Sports Prestige
8	Prestige	Component logic that treats all variables corresponding to the user's responses related to prestigious establishments of Higher Education	Visibility, Impact, Opening, Excellence and Global Rankings
9	Vocational	Component logic that treats all variables corresponding to the user-oriented vocational answers	Realist, Researcher, Artistic, Social, Enterpriser, Conventional
10	Personal	Component logic that treats all corresponding to the user's personal nature responses variables	Satisfaction with High School Area, Will to study away from home

into classes. It was decided to create five classes by each group of data, instead of using a rule of Frequency Distribution, Law of Sturges [6]. This procedure was performed for all variables where it was necessary to organize variables for classes. For this it was necessary to analyse the statistical assumption based on the law of power base [7], where having a number of records can identify how many classes can be created. This process was repeated for all classes that needed to be grouped and is created using logic blocks The logical blocks corresponds to the aggregation of variables into classes by logical arguments. Table 5 shows the blocks and the variables that make up each one.

4 Design Phase

Analysing the variables that compose the Decision Model was possible to structure a relational model. This model gave origin to a database containing all the information related to Higher Education courses.

Figure 1 shows the relational model developed taking into account that the structure could be configured in various ways. This way was one of best met the objectives requirements. In this figure it is possible observe the variables grouped by tables: course, establishments, exams, users, answers and weights. In the tables it is possible observe which variables are evaluated by each group. For example, for the course it is used: name, duration, regime, cycle, DGES Area and the last three years student average classification.

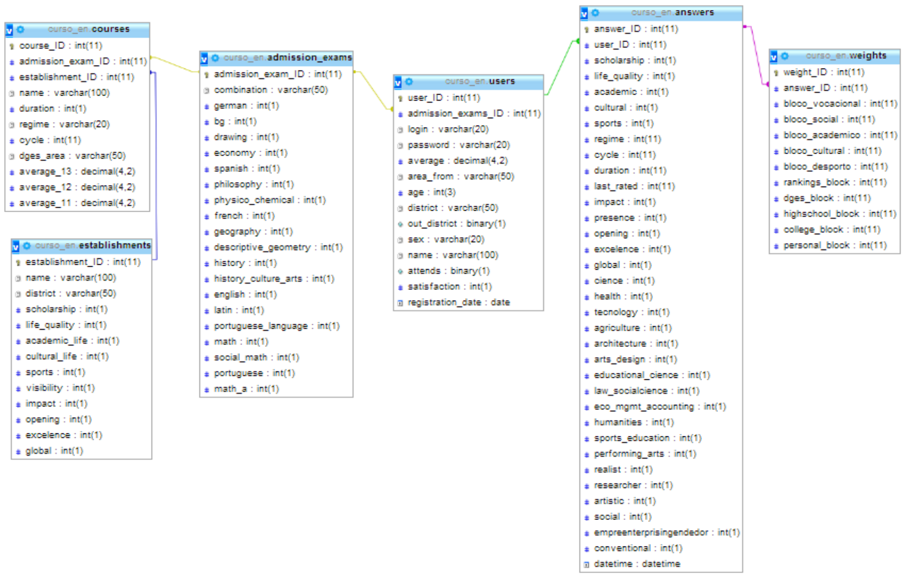

Fig. 1. Relational Model

The relational model presented, the variables and values associated will be stored into a database. Then, this model will be integrated in an Intelligent Decision Support System (IDSS). The IDSS is structured by modules composed by questions related to the variables of one of the 10 logical blocks. Additionally, the users will be able to calibrate the model according to their preferences by selecting a weight for each one of the 10 modules until make up a total of 100%

5 Discussion

The results attained by the questionnaires show the pertinence of developing a tool like this. More than 50% of students don't know which course to choose, 25% students changed the course or thought about that - due to wrong choices made during the application process and finally 93% of students recognize a tool like this useful .

This work allowed for developing a model using 10 logical blocks that contains 27 variables associated. It was possible combine a set of distinct variables and areas in analyses in order to present a complete and global tool. This tool don't give the right choice, i.e., the best course to choice but a set of possible solutions adequate to the student profile. At same time the tool don't block the possibility of students go to a different area than studied in the high school. The possibility to give weights to the answers is a benefit to the student because it allows for configuring the system.

6 Conclusion

Completed the first two phases of the decision making process with regard to the development of Decision Models procedures, can be conclude that the output achieved the main goals established, i.e. the students can use this model in order to support their university application process. The work done and the contributions can be summarized in some items:

- The model is supported on 27 variables;
- The variables were acquired using 21 evidence-based information sources;
- Variables were aggregated into a data model which contains all the information for each variables defined for all 1087 courses of 34 public higher education Portuguese establishments considered in the study;
- The Decision Models can provide endless configurations;
- Once the 10 structured logic blocks can have various weights according to the user profile, this can also remove the logical blocks to understand
- 5 dummy to test the performance of Decision Models profiles were created, i.e. this option allowed for going “manually " with each path weighted by the data model.

7 Future Work

Completed the two phases described here, it still missing presenting all the results of the RIASEC study and develop the last 3 stages in order to complete the development of Decision Models: Choice, Implementation and Monitoring.

Choice: to develop alternatives to the relational model presented in the design phase to analyse their parameters in alignment with project objectives and achieve in this way arrive at the most appropriate solution.

Implementation: to define what is the ideal solution for this stage passes to the implementation of a platform where it will be available to end-users model.

Monitoring: to ensure that the system will be operational for a few years should be designed a monitoring plan models and the respective solution, to ensure that information is updated as needed variables and that the platform has no technical problems.

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Identifying Improvement Findings in IT SMEs through an Ontological Model for CMMI-DEV v1.3

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Abstract. One of the main requirements that software development SMEs must fulfill is to adopt a standard or model quality that guarantees the quality in their products or services software. However, this kind of organization lacks of well-defined processes. In this context, implementing a model or standard quality for them represents some difficulties such as: lack of knowledge about these, its adoptions takes a prolonged learning curve, the certification of these for SMEs and their staff has high costs. Therefore, this paper presents a tool based on ontological Model of CMMI-DEV v1.3. The main objective is to provide SMEs a tool that contrast their current processes obtained through a method to extract of knowledge tacit versus ontological tool for CMMI-DEV v1.3 processes, in order to identify improvement findings to implement them in their actual organizational processes.

Keywords: CMMI-DEV. v1.3, SMEs, Ontological Model, Ontological Tool, Knowledge Extraction.

1 Introduction and Motivation

Currently, the quality of products and services software is a crucial factor to the success of any organization. According to Pino, Garcá and Piattini [1], a high percentage of companies that generate income sources in the software development industry, are the so-called Small and Medium Enterprises (SMEs). These kinds of organizations have realized the need to implement software process improvements that allow to improve the quality of generated products and services software [2]. Due to the product quality is heavily influenced by the quality of the software processes associated. However, an aspect in common between these kinds of organizations is the lack of well defined processes. Therefore, its environment work is chaotic and constantly changing [2].

A solution in this kind of organizations is the adoption of a standard or model quality. However, this implies some obstacles for these organizations, such as: the adoption of a standard or model represents a prolonged learning curve, the

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certifications of these models or standards in SME's have high costs. Therefore, for SME's represents a barrier difficult to overtake, this joined to resistance to change, as mentioned studies done by Muñoz and Mejía [2], and by Santos and Montoni [3].

Therefore, the main objective is to provide to the SMEs a tool that efficiently allows them to contrast their current development processes and activities, towards the Capability Maturity Model Integration for Development (CMMI-DEV v1.3) and to identify improvement findings and therefore to implement them in their actual organizational processes.

The paper's structure is divided as follows: section two describes the development of the CMMI-DEV v1.3 ontology; section three describes the tool based on the ontological model of CMMI-DEV v1.3; section four is addressed the extraction of the organization's tacit knowledge, section five is showed the ontological tool; section six presents the case study, and; section seven defines the conclusions and future work.

2 Framework Ontology CMMI-DEV v1.3

In this section, before presenting the ontological tool, it is shown the construction of the ontology for the CMMI-DEV v1.3 model. To understand the development of the ontological model, this section is divided in four main phases: 1) Understanding of CMMI-DEV v1.3 Model; 2) previous studies analysis; 3) the proposed tool and, 4) the result obtained from the ontological tool.

2.1 CMMI-DEV v1.3 Model

CMMI-DEV is a reference model which aims to help organizations improve their development and maintenance processes for both products and services. It provides an integrated approach for developing their activities as part of achieving their business objectives. Moreover, CMMI provides best practices that address development and maintenance activities applied to products and services covering the product’s lifecycle practices from conception through delivery and maintenance [4,12].

CMMI-DEV supports two types of representations the continuous and staged representations: 1) the staged representation utilizes maturity levels to improve a set of related processes predefined by the model and 2) the continuous representation utilizes capability levels to improve an individual process area selected by the organization.

The CMMI-DEV v1.3 plays various roles [4, 5] a process improvement approach; a way to describe the characteristics of effective processes; a collection of the essential elements of effective processes for one or more bodies of knowledge; a process capability maturity model which aids in the definition and understanding of an organization’s processes. Besides, this model allows to evaluate the organizations' software processes maturity [4, 5, 6] and integrates a complex structure that requires a thorough study [7].

As mentioned by Soydan [7] one of the main problems to develop a CMMI-DEV v1.3 ontological model is that it should be considered that there are several ways for a company to achieve a quality level, thus it cannot be handled a fixed level inference, on the contrary, it should be considered the possible variants that can occur when introducing the information. Therefore, the CMMI-DEV v1.3 Structure was analyzed (see Figure 1) from its official bibliographic.

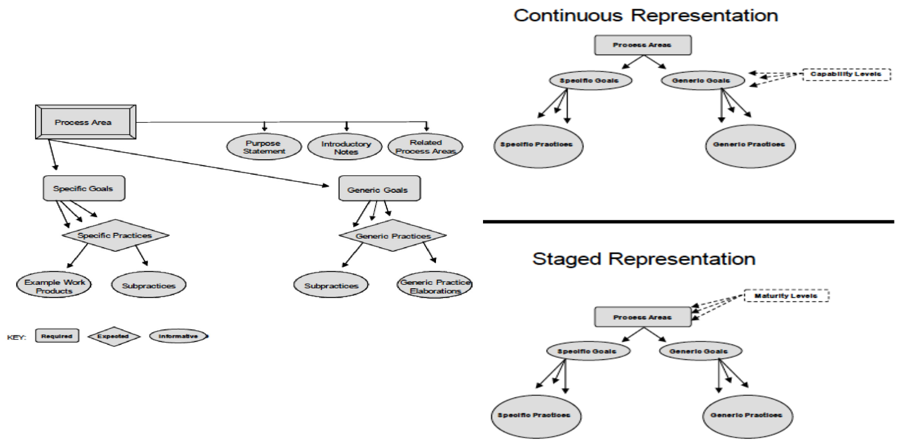

Fig. 1. CMMI-DEV v1.3'Structure and Representation

2.2 Previous Studies

The second phase allows to analyze several researches about the development of an ontology for the model in order to establish the ontological model [7-10].

The main difference established on this analysis is that the detected previous studies for the construction of the ontology for the CMMI-DEV v1.3 model are focused to industry and development organizations in general, while this research must specially focuses in organizations cataloged as SME's. Another important difference is that the application of his ontology does not use the processes established with the organization's tacit knowledge extraction method (Muñoz, Mejía, 2013).

Another research analyzed is of Rodriguez [10]. This author describes how software process ontologies can be derived from software and systems process engineering metamodel (SPEM). SPEM formalizes the way of representing software engineering processes in relation to both their static and dynamic concepts (activities, roles, tasks and work products). The authors include rules for considering reasoning and logics.

2.3 Tool Proposal Based on the CMMI-DEV V1.3 Ontological Model

In order to establish the main structure and its components to ontological model from the official bibliography of CMMI-DEV V1.3 was adopted a methodology based on continuous improvement for the development of ontologies proposed by

Muñoz et al. [11]. It consists of a sequence of stages related to the Plan, Do, Check/Study and Act Cycle (PDCA or PDSA). Once the methodology was adapted, it was defined the viable ontological model with its main elements and relations through the taxonomic structure shown on Figure 2.

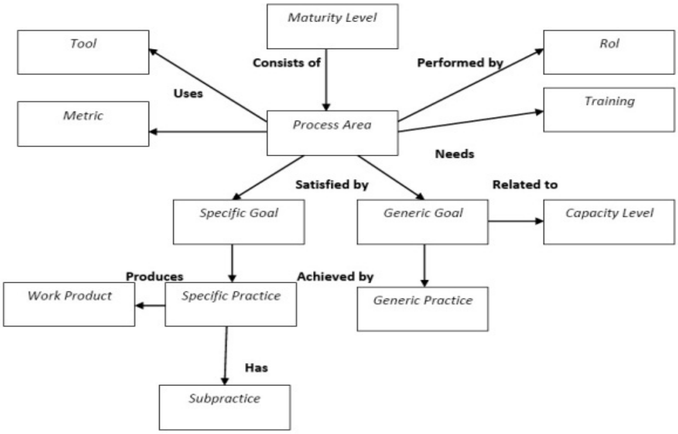

Fig. 2. Taxonomic model of the CMMI-DEV v1.3

2.4 CMMI-DEV V1.3 Ontological Model

Once the taxonomic model is established, in the third phase, it was made an ontological model using the tool Protégé v4.1 based on the ontological language (OWL 2), API [7, 8]. With this objective based on the knowledge of the analysis of previous researches about this topic [7], it was developed a base ontology that includes classes, relations and restrictions conforming the CMMI-DEV v.1.3 model. As a result, the ontological model classes are show in Figure 3:

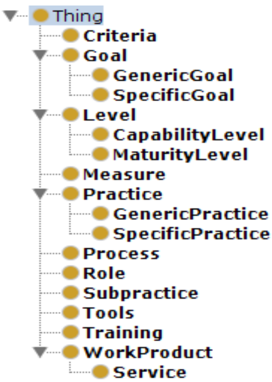

Fig. 3. CMMI-Dev V1.3 Ontology Classes generated in Protégé

3 Ontological Application Constructions

After the taxonomy, relations and principal elements had been defined to the ontological model according to CMMI-DEV v1.3 model structure, the next activity was to develop a tool based on this ontology. For the development of the ontology it was used the Ontological Web Language 2 (OWL2) [8], for the graphic interface it was used the Java programming language. The tool allows to introduce the detected information generated with the tacit knowledge extraction method [2]. As a result, the tool allows to get what elements of the model are meet, what elements are missing in the process according to the CMMI-DEV v1.3 model, enabling the user to detect possible improvements in the organization's processes. Figure 4 shows the main window of the ontological tool.

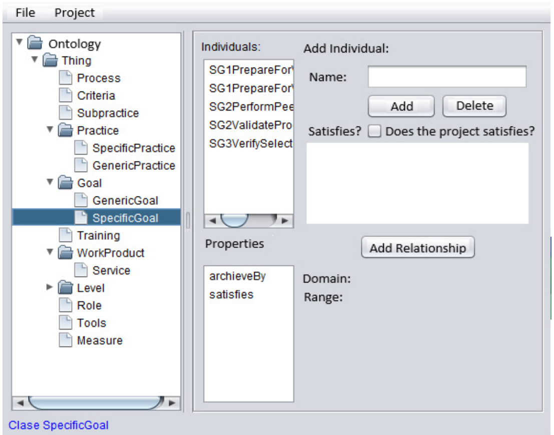

Fig. 4. Software tool created based on the CMMI-DEV v1.3 ontology

Among other features, the tool allows to load existing ontologies and to analyze relations between the distinct elements.

4 Method for Tacit Knowledge Extraction

Before using the tool based on the CMMI-DEV v1.3 ontological model, described in the previous section, it is required to get information of the current processes performed in an organization.

In this section, it is presented the method used for the extraction of tacit knowledge [2]. The method allows to obtain the knowledge about the organization's environment work and its processes that are performed, even when there is no a formal documentation of the activities carried out for software development. The main activities of the method are: Identification of Internal practices, Information analysis, Dictionary of terms and, Process and activities traceability. Next, a description of each activity is described.

4.1 Identification of Internal Practices

To carry out this activity a questionnaire based on the CMMI-DEV v1.3 model is applied, obtaining the information in respect to it. The questionnaire is applied to the three command levels implicated on the organizational structure of a SME, these are: el managerial control, projects development control and the operational control, the developers team.

In order to apply the questionnaire, interviews with the involved people of each control level of the organization, and the audio is recorded for its posterior analysis.

The questionnaire is divided into nine blocks that contain a set of questions, each block covers several processes from CMMI-Dev v1.3. The blocks that make the interview are:: Project Planning, Project Tracking, Risk Identification, Project Requisites, Customer Satisfaction, Providers Management, Development Team Training, Quality Control, and Configuration Management.

4.2 Information Analysis

After the application of the questionnaire to the organization different control levels, the answers of each one of the interviewed, recorded on audio, are analyzed. In each case, the information of each block is organized describing the detected activities according to the questionnaire block that references a process area. With the information gathered, a chart is made to visualize each process, described and detailed.

4.3 Dictionary of Terms

When there does not exist a formal process within the organization and the criteria are not standardized, each of the interviewed uses different terminology, therefore its necessary to establish a dictionary of terms for each actor, including all the language the interviewed uses, this will serve to clarify possible misunderstandings when defining the processes.

4.4 Activities and Processes Traceability

In this activity, each described process is joined with similar ones, the answers, process' elements and charts are compared to obtain a general process. This way is established the activities in common that according to each interviewed are performed. Thus the consolidation of the tacit knowledge is consolidated for each command level within the organization. With the criteria correctly traced, the next activity consists in making a description of the common elements and creates a diagram of the obtained process based on the matching activities. This allows the visualization of the tacit knowledge about the task that are performed in the organization (Refer to Figure 4).

4.5 Mapping of the Process towards CMMI-DEV v1.3

The general process and the detected elements are mapped towards a review list of the elements that make up a process according to CMMI-DEV v1.3, then the process is formalized and the elements are ready to be entered in the ontology.

5 Application of the Tool Based on the CMMI-DEV v1.3 Ontology to the Organization's Processes

When the processes current situation has been established, and the activities and elements that make these processes have been identified through the analysis of the extraction of the organization's tacit knowledge, all the information is entered into the tool to evaluate the maturity of the processes in respect the CMMI-DEV V1.3 model processes.

With the information of the organization's processes entered though the tool interface, the implemented reasoners start to make inferences, and finally show in screen the processes that are being met, the missing activities and the maturity level in which the organization is in respect to CMMI-DEV v1.3. With these results, possible improvement findings are detected to be implemented on the organization.

6 Case Study

In order to put into practice the ontological tool proposed on this research, a case study was performed on the Development Center of Polytechnic University of Zacatecas (CDS-UPZ), México,

After obtaining all the current processes' information through the method described in section four (see Figure 5), the ontological tool was executed and the obtained information.

The reasoners were run and according to the processes that are being carried out, the tool gave the result that the organization is still on level one or initial level of CMMI-DEV v1.3. Also, it was detected which elements and activities are not being fulfilled, this allows to know that even though the organization is on the starting level, it can improve its processes to meet the required quality of the current market.

These improvement findings are the result of evaluating the processes obtained using the knowledge extraction method through the ontological tool. The lack of activities in the processes of planning, training, and others was detected. Overall, the improvement findings are:

- Lack of well defined processes.
- Overestimation in projects planning.
- Lack of specific roles.
- Lack of a training plan for the development team.
- Lack of a formal software development methodology.

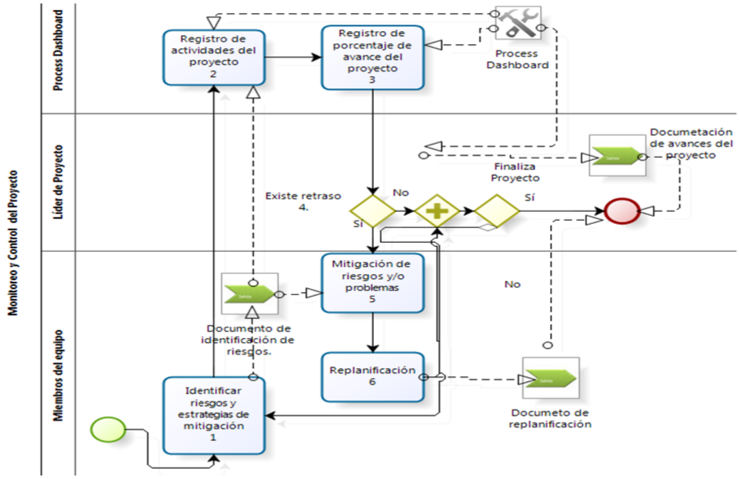

Fig. 5. Example of general process obtained from the knowledge extraction method

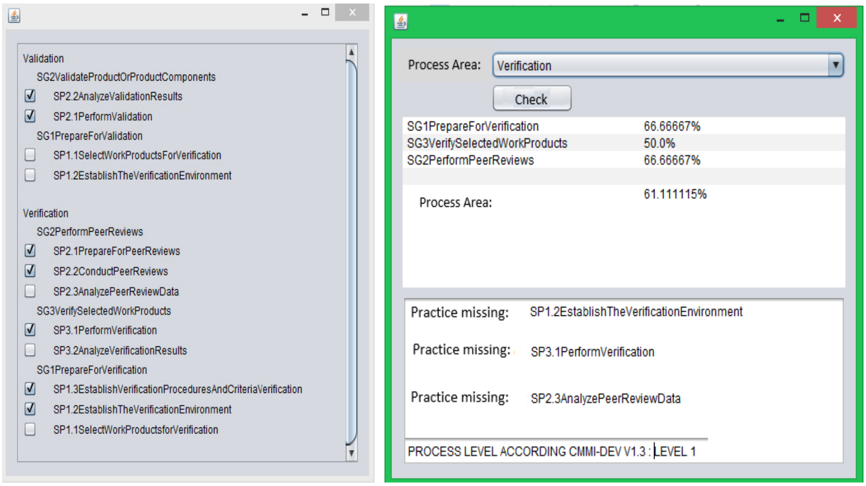

Fig. 6. Proposed software tool based on the ontological model of CMMI-Dev V1.3

Figure 5 shows how after introducing the activities and elements of the general process obtained in the organization's tacit knowledge extraction in the tool through its reasoners calculates the percentage of the organization's processes respect to the process areas established on the CMMI-DEV V1.3 ontology. It also shows the missing activities to satisfy the model and the process level according to CMMI-DEV V1.3., this is performed for each process area and at the end an overall evaluation final is established for the entire organization's process.

7 Conclusions and Future Work

Through the execution of the tacit knowledge extraction method and with the help of the ontological tool based on CMMI-DEV v1.3 it achieves to detect improvement findings on organizations such as SMEs. This proposed ontological tool allows to identify findings to improve the current processes in a SME. Therefore, the proposed tool represents an opportunity to identify findings. Also, in the case study, the implementation of the tool allowed to detect the level according to CMMI-DEV v1.3 model.

As future work it is pretended to apply the proposed solutions in CDS-UPZ, in order to observer the effectiveness and performance of proposed tool. Moreover, it is proposed to use the tool in other organizations and extend the tool to other Ontological model. Also, it will be developing the automation of the knowledge extraction method, since it is fundamental to the establishment of the processes to be compared on the ontological tool.

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The Motivations for Campus Portals Adoption in Saudi Government Universities

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Abstract. In Saudi Arabia, due to the solidity of the economic sector, the government has come up with a long plan to support the portalisation in many public and private organisations to improve the effectiveness and efficiency of administrative processes, improving support for decision making, eliminating bureaucracy, and improving quality of services whilst reducing operational costs. Many universities in Saudi Arabia have advocated to this trend in developing their campus portals (CPs). However, the literature is still missed out the exploration of different motivation factors for CPs adoption in Saudi universities. This empirical qualitative research revealed eight different motivation factors for CPs adoption in Saudi universities including: organisational, technological, educational, user expectations, geographic and administrative motivation, economic and environmental factors. While the results of this study can address the gap in knowledge in this regards, it is thought that the outcome of this research can also provide the decision makers in Saudi universities with better understanding of the issues surrounding CPs adoption.

Keywords: Adoption, Campus Portals, Web portals, Portalisation, University, Saudi Arabia.

1 Introduction

Enterprise Information Portals (EIPs), or institutional portals, have become a trend in organisations. EIPs are seen as technologies that can solve various business problems by improving access to services and information, providing systems integration, offering personalisation and customisation, and improving communication. Campus Portals (CPs) have gained significant importance in recent years and have attracted the attention of many universities worldwide [1-4]. For example, Klein [3] studied forty five universities in the UK and found that all have developed or were developing portals. Similar findings about the USA and Canada were reported by Li and Wood [4]. All of these studies reflect the greatly increased interest in portal technology in the academic environment. Portals offer universities several advantages. First, in the

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complex information environment of universities, portals can help organise and provide information, delivering campus services from various sources and systems in ways personalised and customised to various groups of users in a cost-effective way [5]. Second, by utilising modern portal technologies, universities are able to meet the rising expectations of the academic community [5]. Third, portals offer systems integration. Universities have been implementing different systems. The growth of these systems has resulted in the emergence of software islands that have little or no connection with each other and which have created several challenges for universities to handle daily base business [5-7].

In previous studies, the interest in the adoption of CPs was driven by different means and motivation factors. This is because that the adoption of information systems (IS) in organisations is a complex and challenging task since the variety of potential scenarios for the adoption process at the organisational level is so great that no single, strongly predictive, theory of IS adoption is likely to emerge [8-9]. For example, Bouwman et al. [10] propose a framework and claim that such factors can be related to the organisational, the technological, the economic and the user perspectives. Tornatzky and Fleischer [11] developed the Technology-Organization-Environment framework to study the adoption of a technology in organisations. This framework explained that an organisation's technology adoption process can be jointly explained by three comprehensive constructs including the technological, organisational and environmental factors. However, many researchers on the IS adoption suggested the researchers to focus on specific technologies and contexts rather than focusing on a single theory. The researchers were therefore also recommended to either abandon or integrate the traditional theories of technology adoption with such new approaches to fit the complex scenarios of the adoption process at organisational level [8-9].

In this research, the authors followed this strategy, and so, the focus of this research is on the adoption of CPs in Saudi government universities and the study of the motivation factors based on the implementers' perspectives (portal team). In Saudi Arabia, many government universities have responded to the trend of the government towards to the idea of portalisation. However, the previous studies exposed that the literature still lack a significant body of evidence to the different motivation factors to the adoption of CPs in Saudi universities. The purpose of this study is to investigate into the different motivation factors to the adoption of CPs in Saudi universities from the implementers' perspectives. In doing so; the remainder of the paper is structured as follows. The next two sections give a background to information and communication technology (ICT) and the higher education system in Saudi Arabia. Afterwards, the research methodology is explained. Later, the key results are highlighted and discussed. The authors conclude through some issues raised by the study and such recommendations for further study.

2 ICT in Saudi Arabia

In today's modern societies, ICT plays a key role in national development and contributes to the wider economy. Saudi Arabia has paid particular attention to this issue, and ICTs have become a crucial component in the national and strategic plans for the country. In 2003 a royal decree was issued to change the name of the Ministry of Posts, Telegraphs and Telephones to The Ministry of Communications and Information Technology. The establishment of MCIT was to monitor and control ICT services and regulations and to construct future plans for ICTs. The Saudi ICT market is one of the strongest in the Arabic world, and is growing rapidly. For example, a report by Business Monitor International [12] revealed that the total ICT market was $3.6bn in 2011 and expected to rise to $4.9bn by 2014. An examination of The Annual Report of the National Plan for Information and Communication Technology [13] revealed that ICT plays a key role in the nation's development and it has become important on the Government agendas for the long-term improvement of many public sector organisations such as education, industry, services, health, economic and other areas. The key technologies that are widespread across the country include: the Internet and mobile communications. One main reason behind this growth of internet users in Saudi Arabia is the widespread use of e-services applications such as internet banking, e-commerce transactions and the transformation towards the adoption and implementation of e-government initiatives [14]. There is also a general trend in Saudi Arabia towards to the idea of portalisation in many public and private organisations, such examples including Saudi eGovernment National Portal, The Portal of the Ministry of Interior and Portal of the Ministry of Higher Education [15].

3 The Higher Education System in Saudi Arabia

The Ministry of Higher Education was established by royal decree in 1975. It is the main governing body responsible for planning, organising and managing higher education strategies and policies. The ministry is a large and complex organisation, with twenty-three public universities, eight private universities and eighteen community colleges and institutions. The higher education system tends to be centralised and highly structured. The major elements include: the ministry of higher education, the council of higher education, and higher education institutions including universities and colleges. The Council of Higher Education is the major governing body for all higher education institutions. It is responsible for the establishment of new higher education institutions, departments, units and programs. Furthermore, it coordinates the activities and tasks of higher education institutions, approves regulations and rules for universities operations, and appoints vice rectors of universities [16]. The Minister chairs the board of each university and is responsible for monitoring the implementation of the state education policy [17]. In recent years, higher education has undergone through tremendous changes and developments, including the establishment of many new universities, improving the quality and outcome of teaching and learning, supporting research projects and programs and the investment in many ICT projects. During the last few years, for example, the ministry of higher education and many universities have witnessed the deployment and development of various ICT projects such as The Ministry of Higher Education Portal and The National Centre for e-learning and Distance Learning (NCEDL).

4 Research Methodology

An interpretive qualitative approach was adopted in this study to investigate the motivations for CPs adoption in Saudi government universities, from the implementers' perspectives. A multiple-case study methodology was conducted as it allows researchers based in qualitative data to examine in depth a complex phenomenon in its natural setting and to investigate an area in which few previous studies have been conducted [18-19]. According to Yin [20], case study takes advantage of previous developments of theoretical frameworks that help to guide data collection and analysis. An important element in case study research is the site selection. Site selection should be considered carefully and the research topic is a key issue in this process [21]. In this regards, three government universities in Saudi Arabia have been chosen to carry out this study. The rationale behind choosing these universities is as follows. First, these universities are the leading educational organisations and are highly regarded in the country. They claim that they have invested a large amount of money in developing ICT to support teaching and research. Furthermore, within these institutions, there is a great desire to establish and develop Web Based Information Systems (WBIS). Finally, the universities offered the researchers an opportunity to access and collect data that will be helpful for this study. To respect the promise of anonymity, the researcher cannot name the universities studied, instead, they are referred to here as University A, University B, and University C.

4.1 Participants

In this research, the implementers are concerned with the people who are involved in the process of adopting, implementing and developing CPs at the universities studied. A total of 9 participants have been interviewed in this study, as shown in Table 1. Portal implementers are elite individuals who are involved directly with portal implementations. They are the key actors in the process.

Table 1. Information regarding the participants and their organisational position

University	Role of the Participants	Referred As
A	Portal Project Manager	Participant A1
	Vice President of Portal Department	Participant A2
	Webmaster	Participant A3
B	Portal Project Manager	Participant B1
	Portal Designer	Participant B2
	System Analyst	Participant B3
C	Portal Project Manager	Participant C1
	Portal Designer	Participant C2
	Manager of Information System Department	Participant C3

4.2 Data Collection

The semi-structured interviews and documents analysis were used to collect the empirical evidence from the case universities. Interviews and documentation are the most widely used qualitative methods in case study research [20]. Through interview method, the researcher can best access the interpretations that interviewees have regarding the phenomenon under research, and the views as aspirations of themselves and other interviewees. Documents also contain public and private records and data that researchers gain about settings or informants in a study [22]. The data collection methods and field works journey were arranged early in 2010 from January to April. Using a digital Dictaphone, the participants were interviewed in person face-to-face to allow the implementers to give feedback and tell their unique story relating to the motivation towards the adoption of CPs in their universities and to allow the researchers to ask probing and follow-up questions. The participants also provided the authors with some documents with regards to the adoption and implementation of CPs in their universities. The collected documents were organised according to the organisation name, and given codes, for example (DOC3D) Document 3 from University D.

4.3 Data Analysis

Unlike quantitative analysis, there are no particular, established rules, procedures or methods for analysing qualitative data. However, there are some general approaches and strategies, and most notably the coding process [23]. The common aspect among those researchers is the fact that data analysis in qualitative research aims to prepare, reduce, summarise and organise the data through coding and categorising which will result in the identification of themes and representing them in tables, figures, charts and other representation methods [24]. The researchers have developed indexing and classification methods so that data can be retrieved easily and quickly. For example, each interview was recorded and then transcribed using Microsoft Word Software, and saved in folders according to university name. In the analysis process, the main focal point is on texts as a source of data. In order to understand the text analogues, the researchers engage in a dialogical action with the text analogues and use explanatory principles and their prior knowledge and experience of the topic to understand what is said, read and written and to provide an interpretation of textual materials. The researchers followed the technique developed by Patterson and Williams [25] to analyse the textual materials. Each interview was analysed individually (idiographic level) through reading the text to identify the individual meaning units and significant statements, so that an understanding of the text could be achieved. The meaning units are the "actual statements from the interview and they represent the hard data or evidence" [25]. Then, the researchers did cross-interview analysis (nomothetic level), so that a whole understanding could be developed. This has resulted in generating a thematic representation (thematic labels) of the individuals' perspectives, which "represent the researcher's analysis concerning what the meaning units reveal regarding the phenomenon being studied" [25].

5 Findings and Discussion

This section reports the findings of the study which are interpreted and discussed in the light of the literature and related work. The results revealed that different motivations have contributed to the adoption of CPs in Saudi universities. As shown in Table 2, these motivations include: organisational, technological, educational, economic, environmental, geographic and administrative motivation as well as user expectations. Many researchers have identified why organisations including universities are interested in portal technology [4,7,26-28]. These include: improved access to information, cost reduction, improved efficiency, improved customer service, development of new systems, increased ROI, systems integration, and improved communication and collaboration.

Table 2. Motivation for investing in CPs (Saudi Universities)

Motivation	Example
Organisational	Improving access to information and services. Improving communication.
Technological	Systems integration. SSO.
Educational	Supporting the educational process by providing key applications for learning: Blackboard and WebCT.
User Expectations	Role-based services and resources. SSO access.
Geographic	Overcoming geographic barriers. Providing users with remote access.
Administrative	Improve administrative processes. Deploy e-services.
Environmental	Compete with other universities.
Economic	Cost reduction. Increase ROI. Reduce assets deployed.

5.1 Organisational Motivation

What can be noticed from the participants' responses is the fact that the institutional change that the universities are currently facing requires changes and development in the way the business is conducted. The overall organisational motivation for developing a CP was to improve access to information and services, and to improve communication. Most of the participants consider the portal technology to be a great solution to providing instant access to services, resources and information from anywhere at anytime. The participants reported that the university has a great amount of information, services and resources which are located around the campus means that they require a system that combines them all in one place, as one mentioned that: *"Our university has a tremendous amount of information and data which were scattered and spread over a wide range of places and locations… and bringing these data and information together was a top priority*" (Participant C1). Improving communication within the university and among its members was another organisational motivation for CP development. The technology is seen by many participants as an excellent mechanism for communication by using communication channels such as emails, SMS messages, and online forums. The findings exposed that improving and simplifying the access to services and information and improving communication within universities were common issues. This agrees with findings from other research [7]. Although this can be done via a simple website or an intranet, a portal can do it in more effective and productive ways by providing a SSO access and a personalised view of the campus services and information [27].

5.2 Technical Motivation

Systems integration was a major issue for all universities studied with portal technology seen as a way to integrate different systems and to unify and simplify access to these systems. Access to these systems required sometimes different usernames and passwords, so that a user could have 5 or 10 accounts. This has many issues for the universities such as the difficulties in managing user profiles and raising a security issue by giving users many accounts. Overcoming these issues by integrating these systems within the portal was a priority for the universities, as one of the interviewees pointed out that: *"We had many applications and unifying the access to these applications was an important issue for us… By developing a portal, we managed to apply the concept of SSO to different systems with only one user name and password"* (Participant C2). Systems integration was evident in many project documents. For example, in University B, it was found that a main benefit of the portal was the integration of different systems and applications in one place (DOC2B). In University C it was found that integration among academics, students, staff, research and administrative functions is vital for decision making and user satisfaction in an academic environment (DOC1C and DOC8C). This conclusion is consistent with prior studies reporting that systems integration and SSO were main reasons for portal deployment [7,29]. For example, Bajec [7] argued that portals present an opportunity for universities to transform themselves more effectively, without first having to throw all the legacy systems away, by integrating these systems in one place.

5.3 Educational Motivation

It is not surprising that educational motivation was one of the most important reasons for developing CPs, as universities are places for learning and education. Technology is seen as an enabler to support learning and education. According to the findings, the educational motivations for adopting a CP are providing students and academics with a SSO gateway to access different systems, providing communication channels such as the email system, forums, and SMS; and offering students and academics a collaborative educational environment. The documents showed that a portal provides individuals with access to a learning environment in which they can interact and collaborate in a seamless and personalised way, and which provides them with a valuable and enriched educational experience (DOC2A and DOC1C). However, the findings suggest that the portal only provides links to learning tools such as Blackboard and WebCT, and the universities have not yet exploited portals to the full capacity to support learning and education. In the educational atmosphere of the early twenty-first century, new opportunities and promises of technology for teaching and learning have become widespread [30]. The use of CPs such as Moodle and Blackboard for educational purposes has been well established in the literature. These technologies provide a new operating environment for teaching and learning. These tools help universities to support learning and educational activities such as access to course learning resources, assignment submission, creation of discussion forums, files download and sharing, online quiz instant messages, online calendar, grading, online announcement and news, Wiki and blogs [32- 33]. Portal technology is seen as a tool that can support the educational process by providing students, faculty and staff access to various key applications for learning, teaching and research. However, it seems that the universities in Saudi Arabia only use the portals for providing access to learning tools, resources and applications, and have not yet exploited them fully and effectively. For example, the collaborative and interactive sides have not been implemented as they should be.

5.4 User Expectations

According to the results, users' expectations were one of the most important motivations for adopting CPs. Users in the universities studied have different roles: students, academics and staff. The nature of each group is different from the others; therefore, each requires different resources and services. The findings revealed that users want to have a unique identity with only one user name and password, and they want to deal with a single interface. The following participant suggested that the University has a large number of people with different roles and responsibilities, who would therefore expect a role-based service. He mentioned that: *"We have a large population of faculty, staff and students and we know that their roles are different. We wanted to deliver all the information based on their roles in one screen"* (Participant C1). Another participant expressed a similar view and claimed that users would expect a SSO access and there were particular requests for that: *"With the portal, users only have one username and password that allows them to get access to different systems and applications via a SSO. We have seen demands for this feature"* (Participant C3). This finding suggests that users would expect universities to invest in ICT and deploy cutting edge technology. This agrees with findings of Cobb et al [31] who reported that meeting the rapid increase in customer expectation was a main objective for portal development.

5.5 Geographic Motivation

The main issue here was to overcome the geographical barrier and to provide users with remote access to WBIS and services. It was found that all the universities studied have other campuses and branches around the country, and that portal technology can overcome the geographical barrier to transmit information and deliver services. The vice president of the portal department stated that: *"Our university is a large organisation and we operate in different campuses, therefore, it is important to provide access to information and services to all university members"* (Participant A2). Another issue was to bring the university services and resources to users without the need to physically come to the university. The manager of the information systems department commented on this issue when he said: *"We have some students and staff who do not live in the same city, and sometimes do not have to come to the University. If they want to access the University's services, they can do so by logging into the portal without the need to visit the university to get their business done*" (Participant C3). The portal has proven to be a valuable technology in overcoming geographic barriers, especially when distributing campus information.

5.6 Administrative Motivation

A major motivation for CP adoption and implementation was to establish the concept of paperless office, e-enterprise and the digital campus. The technology was seen to help to improve effectiveness of administrative processes, improve support for decision making, eliminate bureaucracy and simplify procedures, and to deploy the concept of online services. One of the participants mentioned that: *"We wanted to develop some aspects of the administrative processes… The portal has streamlined processes effectively and improved access to information"* (Participant C1). An examination of some project documents revealed that CPs have great potential to streamline and facilitate administrative processes. Part of these benefits is to put forms online, apply the concept of e-services, and simplify several processes through the implementation of workflow applications (DOC1A,DOC2B,DOC5C). It can be said that the portal technology is a great tool to handle different administrative processes that are related to students, academics and staff. It is seen as an excellent alternative to the traditional methods such as improving the effectiveness and efficiency of administrative processes, improving support for decision making, eliminating or at least reducing bureaucracy administrative processes in Saudi universities, and improving quality of services. This issue is unique to this study and has not been discussed or reported in the previous literature. A report by Business Monitor International [12] has revealed that Saudi organisations are spending hundreds of millions of dollars each year on e-administration applications, as government organisations become more aware of the potential benefits and efficiencies from applying ICT.

5.7 Environmental Motivation

The findings showed that competition between universities influences the decision to adopt a CP. This can be regarded as an environmental motivation. Many participants mentioned that portals have become commonplace in universities and are a key technology. Furthermore, most of the participants acknowledged the fact that CPs have attracted attention as they are considered to be a source of competitive advantage. The findings suggested that competitive pressures affect the implementation of CPs. Some participants stated that portals have found their way into universities worldwide and they have to respond to this trend. This issue was evident in many documents. For example, the Universities implemented the portal because they wanted to keep abreast of recent developments in ICT in the academic environment locally and internationally and to adopt and implement new innovations (DOC5A,DOC8C). The findings showed that competition between universities influenced the decision to adopt CPs. This motivation factor is consistent with the literature showing that CPs have become commonplace in universities [2-4].

5.8 Economic Motivation

The findings showed that the universities studied perceived many economic and financial benefits associated with portal adoption. These benefits include: cost reductions, increased ROI, and reduced assets deployed. Many interviewees agreed that a portal technology is a great solution for saving universities money and cutting costs. One of the participants described this issue as follows: *"We did a business case and evaluated how much money the portal would save us. After the portal went live, we saw many benefits, including reduced printing and distribution costs, cuts in communication costs and decreases in the cost of finding information"* (Participant A1). Furthermore, in University C, it was found that there are several financial benefits for the project such as reduced assets deployed, improved cash flow, reduced staff costs, reduce transactional cost and increased stakeholder value (DOC6C). The economic aspect of ICT is mainly concerned with benefits and costs [10]. The findings showed that there are many economic and financial benefits that are associated with portal adoption. These include: increased ROI, reduced costs and increased savings. However, since the universities in Saudi Arabia have implemented portals during the last few years, it is difficult to claim that the ROI has been achieved.

6 Conclusion

This study attempted to investigate into the different motivation factors influencing the adoption and implementation of CPs in Saudi government universities. The literature exposed that there is little known towards the trend of portalisation in Saudi universities. In doing so, three universities were investigated and different data collection methods were used included semi-structured interviews with three implementers (portal team) in each case, and documents analysis to examine those motivation factors. The results explained eight main motivation factors to the adoption of CPs in Saudi universities; these include organisational, technological, educational, user expectations, geographic and administrative motivation, economic and environmental factors. These issues should be considered when universities contemplate a campus portal. The contribution of this study addresses the gap in knowledge which missed out the exploration of the motivation in Saudi government universities towards the adoption of CPs, and also allows others to relate their views to those motivation factors reported herein. It also enables the decision makers in Saudi universities with better understanding for more effective strategy and interventions for the adoption of CPs. However, some limitations in this study are worth noting. For example, the participants of this study is the implementers and so there is also a need to examine the motivation factors from the users' perspectives, such users are academics, students, staff and researchers. This will bring up a complementary and holistic framework of the motivation factors. Although a qualitative framework was seen an appropriate than a quantitative one, the results from the qualitative data were difficult to generalise to other populations. This requires further examination by employing quantitative studies based on the findings and widening the cases to include all the universities in Saudi Arabia including the private and government ones.

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A Review of Security Risk Assessment Methods in Cloud Computing

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Abstract. The Cloud computing is a major technological trend that continues to evolve and flourish. It has potential benefits in achieving rapid and scalable resource provisioning capabilities as well as resource sharing. However, a number of security risk are emerging in association with cloud usage that need to be assessed before cloud computing is adopted. This paper presents a review of the security risk assessment methods in cloud computing. The paper aims to summarize, organize and classify the information available in the literature to identify any gaps in current research then suggest areas for further investigation. At the end, the paper suggests to have a collaborative security risk assessment method that will add great assistance to both service providers and consumers.

Keywords: Cloud computing security, security risk, risk analysis, risk assessment, threat analysis.

1 Introduction

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction [16]. Cloud offers an optimized and efficient computing by enhancing collaboration, agility, scalability, availability, and cost reduction.

Although cloud computing has a considerable benefits over traditional computing models, yet it raises severe security concerns that limit its widespread adoption; loss of governance, lock-in, isolation failure, data protection and insecure data deletion are some examples. While creating a zero risk service is impractical, if not impossible, assessing security risk of cloud based solutions is important to establish trust and to increase the level of confidence of cloud service consumers. Moreover, it provides cost effectiveness, reliable service and infrastructure of cloud providers [4].

Generally, security risk assessment is an assessment aimed at examining possible threats and vulnerabilities as well as the likelihood and impact of them in accordance with the external and internal relative technology standards. By considering the essential cloud characteristics such as the on demand self-service and rapid elasticity, the traditional assessments developed for conventional IT environments do not readily

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fit the dynamic nature of clouds. Hence, the introduction of cloud specific security assessment methodology has significant importance and scope. Recently, several studies have been conducted to improve traditional security assessment techniques and present new paradigms for analyzing and evaluating security risks within cloud environment.

However, security assessment in cloud is still challenging domain and a growing area of research. Identifying security risks that cloud consumers encounter is a complex task [18]. Cloud computing is a multilayered environment that mainly encompasses deployment model layer, followed by delivery model layer. Each of these fundamental layers poses a specific set of security risks that are inherited through the layers. Therefore, different combinations of deployment models and the utilized delivery models have different security risks that must be addressed and considered.

A lack of security standards and security control transparency present further challenges in cloud risk assessment. Security standards are important to measure security risks of cloud providers. Hence, security assessment can't give information unless it is compared with standard [3]. In addition, the lack of transparency is because the cloud providers usually do not want to reveal their own infrastructure to consumers for monitoring or risk assessment, as this will likely lead to reduced confidence in cloud services due to the uncertainties associated with the quality and level of security implementation. By considering the above challenges, how can we assess security risks of adopting cloud services? What are the methodologies and how effective are they? To answer the above questions, this paper presents a review of security risk assessment methods in cloud computing, classify them and compare their process in order to identify the gaps in current research then suggest areas for further investigation. The reminder of this paper is organized as follows: Section 2 presents a literature review of security risk assessment in cloud. In Section 3, we describe the method we adopted to carry out the review. Section 4 discusses the results obtained from the review. Finally, some conclusions and future work are provided.

2 Literature Review

2.1 The Process of Risk Assessment

Risk assessment is the core process of risk management. Organizations use risk assessment to determine the extent of the potential threats associated with the information system. The output of this process helps to identify controls that are fully proportionate with the risks to which the organization is exposed. The identified controls are used to reduce and/or eliminate risk during the risk mitigation process [5]. Meanwhile, risk assessment involves two processes: risk analysis and risk evaluation. Risk analysis is the systematic approach for describing and calculating risk. It includes the identification of undesired events, and the causes and consequences of these events [22]. Whereas, risk evaluation is the comparison of risk analysis results with the acceptance criteria for risk and other decision criteria.

There are a number of distinct approaches to risk analysis. However, these essentially break down into two types: quantitative and qualitative. In quantitative approach, the value of the potential losses associated with threat needs to be determined. Then the probability of the occurrence of the risk failure needs to be estimated. Finally, the Annual Loss Expectancy (ALE) is calculated and risk priority is determined accordingly [5]. While qualitative analysis deals with estimated potential loss and probability data is not required. Most qualitative risk analysis methodologies make use of a number of interrelated elements: threats, vulnerabilities and controls.

2.2 Security Risk Assessment Frameworks in Cloud Computing

The European Network and Information Security Agency (ENISA) [6] has published a guide that allow an informed assessment of the security risks and benefits of using cloud computing. For the purposes of the risk assessment, a medium-sized company was used as a use case and the aim was to expose all possible information security risks. The risks identified in the assessment are classified into three categories: technical, legal and policy and organizational issues. Each risk is presented in a table which includes probability level, impact level, reference to vulnerabilities, reference to affected assets and level of risk. The estimation of risk levels is based on ISO/IEC 27005.

In addition, ENISA makes concrete recommendations on how to address the risks and maximize the benefits. One of the most important recommendations is a set of assurance criteria designed to: (1) assess the risk of adopting cloud services, (2) compare different cloud provider offers, (3) obtain assurance from the selected cloud providers and (4) reduce the assurance burden on cloud providers. The recommendation provides a set of questions that an organization can ask a cloud provider to assure themselves that they are sufficiently protecting the information entrusted to them. However, this guidance does not provide detailed recommendations with regard to the cloud and risk assessment function.

Another initiative in assessing security risks is taken by Cloud Security Alliance (CSA). The CSA leads a number of ongoing research initiatives through which it provides white papers, tools and reports to help companies and vendors secure cloud computing services. It has published guidelines on different security issues related to cloud computing. The guide consists of twelve domains and the second domain is dedicated to governance and enterprise risk management. The proposed guidelines are not compulsory and may not all be applicable to every cloud deployment, but help to identify threats in the cloud context and choose the best options by which to mitigate vulnerabilities. Meanwhile, a simple framework for evaluating initial cloud risks and informs security decisions is provided [3]. Among the CSA's recommendations, high emphasis is placed on defining metrics and standards for measuring the performance of information security, which should be assessed and be documented on the contracts. Furthermore, the CSA provides Governance, Risk and Compliance Stack [27] as a toolkit for assessing private and public clouds against industry-established security best practices. Also, the CSA has established a CloudAudit project that seeks to simplify the process of gathering audit data by creating a standard method for cloud providers to communicate how they address security, governance and compliance.

2.3 A Classification of Cloud-Based Security Risk Assessment Methods and Tools

Recently, several studies have been conducted to improve traditional security assessment techniques and present new paradigms for analyzing and evaluating security risks in cloud environment. We classified cloud-based risk assessment methods into five risk categories as shown in Table1.

1) Risk assessment as a service: Security as a service (SecaaS) solutions have been developed to provide and support security assessments in which a cloud- hosted solution performs the assessments and stores the resulting data. Today, several tools for a number of security assessment areas have been implemented using the SecaaS delivery model [14], [29]. In the SecaaS delivery model, customers get the typical benefits of using cloud computing such as scalability and on demand service. CSA have developed guidance for SesaaS implementation [31].

In [19], risk assessment as a service is introduced as the new paradigm for measuring risk in real-time by one or more of the entities in the cloud. A cloud provider can perform continuous self-assessments as a best practice through evaluation of its own run-time environment. Moreover, a trusted third party and cloud customer could assess the provider on an ongoing basis through privileged access to certain internal measurement interfaces. However, this work has not implemented such a service but rather offer it as a paradigm to be pursued.

2) Qualitative and quantitative assessment: Risk assessment have analyzed security risk by using qualitative or/and quantitative approach. Several quantitative risk assessment methods exist. In [22], a quantitative risk and impact assessment framework (QUIRC) is introduced to assess associated six key categories of security objectives (SO) (i.e., confidentiality, integrity, availability, multi- party trust, mutual audit ability and usability) in a cloud computing platform. The framework defines risk as a combination of the probability of a security threat event and its severity, measured as its Impact. The impact is determined by Subject Matter Experts (SME), the knowledgeable about the impact of threats on their particular type of business. The probability of each event should also be collected from earlier records and research, specific to the business and the geographical region, using sources such as SANS report. Table 2 shows the pros and cons of QUIRC assessment method.

In [30], a SEmi-quantitative BLO-driven Cloud Risk Assessment (SEBCRA) prioritizes and categorizes cloud risks according to their impact on different Business Level objectives in a given organization. The approach is designed for a Cloud Service Provider (CSP) to improve the achievement of a BLO, i.e., profit maximization, by managing, assessing, and treating Cloud risks. In an exemplary experimentation, the risk assessment approach demonstrates that it enables a CSP to maximize its profit by transferring risks of provisioning its private Cloud to third-party providers of cloud infrastructures. Table 2 shows the pros and cons of SEBCRA assessment method. However, a simple method for qualitative or quantitative analysis will lead to the inaccuracy and one-sidedness of the evaluation results. Therefore, several studies used an integrated method of qualitative and quantitative analysis to assess risk in cloud environment [4], [20], [23], [30].

Table 1. A Classification of Cloud Security Risk Assessment Methods and Tools

Methods	Risk Modeling	Stakeholders	Ref.
Assessment As a Service	Cloud service model	Cloud customer	[14],[19], [29]
Qualitative/ Quantitative Analysis	Textual language model	Cloud provider	[8], [12], [25]
	Threat and vulnerability analysis	Cloud customer and provider	
Graphs Analysis	Attack Defense Trees (ADT)	Cloud provider	[15],[21], [23]
	Decision Tree Analysis (DTA)	Cloud customer	
	Graph mathematical model	Cloud provider	
Hierarchal Assessment	Risk Breakdown Structure (RBS)	Cloud customer	[7],[20], [23],[24]
	Analytic Hierarchy Process (AHP)	Cloud customer and provider	
	Hierarchical assessment Indicator system		
Security Matrix	Trust Matrix	Cloud customer	[1], [17], [26], [27]
	Cloud Control Matrix (CCM)	Cloud customer and provider	
	Trust and Assurance Registry (STAR)	Cloud customer	

3) Graphs analysis assessment: Graphs and mathematical models can be used to address and calculate security risk in clouds by simulating attacker possibilities. In [15] they presented a mathematical model for threats that considers communication in order to identify security risk for individual entities, and then calculates it for a whole enterprise. The model is built by representing communications as a directed graph and then established a matrix to discover the risk. Furthermore, in [23] a hybrid risk-analysis method based on decision tree analysis (quantities) and risk matrix (qualitative) is proposed for risk assessment. In this method, risk factor from a user's viewpoint is systematically extracted with the Risk Breakdown Structure (RBS) method then analyzed and evaluated. A detailed countermeasure and proposal are produced on the basis of these results. The risk matrix method is used to classify risk into four kinds (Risk Avoidance, Risk Mitigation, Risk Acceptance, and Risk Transference) in accordance with the generation frequency and degree of incidence.

4) Hierarchal assessment: In [20] a security risk assessment method has been introduced based on an Analytic Hierarchy Process (AHP) model. The assessment is carried out using the principles of: decomposition, pairwise comparison, and synthesis of weights. Thus, AHP has three layers of decomposition: formulating the problem of assessing cloud security risk in a hierarchical structure is the first step in AHP. Then, in level two, 8 major factors were identified for assessing. In level three, 39 factors were identified corresponding to higher levels and specific local conditions. The evaluation module uses the constructed AHP tree to assess the system with the help of the judgment matrix that is filled by the cloud's experts. Finally calculating the weighted vectors and getting the final risk order. Table 2 shows the pros and cons of the above hierarchal assessment method.

Table 2. Pros and Cons of Risk Assessment Methods

Ref.	Pros	Cons
[4]	It supports service provider and infrastructure provider as well as wide range of scenarios such as Cloud bursting and Cloud brokerage.	Risk assessment model need to be developed to suit each of the identified risk categories.
[9]	It enables cloud service providers to include security in their SLA offerings, increasing the likelihood that their services will be used.	It can be used just to compare between cloud providers to select the best one based on calculation of risk factor of each one
[20]	It based on collaborative computing. It can effectively decompose the risk assessment in cloud (complex problem) into an orderly hierarchy.	There is a lack of complete model or method of risk assessment in cloud computing environment
[22]	It enables cloud vendors, customers and regulation agencies to comparatively assess the relative robustness of different cloud vendor offerings in a defensible manner	The precise collection of historical data for threat events probability calculation, which requires data input from those to be assessed Cloud computing platforms and their vendors.
[25]	Develop a custom, domain specific language for cloud deployments by their functional and non- functional security relevant properties. Then, derive risk profile to secure cloud deployment	The method is static because: (1) it doesn't consider the evolution of a cloud deployment and (2) the way to it derives risk related values.
[30]	It evaluates the impact of cloud-related risks on BLOs considered, instead of considering effects on the whole loud organization.	There is a lack of complete model or method of risk assessment in cloud computing environment

In [7], a hierarchical framework is built to analyze the risk and set the goal for the assessment. After that, an indicator system is built under each principle and sub-indicators are introduced for assessment. For example, the first indicator could be risk of cloud computing platform, risk of cloud storage, risk of cloud security and so on. Secondary indicators of cloud platform risk could then be risk of operating system, risk of application software and risk of availability.

5) Security matrix assessment: In [1], Trust Matrix is used for security risk analysis in cloud environments. Two variables, namely "data cost" and "provider's history" are considered. In "data cost" users can assign a cost to data based on the data's criticality whereas "Provider's history" includes the record of the past services provided by the provider to consumers. Additionally, Cloud Control Matrix (CCM) has been released by CSA in 2013, as a baseline security control framework designed to help enterprises assess the risks associated with a cloud provider. It gives a detailed understanding of security concepts and principles that are aligned to the CSA guidance in 13 domains. The CCM has included a risk management domain to ensure that formal risk assessments are aligned with the enterprise-wide framework, planned and scheduled at regular intervals determining the likelihood and impact of identified risks, using qualitative and quantitative methods. Thereby, it facilities transparency and increase trust level between the cloud customer and the cloud in order to make cloud a secure environment to the future of business [26].

3 The Review Methodology

This review has been accomplished by reviewing the existing literature regarding security risk assessments in cloud computing environment. The goal is to identify the existing risk assessment methods, categorize them and suggest areas for further investigation.

3.1 Question Formalization

The question focus was to identify the most relevant issues in cloud computing which consider security risk and their assessment methodologies. Therefore, the research question addressed by the researchers was: How to identify, analyze and assess security risk in cloud computing? The keywords and related concepts that make up the question were used during the review execution as: cloud security risk, threat identification, threat modeling, vulnerabilities assessment, risk analysis models and risk assessment methods.

3.2 Selection of Sources

The reviews is conducted by searching academic gateways, online databases, catalogues, academic journals, conferences and workshops to obtain related information and recent articles while considering authorship, credibility and authenticity. In an attempt to perform an exhaustive search, basically we considered the following electronic sources because they had published papers on the topic: Institute of Electrical and Electronics Engineers digital library (IEEE Xplore), Association for Computing Machinery digital library (ACM), ScienceDirect, SpringerLink and Google scholar. Once the potentially relevant primary studies have been obtained, we assessed them for their actual relevance. The selection criteria through which we evaluated the sources were based on practical issues such as authors experience and the language, for instance all the included studies were written in English and available on Web. Furthermore, the inclusion and exclusion criteria were based on the research question. Thus, we included studies that contain issues and topics that they consider in security risk assessment in cloud and these studies must described methods or framework for risk assessment.

3.3 Review Execution

The review is executed by searching in the defined sources and evaluating the obtained studies based on the defined criteria. Writing this review is after obtaining a set about 100 results which were flirted according to the inclusion criteria to produce a set of 45 relevant studies. This set was filtered again with exclusion criteria to give a set of studies which corresponds with 15 primary studies. Based on the security risk assessment review, several interviews with cloud computing experts were conducted. In these interviews the main questions for cloud provider and cloud customer respectively are: “How would you demonstrate adequate risk management and compliance to your customers”? and “How do you evaluate various cloud providers on their security level?” The interviews conclude that both cloud customers and providers should develop robust information security risk assessment, regardless of the service or deployment model. The assessment should be collaboration between customers and providers to achieve agreed upon goals which support the business mission and information security program.

4 Results and Discussion

By reviewing the literature, several methodologies and frameworks for performing risk assessment have been reviewed and suggested. We have classified risk assessment methods into five categories: assessment as a service, quantitative and qualitative, hierarchal, graph analysis and security matrix assessment. Basically, these risk assessment methods have analyzed security risks by using qualitative or/and quantitative approach. For comprehensive risk assessment, risk analysis is accomplished using an integrated method; a combination of qualitative analysis and quantitative analysis. Meanwhile, some studies have used risk inventory as a Knowledge Base (KB) to include facts, scenarios, and reasoning rules that represent security and exploitation related knowledge. In addition to the risk assessment methods that has been reviewed, the CSA leads a number of ongoing research initiatives like security guidance, CCM and STAR to facilitate risk assessment in cloud computing. Despite all these methodologies and initiatives, currently no concise methodology exists for analyzing and evaluating security risks of cloud based solutions. Thus, the adoption of cloud solutions in a number of industries is prevented. Most of the studies view the problem of assessing security risks either from cloud customer or cloud provider perspectives. The need for a comprehensive, shared and transparent risk assessment methodology that considers both customer and provider is recommended. Such shared assessment enables the cloud provider to prove how the security risks have been managed and mitigated, as well as enabling the cloud consumer to determine the risk tolerance and define security requirements accordingly.

5 Conclusion

Due to the obvious cost and convenience benefits of cloud computing, adopting cloud-based solutions is widely accepted. However, the typical decision of cloud adoption taken by management often considers the cloud benefits without any attention or a proper evaluation of the associated cloud risk. Thus, developing a mechanism that facilities and standardize the process of security risk assessment before cloud adoption is critical. It increases transparency, reduces uncertainties and establishes trustworthiness. Meanwhile, several researches and initiatives have been conducted. We have classified the cloud risk assessment methods into five categories: assessment as a service, quantitative and qualitative, hierarchal, graph analysis and security matrix assessment. The main process and components of the risk assessment methods have been identified and considered. However, the characteristics of cloud computing challenge the development of mechanisms and standards that assess security risk of adopting cloud computing in effective and efficient manner.

6 Future Work

Security risk assessment in clouds is needed for both customers and cloud providers. The security concerns because cloud customers do not see what happens inside a cloud and how their data is handled. They have to fully trust the cloud providers to act honestly and not breach the confidentiality of data and computations. On the other hand, cloud providers prefer to hide the cloud topology and operational details. Thus, there is a necessity to balance the opposing needs of the providers and customers. As for future work, we are looking to make cloud computing more trustworthy and reliable, by bridging the above gap. We suggest to approach this problem in two directions: (1) by building distributed, collaborative and intelligent risk assessor that guide customer to evaluate the security level of cloud provider and identify the associated risk before the decision of cloud adoption has been taken. (2) By designing a mechanism that will allow the cloud provider to prove the confidentiality and integrity of the data and computation without disclosure of sensitive cloud topology information.

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Selecting Suitable e-Procurement Decision Models for the Maldivian Public Sector by Evaluating MCDA Methods

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Abstract. Public sector procurement is governed by laws and regulations enforcing a rigid structure with multiple criteria for assessing and selecting suppliers. This paper analyses legal and operational requirements of public sector e-procurement of the Maldives education sector. The research was based on a desktop review of traditional academic sources as well as gray literature to identify legal and fiscal constraints and regulations, followed by a field research to identify operational requirements. Subsequently, an evaluation study, which applied the findings of the desktop study and the field research, was conducted to select an appropriate Multi-Criteria Decision Analysis (MCDA) method for that specific context. After a thorough analysis of MCDA methods, two methods emerged as applicable for the Maldivian context and capable of meeting both operational and legal constraints. The paper provides an extensive discussion on the selection of suitable MCDA methods for Maldivian public sector procurement requirements.

Keywords: Multi-Criteria Decision Analysis (MCDA), Public Sector Procurement, e-Procurement, Decision Model, Evaluation.

1 Introduction

Multi-Criteria Decision Analysis (MCDA) is one of the well-known branches of decision making [1]. MCDAs are important in decision making when a wide number of factors or criteria are required for decision [2]. Even though there are a wide variety of MCDA methods, they all have common features, namely the concepts of alternatives for decision making and a set number of attributes that need to be assessed [1]. MCDA methods are the core of modern procurement and have generated significant amount of research, controversy and discussion.

The research reported in this paper focuses on identifying and selecting suitable MCDA methods that can be used in the design and development of an e-Procurement Decision Support Systems (DSS) for the public sector in the Maldives focusing on education sector.

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The features and characteristics of public sector procurement are based on major public sector principles such as non-discrimination, equality, transparency and proportionality [3]. This results in an organised step-by-step procedure for public sector procurement. However, this research focuses only on decisions that are based on the performances of the suppliers against a preset list of criteria. These criteria allow public sector institutions to state differentiated priorities when they announce for bids. This situation creates a context in which MCDA techniques can be applied to supplier assessment and selection.

The research design of the study involves comparative analysis of characteristics of MCDA methods against legal requirements and operational requirements of the research context. After an initial literature review that enabled the identification of the most commonly used MCDA methods, the research was divided into four different steps. First, a review of gray literature on legal and fiscal aspects of procurement in the Maldives public sector was undertaken. Second, a field research using focus groups with public sector procurement decision makers was conducted. Third, a more extensive literature review on the identified MCDA methods was conducted. Finally, an evaluation analysis was performed on the group of MCDA methods, by applying the constraints identified in the literature review and the field study. This paper presents the findings of this research in detail.

2 Procurement in Public Sector

The objectives of public sector procurement is the same as in the private sector [4] and many authors define procurement objective as to purchase the right quality of material, at the right time, in the right quantity, from the right source, at the right price [4-7].

Public procurement must adhere to the guidelines provided by public authorities. In every country, public procurement must comply with specific legislative requirements [8]. The public purchasing laws require the contract to be awarded to the lowest capable bidder who fits into the requirements laid by invitation for bid [4, 8, 9]. Public procurement has limited flexibility and narrow evaluation criteria when dealing with bid evaluation as it has legal bindings [4].

Clear and accurate specification is required to provide information to bidders to get competitive bids without varying interpretations [10, 11]. The development of good specification requires lot of time [4]. In fact, public sector procurement emphasis on the bid process with a rigid structure from invitation to bid, bid opening, evaluation and till awarding [4]. The extensive authorization process makes procurement a dull, difficult and time-consuming process [7].

Every country has developed guidelines based in their context for public procurement and it provides systematic approaches for bid evaluation [12]. European Directives states to use either Lowest Price (LP) or the Most Economically

Advantageous Tender (MEAT) approach. LP is used when features of the material or service other than price are identical to differentiate suppliers, otherwise tenders are awarded using MEAT [8], similarly in UK it is to maximise the 'value for money' [9] and in USA it is the lowest responsible and responsive bidder [11] in choosing a supplier.

3 Public Sector Procurement in the Maldives

Dhaulathuge Maaliyyathu Gaanoonu 2006 (literally, *Public Finance Act 2006*) and *Dhaulathuge Maaliyyathuge Gavaaidhu 2009* (literally, *Public Finance Regulation 2009*) are the governing laws and regulations for the public sector procurement in the Maldives [13].

These two legal documents governing public sector procurement in the Maldives were thus studied carefully to identify the legal procurement requirements of the public education sector, which is a part of the public sector in the Maldives and the main focus of this research.

The method of procurement in public sector in the Maldives is consistent with what happens elsewhere in the public sector, that is, the regulations contain a number of exceptional clauses that allow the method to vary depending on the product, value, urgency, location, suppliers capability [9, 14]. However, in normal circumstances the method of procurement should only depend on the value of the procured product as described in literature [4] and also based on public finance regulations of Maldives [14].

3.1 Maldivian Guidelines for Public Sector Procurement

The main points in the guidelines provided by the public finance regulation in context of the research dictate that the public procurement should:

- be a transparent process;
- be able to create competitive biddings in order to provide fair opportunities to all capable suppliers;
- done according to the National regulation and be the same for all bidders;
- be able to use modern technology to support the process;
- be led by a clearly identifiable and responsible person for the procurement; and
- strictly follow the approved budget and any deviations can only be justified if it risks a person's life or if it stops any basic public service.

Any procurement of material or service which amounts more than MVR 25,000.00 should be announced for public bidding and the procurement should be made based on the bids submitted [14].

In this case, procurement specification should be publically and provided in writing to the potential bidders. This information should also provide information on selection guide by providing the evaluation criteria including weights and how points will be allocated [14].

There must be a Bid Evaluation Committee (BEC) in every public office that does bid evaluation. BEC needs to have a justified reason for choosing a particular supplier and it should be signed by an authorised person [14]. The justification is the evaluated results of the bids by the BEC. This is the main focus of this research, that is, to provide a good MCDA method that can guarantee a good basis for this justification.

3.2 Bid Evaluation Criteria

Even though there are number of criteria used in public sector procurement, there are compulsory criteria that must be used in supplier selection in public sector in the Maldives [14]. BEC is responsible to evaluate the bids based on price and duration [14]. In addition, regulation prescribes to look for the following criteria:

- Financial capability of the supplier;
- Technical capability of the supplier;
- Justifiability of the prices submitted by suppliers compared to estimated price of the procurement material or service;
- Similar past experiences of the suppliers in terms of size and its execution;
- Any other important criteria perceived by the public sector department.

4 Identification of Operational Requirements

For the purpose of identifying operational requirements, a field research was done involving a set of focus group discussions with BEC members of public sector education institutions in the Maldives.

Ministry of Education (MoE) represents 213 schools for which most of the procurements are handled by MoE's procurement department. However, depending on the procurement, MoE can empower 19 of these 213 schools to make their own procumbent decisions. Each of these 19 schools and MoE has their own BEC. As a result, there is a total of 20 distinct BECs for the 213 schools under MoE. The participants of the focus groups in this research involved senior officials of the MoE and other government institutions represented in these BECs.

During the initial meetings, the MoE stated that all institutions under its responsibility follow the same procurement procedure and have the same expectations in terms of procurement. Therefore, there is no need to carry out the focus groups with BEC members in all these institutions. In addition, although every BEC has a limited number (e.g. 5 to 7) of members, all of these members are senior government officials who have multiple responsibilities other than BEC functions. Therefore, it will be neither feasible nor practical to get involved all these BEC members in this study. Nevertheless, in order to enrich the data and verify the findings, the researchers requested to conduct the focus groups with at least three BECs in three different locations and with three different institutions. Consequently, the researchers carried out three focus groups respectively with the BEC of MoE (3 participants), the BEC of a primary school (4 participants), and the BEC of a secondary school (3 participants). These three groups cover BEC members who make procurement decisions for 196 schools out of 213 schools, covering 92 percent of the schools under MoE.

This research used video recording which helped to easily identify individual speakers and in the transcription. It also helped to keep track of the sequence of the talk in transcription. Furthermore, these focus groups were to discuss technical procedures and information and in this case video recording helped to recap the verbal and non-verbal explanations given. Analysing focus group data usually involves the same processes of any other quantitative data analysis. However, group context is referenced by analysis of groups rather than individuals and keeping the balance between concepts provided by the group and individual ideas within it [15]. In the case of this research thematic analysis was used to code the transcripts and establish a list of operational requirements.

5 Evaluation of MCDA Methods in the Maldivian Context

An extensive review of the literature allowed the researchers to identify all of the most common MCDA methods which were distilled into the 41 potential candidates out of more than 80 found, as presented in Appendix I. The final step of the research involved a criteria-based evaluation of the identified MCDA methods. As defined by Chen et al. [16], criteria-based evaluation is an "evaluation that is conducted according to predefined checklists, heuristics or principles". These same authors state that these criteria stem from "specific theories, as well as sets of guidelines, standards or even legal requirements". In the case of this research, the criteria-based evaluation of the MCDA methods (as further illustrated in Figure 1) is performed against the legal and operational requirements of the Maldivian context being identified from the literature review and field research. This evaluation analysis aimed to check which of the identified MCDA methods comply with public sector requirements and could become good candidates for the design and development of the new e-Procurement Decision Support System.

For the analysis, the MCDA methods were grouped into five categories by considering propositions found in the literature [17-19]. These five categories include: linear weighting and elementary methods, single synthesising criterion or utility theory, outranking methods, fuzzy methods, and mixed methods. The characteristics of the categories were then compared against operational and legal requirements established from the above stages. The individual methods of the categories which satisfy public sector requirements where then further compared with public sector requirements to select suitable methods from the category. No individual method was further considered if its parent category does not meet public sector requirements.

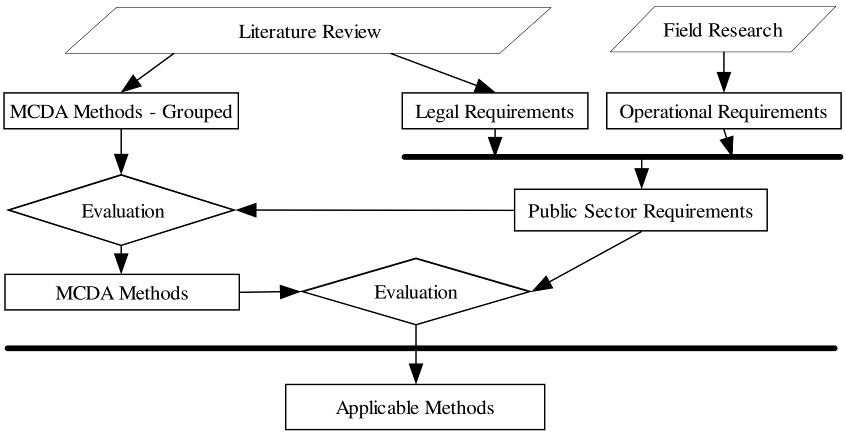

Fig. 1. Evaluation Model

Linear weighting and elementary methods, outranking methods, fuzzy methods, and mixed methods were rejected at their group level analysis. For illustration purpose, a rejected group and the selected group are discussed below.

5.1 Linear Weighting and Elementary Methods

This category includes two major families of methods, namely elementary and linear weighting methods. Elementary methods are more appropriate for problems with a single decision maker and with few alternatives and criteria [20]. Elementary methods choose the alternatives based on the performance of prioritised or chosen criteria without the aggregation of performances of all the criteria. Ignoring some of the established criteria is contrary to the regulations of major public sector, namely the principles of proportionality, equality and non-discrimination. Therefore, these methods are not considered applicable for the research context.

Weighted sum is likely to be the most common linear weighting method for supplier evaluation [21]. It is a compensatory method [17]. This method calculates the ratio for each attribute for every supplier by dividing the performance values of the attribute by the maximum value of the attribute, in case of input factors, subtracting these ratios from 1. Next, the allocated weight for each attribute is multiplied by the ratio calculated to get the weights for individual attributes. Finally, all the calculated weights for each individual attribute for every supplier is added to get the total figure for the supplier [8].

Due to the rationale followed by the weighting, most people would, at first glance, accept that the procedure is logical and commonsensical. However, the use of this weighed sum procedure is in fact the most common mistake in public procurement procedures [21]. Mateus et al. [21] further explained with an example that the definition of weights is completely arbitrary and inconsistent with the real preferences of the procurement authority. With regard to compensation, these authors provide the following example:

> In a case of only two criteria selected, if 75% weight for one criterion (A) is defined and 25% weight for another criterion (B) then losing 10 partial points on criterion A (75% x -10 = -7.5 overall points) is equivalent to gaining 30 partial points on criterion B (25% x +30 = +7.5 overall points). Since the weights embody trade-offs, the assignment of weights will have to take into account the way those values were identified, that is, the performance levels set for each criterion [21].

Keeney [22] also identified the same issue and listed 12 common mistakes in making value trade-offs. Boer et al. [23] have also discussed five common mistakes using weighted sum in public sector procurement. The examples shown by Boer et al. [23] showed undesirable outcomes in all the 5 cases.

Despite being one of the most commonly used methods in procurement; weighted sum does not seem to be ideal for public sector procurement in the Maldives due to all the criticisms described above. This is specially so due to the vulnerability of the method to manipulation by both suppliers and buyers, as well as the very high risk of the tendered products or services approved no meeting the public sector principles and standards behind regulations. The BEC members involved in the focus groups were also aware of these risks, but were struggling to identify an alternative approach. Nonetheless, and for the sake of clarity in this discussion this is currently the method used in Maldivian public sector. This represents of course a dissonant finding with reality of practice and it is expected that this study may contribute to a rectification discussion on current procurement practices.

5.2 Single Synthesizing Criterion or Utility Theory

This is the most conventional approach [24]. The assumption of these methods is that there exists a utility (or a value) function U to represent the decision maker's (DM) preferences. Based on this assumption, such a function is assessed and therefore the ranking of the choices is straightforward. The assessment of this function can be achieved in an additive, multiplicative, distributional mode and many other methodologies were developed with the premise that there exists a partial utility functions u_j according to each attribute j [17]. This is in general terms a much better approach that fits both the principles and regulations of the Maldivian public sector, taking into account the differences and utility of the different criteria, rather than just aggregating these around perception and often prejudice based assigned weights. However, there are a number of methods under this family and therefore a closer inspection of these is necessary in order to assess their applicability in this research context. For the illustration purpose, two methods are discussed below.

DEA. Charnes et al. [25] introduced the Data Envelopment Analysis (DEA) concept [8, 26, 27] as a linear programming based technique to evaluate the efficiency of a group of decision making units (DMUs) that use multiple inputs (costs to the organisation) to produce multiple outputs (benefits to the organisation) [8, 28].

Weights are not pre-defined in DEA method by DM [8]. DEA model internally derives weights when applied. Optimal weights for the criteria are automatically calculated based on performance scores of the supplier. There is no control or involvement of DMs in the importance of the criteria in DEA approaches [29].

The DEA approach does not meet the requirements of the Maldivian regulations as weights or priority ranking are not predefined, but allocated internally. Therefore, DAE is not considered applicable for the research context.

COPRAS. COmplex PRoportional Assessment (COPRAS) was developed by Zavadskas and Kaklauskas in 1996 for determining the priority and the utility degree of alternatives [30, 31].

Podvezko [32] stated that stability of COPRAS is also less compared to other methods when data variation is considered as it may have huge degree of change in ranks of the alternatives due to changes in data unlike other methods [32].

However, public sector requires considering any difference in data results in a relevant difference in output, in order to respect the principles of proportionality and non-discrimination. This makes COPRAS attractive for public sector procurement.

6 Conclusions

This paper has discussed the evaluation of major MCDA methods and its characteristics against Maldivian public sector procurement requirements and constraints. The aim was to identify methods that could meet the requirements of the Maldivian context. The evaluation research resulted in the identification of only 2 out of more than 80 methods that could meet the rigid procedures, regulations and expected outcomes of the decision making for the Maldivian public procurement, namely: TOPSIS and COPRAS.

TOPSIS provides the best alterative in terms of the closest distance to the ideal solution and making it possibly the farthest from the negative ideal solution. This approach helps public sector to find the best possible solution from the available alternatives.

COPRAS provides alternatives based on the priority and the utility degree of alternatives. This approach helps public sector to select the best alternative base on the utility of the alternative.

These findings are significant as they are in conflict with the current reality of practice in that country where weighted sum is used. In fact, and despite being one of the most commonly used methods in procurement; weighted sum, as discussed above, does not seem to be ideal for public sector procurement in the Maldives due to the vulnerability of the method to manipulation by both suppliers and buyers, as well as the very high risk of the tendered products or services approved not meeting the public sector principles and the standards behind the regulations. This dissonance between these research finding and the reality of practice are expected to contribute to a discussion that may lead to the rectification of current procurement practices at National level.

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Appendix 1

Table 1. MCDA methods (Adapted from Guitouni and Martel [17])

No	Method	Author(s)
	Linear weighting and elementary methods	
1	Weighted Sum	Churchman and Ackoff (1954)
2	Lexicographic method	Roy and Hugonnard (1982)
3	Conjunctive method	Hwang and Youn (1981)
4	Disjunctive method	Chen and Hwang (1992)
5	Maximin method	Hwang and Youn (1981)
	Single synthesizing criterion or utility theory	
6	TOPSIS	Hwang and Youn (1981)
7	MAVT	Keeney and Raifa (1976)
8	UTA	Jacquet-Lagreze and Siskos (1982)
9	SMART	Edwards (1971)
10	MAUT	Bunn (1984)
11	AHP and ANP	Saaty (1980), Saaty (2005)
12	DEA	Talluri et al. (1999)
13	COPRAS	Zavadskas et al. (2007); Chatterjee et al. (2011)
	Outranking methods	
14	ELECTRE	De Boer et al. (1998); Dulmin and Mininno (2003)
15	ELECTRE I	Roy (1968)
16	ELECTRE IS	Roy and Bouyssou (1993)
17	ELECTRE II	Roy and Bertier (1971)
18	ELECTRE III	Roy (1978)
19	ELECTRE IV	Roy and Hugonnard (1982)
20	ELECTRE TRI	Yu (1992); Mousseau et al. (2000)
21	PR OMETHEE	Dulmin and Mininno (2003)
22	PROMETHEE TRI	Figueira et al. (2004)
23	PROMETHEE/GAIA technique	Dulmin and Mininno (2003)
24	NAIADE	Munda (1995)
25	ELECCALC	Kiss et al. (1994)
26	UTADIS	Doumpos et al. (2001)
27	MELCHIOR	Leclerc (1984)
28	ORESTE	Roubens (1980)
29	REGIME	Hinloopen and Nijkamp (1982)
30	PROMSORT	Araz and Ozkarahan (2007)
31	EVAMIX	Voogd (1983)
32	QUALIFLEX	Paelinck (1978)
	Fuzzy methods	
33	Fuzzy relationship hierarchy	Lin and Chen (2004)
34	Fuzzy set approach	Sarkar and Mohapatra (2006)
35	Fuzzy suitability index (FSI)	Bevilacqua et al. (2006)
36	Fuzzy weighted sum	Baas and Kwakernaak (1977)
37	Fuzzy miximini	Bellman and Zadeh (1970)
38	AI methods	Ng and Skitmore (1995); Vokurka et al. (1996); Kwong et al. (2002); Choy et al. (2002); Choy et al. (2003); Choy et al. (2005)
39	CBR	Ng and Skitmore (1995); Choy et al. (2003)
	Mixed methods	
40	Martel and Zaras method	Martel and Zaras (1990); Martel and Zaras (1995)
41	Fuzzy conjunctive/ disjunctive method	Dubois, Prade and Testemale (1988)

An Application to Select Collaborative Project Management Software Tools

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Abstract. In an increasingly competitive market the use of project management techniques can help controlling scope, time, and cost in an efficient way. Either due to size or complexity that may exist in a project, it may be essential to use project management software tools. Some projects involve teams of people who may be geographically dispersed, being essential to exchange information among project stakeholders, hence the need for collaborative tools, best known as groupware. In this paper, we present an overview of project management and collaborative project management techniques and tools. Next, we present a framework, based on ISO 9126 and ISO 14598, to classify collaborative project management software tools. Finally, we present a model and an application to help on the selection of this type of tools.

Keywords: Project Management, Collaborative Management, Collaborative Tools for Project Management.

1 Introduction

Today, Project Management (PM) is a key area for organizations, because without PM techniques the effort to implement a project would summarize to the common sense of the project manager, being difficult to effectively monitor deadlines, manage resources and costs and keep the scope controlled.

It is important, before defining more precisely what PM is, to establish what a project is. A project may be defined as a temporary endeavor that is progressively developed, aiming to create a unique product or service [1].

The PM paradigm has changed over the years, mainly due to the increasing number of projects that are geographically distributed, in which the teams are in different places and cultures, and so the present and future PM becomes more concerned with information and with knowledge [2]. Increasing competitive pressures are driving organizations to use collaborative technology to improve its effectiveness and efficiency. The use of groupware technology is being adopted by organizations to improve collaboration and knowledge sharing [3].

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For a project to succeed it is important to use software tools that support PM, especially in complex projects being subject to time and budget uncertainties. All users should be supported by tools, since it is almost impossible to manage complex projects using manual planning techniques [4].

2 Project Management and Collaboration

Project Management can be defined as the planning and control of integrated tasks in order to successfully achieve the goals for the benefit of the project participants [5]. According to Brian (1995) PM is a science of organizing, planning and controlling to create changes in products with a predictable cost, within the defined time and with the desirable quality. This definition has been the starting point for many of the PM techniques and methodologies used over the last 25 years. However Brian poses the question "What can we do better?". Although in the last years, PM techniques have improved, projects became harder to manage. The reasons for this fact are difficult to identify, but may be related to the increasing complexity of projects and the difficulty to apply PM techniques effectively. To deal with these problems Brian speaks of the importance of the interaction and communication between individuals involved in the project. There is an increasing need for collaboration [6].

The focus on the trends of today's PM is to find technology that allows the creation of a professional environment for geographically dispersed teams, similar to the expected one if these teams were in the same geographical space.

The collaboration is an added challenge when it involves the participation of individuals who are geographically dispersed. The need for collaboration is seen as an alignment between stakeholders from various parts of the organization so that they show an attitude of cooperation and focus on achieving project objectives [7].

The collaborative project management can be understood as a method that is used to plan, coordinate, control and monitor complex projects that are geographically distributed [2].

In recent years there has been an increasing demand for technology that allows collaboration between users who share common work. In an attempt to adapt to this kind of situation, software has been developed that aids collaborative work, best known as Groupware (or collaborative systems), which includes mechanisms to support interaction among members of a workgroup, manipulating objects, in shared workspaces [8].

Increasing competitive pressures are forcing organizations to use collaborative technology to improve its effectiveness and efficiency. The use of groupware technology is being adopted by organizations to improve collaboration and knowledge sharing [3].

Technological artifacts such as collaborative systems can be useful for knowledge gathering, which should be placed in appropriate repositories, so that every people belonging to the organization have access to it [9].

Collaborative systems allow teams that are geographically dispersed perform communication, coordination and cooperation effectively and efficiently. There are two dimensions in collaborative systems that allow describing when and where the interaction occurs: (1) the horizontal dimension, which means having collaborative tools that allow to detect where (on the same site or on different sites) the participants are; and the (2) vertical dimension, which distinguishes between synchronous communication (at the same time) or asynchronous communication (communication at different times) [10].

3 Software Tools for Collaborative Project Management Support

An initial search on the web was done in order to find the Collaborative Project Management Tools (CPMT) to be analyzed. This search was done using a search engine (Google) that had links to the official pages of several tools, forums and scientific papers. However, given the wide range of choices, first it was necessary to understand the essential characteristics of a CPMT. There are several desktop and web-based tools which offer resources for organizing tasks, defining goals and support team work. The following characteristics considered essential in a CPMT were defined:

- Correctly planning a project based on the realization of inter-related tasks;
- Evaluate and assign resources (human and material) needed to carry out a project, in accordance with identified needs;
- Manage the project calendar;
- Reporting;
- Generate Gantt charts;
- Accept precedence relations between tasks (end-start, start-start, end-end, start-end).
- Establish hierarchical levels, creating a work breakdown structure.
- Define scheduled dates for the tasks.
- And besides the previous functionalities, allow collaboration (file sharing, emails, forums, chats or wikis).

This last point was very important since the goal was to study tools that allow some form of collaboration, and have at least one of the features mentioned above.

Next, we present the sixty tools selected for evaluation in this study. Due to space limitations, just the name of the CPMT will be presented (see table 1).

Table 1. Software tools for collaborative Project Management analyzed

2-plan	Clarizen	Freedcamp	LibrePlan	PHProjekt	Teambox
5pm	Collabtive	Ganttic	LiquidPlanner	ProjectManager	TeamLab
AceProject	Comindware Tracker	GanttProject	Mavenlink	Project.net	Teamwork
ActiveCollab	Comindwork	Genius Inside	Merlin	Projectplace	Ubidesk
AjaxWorkspace	ClockingIT	GroveSite	Clientspot	ProjectPier	Vkolab
AtTask	Dooster	Goplan	Open Workbench	Projecturf	Web2project
Basecamp	Deskaway	GroupCamp	OnStage	ProWorkflow	Work Zone
Celoxis	DotProject	HyperOffice	OpenProj	QuickBase	Workspace
Central Desktop	Easy project	IManageProject	OneDesk	Redmine	Wrike
Cerebro	E*Groupware*	InLoox	PhpGroupware	Smartsheet	Zoho Project

According to Waltano Júnior (1992) [11], ISO 14598 provides requirements and recommendations for practical implementation of the evaluation of software products. The evaluation process is based on ISO 9126, which defines software quality metrics and can be used both to evaluate finished products and products in development. This standard can be used by evaluation entities, software vendors, software buyers and users, each with their goal [12].

The standard is divided into six parts, which are: 14598-1: Overview; 14598-2: Planning and Management; 14598-3: Process for the Development Team; 14598-4: Process for Customer; 14598-5: Process for the Assessor and 14598-6: Assessment Module. The assessment process according to ISO/IEC 14598-1 is defined by: establish assessment requirements (establishing the purpose of the assessment, identify types of products to be evaluated, specify the quality model); specify the evaluation (select metrics, establish levels of scores for the metrics, establish criteria for judgment); design evaluation (produce the assessment plan) and perform assessment (obtain measures, compare criteria, judge the results) [11].

ISO 9126 is divided into two subtypes: internal and external quality, and quality in use. The internal and external quality is the sum of the characteristics of the software product, and the quality in use is the view of the quality of the software product from the point of view of the user [13]. The internal and external quality of the software is perceived in the six characteristics, but only their sub-characteristics can be measured using metrics, Figure 1 [14].

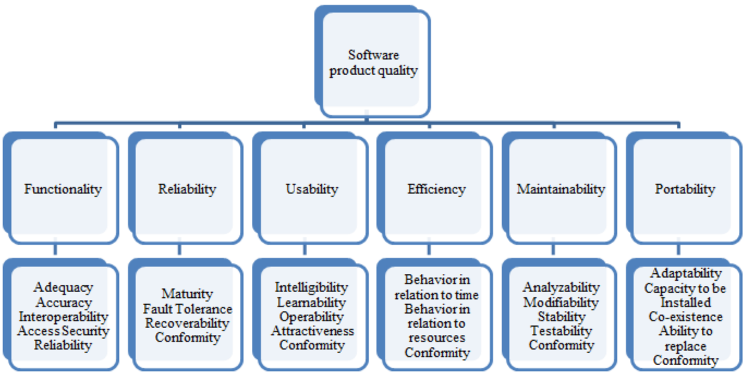

Fig. 1. Quality Model - ISO 9126 (Internal and external quality) [15]

4 Comparative Evaluation of Collaborative Project Management Software Tools – Model Developed

After a literature review about project management and document analysis (theses, official documents of tools, scientific articles and forums), we proceeded to the definition of the group of requirements based on characteristics and sub-characteristics of the ISO 9126, presented in section 3. Afterwards, we have developed an evaluation model that can support project managers to choose the best tool that fits their needs. Based on the requirements, we defined a set of criteria and metrics to be used in the evaluation process. This section summarizes the proposed model and the results of the evaluation process of the sixty tools.

To use the model, the user (the project manager) must follow the following steps: define and group the assessment criteria (requirements group), associate weights to the subcriteria (requirements), assign a level of attainment to each sub-criterion and finally verify the type of solution.

First, we have started by grouping the evaluative criteria, based on the characteristics and sub-characteristics defined in ISO/IEC 9126. The features selected to be evaluated were: "Functionality", "Usability" and "Portability". The grouping of the requirements was defined as represented in the hierarchical structure shown in Figure 2.

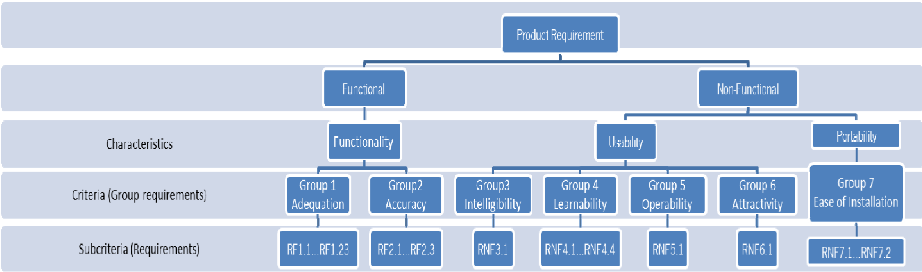

Fig. 2. Grouping of requirements

The sub-criteria considered for evaluations were grouped into three categories: project management, collaborative and others (see table 2).

Table 2. Requirements

Project Management	Collaborative	Others
Subtasks; Definition of task start and end dates; Milestones; Definition of tasks precedence's; GANTT chart; Critical path; Network diagram; Importation of projects; Exportation of projects; Input of work duration (days, weeks, months); Calendar; Event notification; Event log; Highlight important dates; Reporting; Appoint resources (people); Appoint resources (material); Indicate if a resource is overloaded; Input costs of resources; Project budget; Project control.	Chat; Email integration; Online conference; Forum.	User friendly; Help; Tutorials; Tool demonstration videos; Free updates; Shortcuts; Graphical user interface customization; Easy installation in a specific environment; Easy configuration.

After defining and grouping the requirements to assess, we proceed to the assignment of metrics. First, we define the priority or weight of each sub-criterion, which may be essential (weight of 3), important (weight of 2) or desirable (weight of 1). The priority demonstrates the importance of the tool having certain requirement.

After setting the priority or weight of each sub-criterion we have to assign the level of service, using the same analysis method of Cerqueira & Silva (2009) [16] which comprises: total (value=2), partial (value=1) or none (value=0). Total means that the tool has the complete requirement, partial means that the tool has partially the requirement, and none means that the tool does not have the requirement.

Besides the level of attainment and priority, we indicate a note regarding the type of assessment and respective percentage. Using the same analysis method of Marçal & Beuren (2007) [17] we considered the following levels: Excellent (90-100), Good (75-90), Satisfactory (60-75), Regular (50-60) or Poor (0-50). The total score reached by each tool is evaluated, using the set of evaluation criteria established for each characteristic according to equation 1 [16].

$$\text{Total Score} = \sum_{I=1}^{N} (P \times A) \qquad (1)$$

N =Feature's number of criteria
I = Identifies the criteria (ranging from 1 to N)
P = Criteria's weight of priority
A = Criteria's level of attainment

5 The Application to Compare CPMT and Results Obtained

In order to use the decision support multicriteria model, we have developed a software application. This allows project managers to define what tools they want to compare, the requirements needed and the respective weights. The developed application allows the introduction of new tools and their respective requirements, as well as to remove tools, and presents as a result the assessment of the tools under analysis. The name of the tool and the respective score are depicted in descending order, as well as the weights assigned to each requirement. When selecting a tool from the list of results, general information about the selected tool is shown. The application was developed using the program Lazarus and Pascal programming language. For constructing the database, SQLite was used. The application interface is shown in Figure 3.

The evaluation of the *functionality* feature shows that the tool Genius Inside obtains the highest score in comparison to other evaluated tools. This tool provides explicit support for multiple project management, resource managing, budgets, risks, schedules and planning. In terms of collaboration it is an excellent tool for professionals who are, for example, familiar with Facebook, Twitter and Linkedin. The tool with the lowest score is the Goplan; it lacks basic functionalities required for project management, namely resource management, budget etc.

The evaluation of the *usability* feature shows that the tools with the highest score are 5pm, Celoxis, and ClockingIT. However, other tools like Cerebro, Comindware Tracker, Easy project, GanttProject, InLoox, TeamLab, and OpenProj are very close to the score of the first; they do not comply with only one assessment criterion.

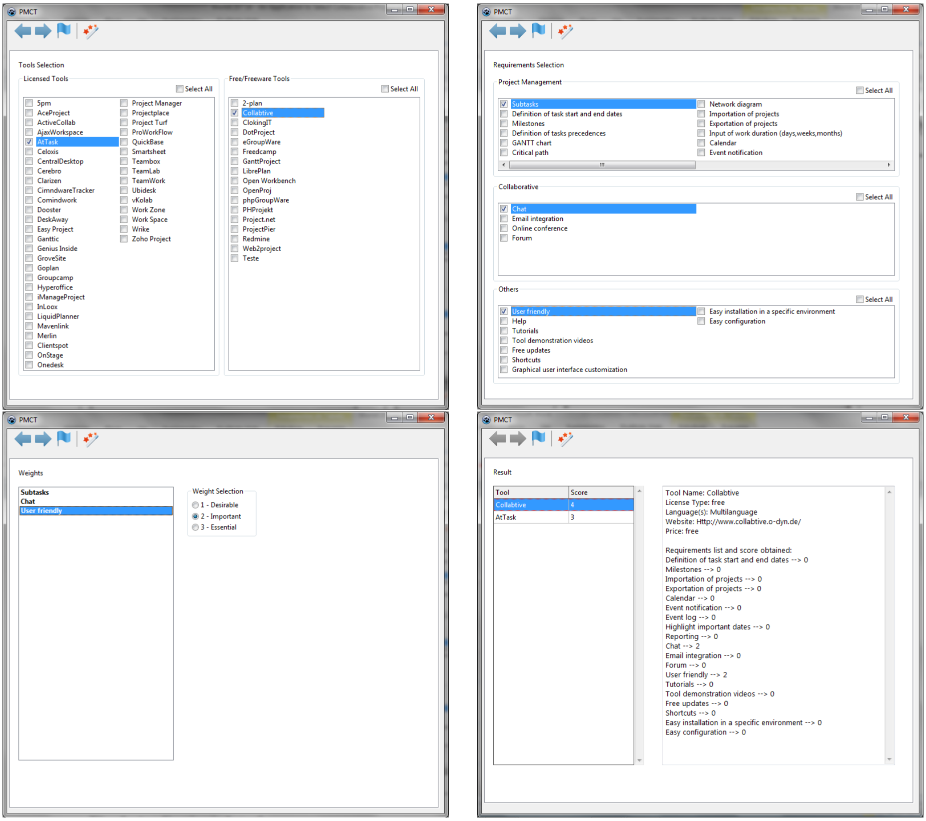

Fig. 3. Application´s Interface

As the results are almost identical, it can be stated that with regard to the *portability* feature, all tools have the desired quality, except ActiveCollab. This is mainly due to the fact that this tool is difficult to install, requiring technical expertise to do it. DotProject, Merlin and phpGroupWare present also lower performance in the *portability* feature. For example, DotProject is difficult to install, demanding a previous installation of MySQL and PHP and requires some specific technical settings.

The tools Celoxis and Genius Inside have the best overall score. The tool Goplan gets the worst overall score. The fact that Celoxis and Genius Inside are quite complete tools, allowing the management of resources, documents, budget, risk, and planning, makes them excellent tools in terms of *functionality*. Regarding the *usability* feature, such prominence does not exist, primarily due to the learning curve that is needed to deal with the complex modules that these tools include. Hence, some professionals may value the *usability* over *functionality*, in order to save time with the learning process.

Comparative Table

The multicriteria decision model was applied to sixty tools. After evaluating the service levels of the criteria for each tool, a comparative table was constructed. In Table 3, we present a sample of the comparison involving two tools, exemplifying how to determine the score for each tool, taking into account their level of attainment (A) and their weight (or priority) (P). The score of each criterion in the comparative table is the result of multiplying the priority assigned to each criterion with the level of attainment, named Result (P*A). Besides the level of attainment and priority, we indicate a grade considering the type of evaluation. As an example of evaluation and comparison of the sixty tools, the 2–plan tool has a result of 59%, which means that it is considered as a tool with a regular type solution. The tool 5pm obtained a result of 66%, which is considered a satisfactory type solution.

Table 3. Comparative Table

Software	Requirement	RF1.1	RF1.2	RF1.3	RF1.4	RF1.5	RF1.6	RF1.7	RF1.8	RF1.9	RF1.10	RF1.11	RF1.12	RF1.13	RF1.14	RF1.15	RF1.16	RF1.17	RF1.18	RF1.19	RF1.20
	Priority (P)	3	2	3	1	2	3	2	2	1	1	2	3	2	2	2	3	2	2	2	2
2-plan	Attainment (A)	2	2	2	2	2	2	0	0	1	1	0	2	2	2	2	2	0	2	0	0
	Result (P*A)	6	4	6	2	4	6	0	0	1	1	0	6	4	4	4	6	0	4	0	0
5pm	Attainment (A)	2	2	2	2	2	2	0	0	2	2	2	2	2	2	2	2	0	2	0	0
	Result (P*A)	6	4	6	2	4	6	0	0	2	2	4	6	4	4	4	6	0	4	0	0

Software	Requirement	RF1.21	RF1.22	RF1.23	RF2.1	RF2.2	RF2.3	F SUM	RNF3.1	RNF4.1	RNF4.2	RNF4.3	RNF4.4	RNF5.1	RNF6.1	U SUM	RNF7.1	RNF7.2	P SUM	Ranking	Percentage
	Priority (P)	2	2	2	2	2	3	55	2	2	1	1	1	1	1	9	2	2	4	136	100%
2-plan	Attainment (A)	0	0	0	0	0	0	26	1	2	2	2	2	2	0	11	2	2	4		
	Result (P*A)	0	0	0	0	0	0	58	2	4	2	2	2	2	0	14	4	4	8	80	59%
5pm	Attainment (A)	0	0	0	0	0	0	30	2	2	2	2	2	2	2	14	2	2	4		
	Result (P*A)	0	0	0	0	0	0	64	4	4	2	2	2	2	2	18	4	4	8	90	66%

Figure 4 shows the final score obtained (in percentage) for each software tool analyzed. For example, the 2-plan tool obtained a total score of 59% representing the percentage at which to tool meets the full requirements considered. The highest score obtained was 88% for tool Celoxis and Genius Inside.

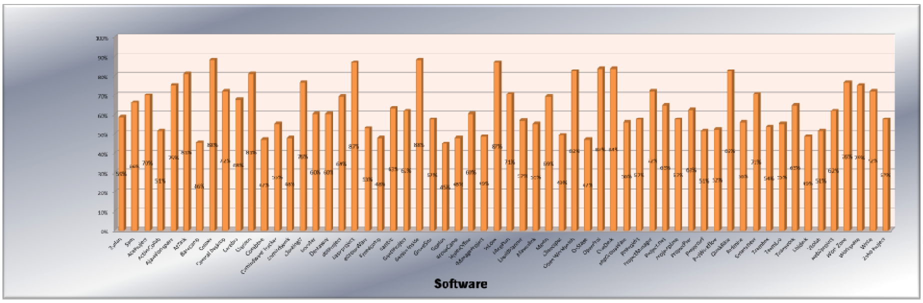

Fig. 4. Final ranking obtained

6 Conclusions

CPMT are an essential support for an effective PM. This is due both to the complexity inherent to PM activities and the increasing tendency for teams to be geographically distributed, requiring strong coordination and control. In addition, project managers are constantly pressured to increase efficiency, and to perform more tasks with fewer resources. CPMT can help to handle and support the various challenges in an increasingly globalized and demanding market. In this research we began to survey a representative sample (sixty CPMT) available on the market. After selecting the tools, we have developed a decision support multicriteria model where we have identified a set of relevant criteria to assist in the evaluation and comparison of CPMT, according to the ISO / IEC 9126 and ISO / IEC 14598. Finally, we developed a computer application that implements the proposed decision support multicriteria model that aims to support project managers in evaluating a set of CPMT, taking into account the predefined criteria. The results obtained for the sixty CPMT analyzed allowed concluding that the tools Celoxis and Genius Inside have the best overall score, mainly due to the *functionality*, *usability*, and *portability* features. The tool Goplan got the worst overall qualification. Besides the comparison of CPMT, it is important to note that a software application was developed allowing the comparison of any CPMT.

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Quantitative Scenario-Based Assessment of Contextual Factors for ICT4D Projects: Design and Implementation in a Web Based Tool

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Abstract. The success of a development intervention is primarily defined by its longer-term results. Information and Communication Technology for Development (ICT4D) projects are no exception. In particular, the external context in which such projects are to be deployed plays a crucial role for achieving better development results. Thus, an analysis of contextual factors is essential for decision-makers at the project proposal screening and evaluation. Guided by the results-based management framework, a tool for influence assessment of contextual factors is designed and presented in this paper. The tool comprises a suggested model for common ICT4D contextual factors and a complementing method for their assessment. The method employs a scenario-based judgments elicitation process for data extraction together with Monte-Carlo simulation for data processing and aggregation. While the tool is not intended for comprehensive and deep analysis, the underlying streamlined process along with the easy to interpret assessment results arguably ensure further wide adoption.

Keywords: Project evaluation, risk analysis, opportunity analysis, decision support system, sensitivity analysis, contextual factors, ICT4D.

1 Introduction

Large investments in Information and Communication Technology for Development (ICT4D) are driven by the theory that more and better information and communication furthers the development of a society. As a framework for managing development projects the Results-based management (RBM) methodology has gained wide adoption, cf., e.g. UNDG RBM handbook [1]. RBM is a life-cycle approach to management that integrates strategy, people, resources, processes, and measurements to improve decision-making, transparency, and accountability.

RBM specifies a so-called “results chain”, which implies “causal sequence for a development intervention that stipulates the necessary sequence to achieve desired

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results – beginning with inputs, moving through activities and outputs, and culminating in individual outcomes and those that influence outcomes for the community, goal/impacts and feedback. It is based on a theory of change, including underlying assumptions" [1].

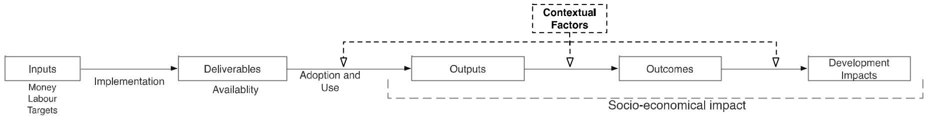

Fig. 1. The results chain. Adapted from Heeks et al. [2]

With respect to ICT4D initiatives, Heeks et al. [2] suggest the ICT4D Value Chain, which is in essence an adaptation of the RBM results chain for ICT4D. An important part of the chain are "exogenous influencing factors", which either favour or threaten intended ICT4D interventions' results such as a widespread ICT adoption and socio-economic benefits (see Fig. 1).

Of special concern for this paper, the RBM methodology requires definitions of assumptions and risks affecting development results of an intervention. "Assumptions are the variables or factors that need to be in place for results to be achieved", whereas, a "risk corresponds to a potential future event, fully or partially beyond control that may affect the achievement of intended results" [1]. It is worth noting that in contrast to the majority of risk management approaches not only negative, but also positive impacts of risks should be considered. As mentioned in the UNDG RBM handbook [1], such an approach to risk management "enables a more balanced consideration of both opportunities and threats, thereby promoting innovation and avoiding risk aversion".

In this light, a *contextual factor* can be viewed as an external uncertain condition that might have a positive or a negative impact on the planned results of the ICT4D initiative. This includes both threats that might prevent projects from achieving their objectives as well as opportunities that would enhance the likelihood of fulfilment of those objectives are included in the concept of contextual factors.

1.1 What Are Contextual Factors?

In terms of the Sen's "Capability approach" [3] contextual factors favour or threaten the conversion of a resource or opportunity into a development benefit. Contextual factors specifically determine people's ability to choose to exploit the opportunity to realize a development benefit [3]. Assessment of contextual factors recognizes the diverse nature of the different contexts within which ICT4D projects are implemented. It avoids the adoption of a one-size-fits-all approach to the development and deployment of ICT4D initiatives.

Much of recent research has aimed at investigating different contextual factors and evaluating their respective role in achieving development results in particular cases ([4-8]). While these studies identify particular factors for given cases and provide qualitative description of their impact, there is lack of approaches for quantifying impact of the factors on a given development intervention. A balanced analysis of contextual factors is especially important at the planning stage of an ICT4D intervention. Thus, contextual factors need to be operationalized in order to properly manage a development project, programme and a portfolio.

1.2 Contextual Factors Analysis and Risk Analysis

As can be seen before, the concept of contextual factor can be directly translated to the concept of risk, since both are "the effect of uncertainty on objectives, whether positive or negative" [9]. Managing risks has always been an important aspect of project management and development projects are no exception. However, while schedule and cost are traditionally important objectives on the operational level during the project implementation, the development domain mainly concerns about project scope and longer-term project results (referred to as the project outputs and project outcomes).

One of the broader views on risk management defines the project success as "an opinion of a project stakeholder on various project characteristics" [10]. Thus, risk management should concern project stakeholders and serve as a communicative means [10, 11]. In the context of development some of the key stakeholders are project implementers, donors and end-beneficiaries.

From a strategic perspective contextual factors pose not only threats but also opportunities. For instance, Olsson [12] argues that it is important for a project manager to have the ability to develop a holistic view within the project in order to manage opportunities along with threats. In this respect, Hilsson [13] extends conventional "Probability – Impact" risk assessment approach to embrace upside of a risk, i.e., opportunity.

1.3 Motivation

The underlying assumption in this paper is that a better understating of contextual factors' influence on success of ICT4D interventions should result in better decisions regarding what projects to execute within the intended environment (e.g., country). Alternatively this should provide support when deciding where and when an ICT4D project proposal would yield better development results.

To the best of our knowledge, there are no suggested ways to employ quantitative evaluation of contextual factors influence given intrinsic uncertainty about their actual magnitude and the general fuzziness of the concept. Considering the decision-makers in donor and implementing organizations as users, this paper suggests a tool for enhancing the screening process for ICT4D projects to be funded, as well as the designing ICT4D project proposals. The tool comprises a suggested list of common ICT4D contextual factors, and a method for scenario-based assessment of contextual factors for ICT4D projects. The main focus of the paper is put on the method design and implementation. The tool has been implemented as a web-service and integrated with the iMENTORS platform – a one-stop-shop data warehouse on ICT4D projects in Sub-Saharan Africa.

In Section 2 we specify the method as a step-by-step procedure. Section 3 outlines the tool's implementation aspects. Section 4 concludes the paper with discussion on design features of the method, future development and application areas.

2 Scenario-Based Evaluation Method

The scenario-based evaluation method prescribes the way initial evaluation data is captured, translated into decision data, represented in simulations and aggregated. Finally the evaluation results are analysed and interpreted as basis for final contextual factors classification.

The method is broken down into 9 consecutive steps, which can be encapsulated into 3 distinctive phases. The first phase "Scenarios elicitation" is where the data required for contextual factors evaluation is captured from decision-makers/experts by means of assessment forms. In the subsequent "Processing phase", the extracted data is first translated into numeric data followed by a Monte-Carlo simulation. Finally, at the "Analysis phase", simulation results are analysed by means of statistical measures and on their basis contextual factors are classified in terms of importance/priority. The detailed specification of each step is further presented.

2.1 Scenarios Elicitation

Most of the difficulties with assessment of contextual factors come from their prior definition and formulation. For this reason we suggest the model of ICT4D contextual factors (Table 1), which summarises past development studies [2-4]. Consisting of 15 factors grouped into 4 major groups, the model should facilitate a holistic, complete discussion of the factors as well as an easy to do analysis of contextual factors.

All the factors have been formulated as positive statements/indicators, i.e. the higher their magnitude - the better. New factors can be defined and added to the analysis as long as they meet the "positive language" requirement.

The evaluation is based on subjective judgments, which are elicited from decision-makers or experts (presumably the evaluators). The evaluator picks up those contextual factors to be analysed from a pre-defined but comprehensive list, selecting those which in his/her view are most influential for a given output achievement/project success. Thus, only selected factors are utilised in further evaluation – not the whole model. Additionally we opt to limit evaluators with an overall number of selected factors up to seven for a given analysis case, since a higher number might be overwhelming to assess.

Table 1. ICT4D contextual factors model

Category	Contextual factors
Political	Governmental/municipal support for ICT development Efficiency and Transparency of national/local governance ICT legislation maturity
Economic	Recipients disposable income Employment rate Affordability of ICT services Services' price stability
Socio-cultural	Recipients general education level IT literacy of recipients Personal motivation of recipients Recipients cultural and ethical support Health Safety
Technical	Accessibility of ICT infrastructure Accessibility of public infrastructure (e.g., electricity) Availability of skilled technical support

2.1.1 Step 1. Specify Extreme Cases for Factors

As mentioned above, RBM requires specifying assumptions when designing development interventions. In terms of our definition of contextual factors, it is reasonable to interpret the assumption as a particular state/level of a respective contextual factor. That is, an assumption should be expressed as a required level of a contextual factor.

At this step, the evaluator defines to what extent the magnitude of a given factor might deviate from its assumed level, both in the negative and the positive directions. The evaluation is done through two sub-steps by providing values for the extreme cases, i.e., for the "worst" case and the "best "case. However, a rather reasonable and plausible deviation should be specified for each case.

The deviation is evaluated in degrees of a respective 6-value linguistic scale (see Table 2). The middle or "zero" point at the scale represents the assumed (most likely) level of magnitude of the factor. Thus, the "worst" and the "best" case scenarios are interpreted as particular degrees of respectively negative and positive deviations from the assumed level of the contextual factors.

2.1.2 Step 2. Estimate Impact of Contextual Factor

As input this step requires intended projects' results to be listed. While several result types are possible, the focus of the current design has been done on assessing outputs. However, we believe the method can be effectively applied to outcomes.

Given the worst-case, best-case and most likely-case scenarios, for each of them the evaluator estimates a given contextual factor's impact on the achievement of the intended development results. The impact of a contextual factor can be either negative ("threat") or positive ("favour"). It is measured in degrees by means of the 12-value bivalent linguistic scale (Table 3).

2.1.3 Design of the Scenario-Based Elicitation Process

A user experience solution to the scenario elicitation process (see the step 2 of the method) is utilizing IF-THEN statements enhanced with a linguistic scale. Experts provide their judgments regarding possible scenarios for the contextual factors by constructing the IF-THEN textual statements, where the "IF" part contains a given contextual factor's magnitude value specified at the step 1, in the "THEN" part the user is to specify the degree of impact at the given magnitude value as a consequence for the scenario. Since this is built around a natural way of formulating scenarios, this should improve comprehensibility and usability for the users unfamiliar with "what-if" and sensitivity analysis.

As mentioned before, the factors are formulated in the "positive language", enabling the following consistency check: the value for the worst-case cannot be better (higher) than the "most-probable" case, and similarly, the best-case cannot be worse (lower) than the "most-probable" case.

To exemplify step 2, an ICT4D project aiming to "implement an e-library service in universities" can be taken. One of its intended outputs is to enable students to participate in online research collaborations. "Affordability of computer" is one of the selected factors. Supposedly defined at the step 1, the worst-case for the magnitude of this factor is "substantially lower" (than assumed), the best-case - "negligibly higher" (than assumed), the most likely case is the assumed magnitude by definition. The Fig. 2 depicts a mock-up for the Step 2 screen, where an evaluator is to estimate impact of the factor on the intended output, i.e., define a consequence for the specified cases and thus, define scenarios. As instance, at the expected magnitude of the "Affordability of computer" factor, it "slightly threatens" achievement of the output. In the worst-case scenario the "Affordability of computer" might be "substantially lower" (than expected), in this case the output achievement is "somewhat threatened". Finally, in the best-case scenario, when the factor is "slightly higher", it has negligible impact on the output achievement.

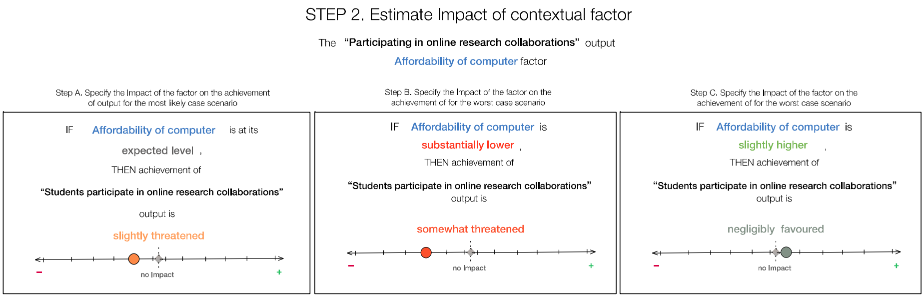

Fig. 2. "Step 2. Estimate impact of contextual factor" example.

2.2 Processing Phase

The following steps constitute the Monte-Carlo simulation approach taken for contextual factors assessment. This technique considers the inputs as random variables and run a number *N* of computations (so-called trials) by sampling the input in order to obtain *N* possible results. The sampling can be defined by a parametric distribution function, which makes the uncertainty representation very flexible.

This approach has been chosen, since it can address complex situations that would be otherwise difficult to understand and solve analytically [14]. Finally, the approach should be easier for experts, since it doesn't require determined individual scenarios but considers range limits and associated confidence levels. This effectively serves the goal of providing comprehensive and balanced assessment of contextual factors.

The Processing phase is further presented as for one contextual factor at a time. Thus, the phase should be reapplied for each contextual factor being evaluated.

2.2.1 Step 3. Translate Linguistic Values into Numeric Ones

At this step all the linguistic values for factor magnitude and factor impact, each with values for the worst, best, and most-likely cases, are represented numerically. Factor magnitude linguistic evaluations (Step 1) are translated into numeric values in accordance to the Table 2.

Table 2. Factor magnitude linguistic values with associated numbers

Scenario	Linguistic term	Numeric value
"Worst-case" scenario	Minimal plausible magnitude	-8
	Enormously lower	-5
	Substantially lower	-3
	Somewhat lower	-2
	Slightly lower	-1
	Negligibly lower	0
"Best-case" scenario	Negligibly higher	0
	Slightly higher	1
	Somewhat higher	2
	Substantially higher	3
	Enormously higher	5
	Maximum plausible magnitude	8

The linguistic values for Factors Impact evaluations (step 2) are mapped with numeric representations in accordance to the Table 3.

Table 3. Factor impact linguistic values with associated numbers

Affect	Linguistic term	Numeric value
Threat	Blocked/terminated	-8
	Enormously threatened	-5
	Significantly threatened	-3
	Somewhat threatened	-2
	Slightly threatened	-1
	Negligibly threatened	0
Favour	Negligibly favoured	0
	Slightly favoured	1
	Somewhat favoured	2
	Significantly favoured	3
	Enormously favoured	5
	Safe/guaranteed	8

2.2.2 Step 4. Define Input Variable

Given the numeric values for the 3 scenarios estimation, the factor magnitude, denoted as x, can be represented as a random variable with a triangular probability density function (triangular pdf) f_x defined as (1).

$$f(x|a,b,c) = \begin{cases} 0, & x < a, \\ \dfrac{2(x-a)}{(b-a)(c-a)}, & a \le x \le c, \\ \dfrac{2(b-x)}{(b-a)(b-c)}, & c < x \le b, \\ 0, & b < x, \end{cases} \tag{1}$$

where a, b, c are parameters defined by factor magnitude's values for the "worst", "best", and "most likely" cases', i.e. the lower bound, the upper bound, and the mode of the triangular distribution respectively.

Among several options for the sampling (e.g., the beta distribution), the representation by triangular pdf naturally fits the three-point estimation approach taken for scenarios elicitation. Other reasons for the choice include its computational efficiency, cognitive transparency, and sufficiency for the tool's aims.

2.2.3 Step 5. Generate Trials for Factor

At this step the factor magnitude defined previously as a random variable is sampled by generating n random variates. To find a random variate for a given triangular pdf with parameters a, b and c, the following routine is run:

1. Generate a random $u \sim U(0,1)$
2. The variate equals to (2), which is derived from the cumulative distribution function of f_x.

$$\begin{cases} X = a + \sqrt{U(b-a)(c-a)}, & 0 < U < F(c) \\ X = b - \sqrt{(1-U)(b-a)(b-c)}, & F(c) \le U < 1 \end{cases}, \tag{2}$$

where $F(c) = (c - a) / (b - a)$.

2.2.4 Step 6. Calculate Impact for Each Trial

At this step for each previously generated factor magnitude we calculate its impact on each given project output in accordance to a function. Each factors' impacts on a j:th project output is presented as a piece-wise linear function $y_j = I(x)$ of a factor magnitude x defined as (3). Since contextual factors are formulated in the "positive language" (see the Preparation section), it is reasonable to assume that $y_j = I(x)$ is monotonically increasing.

For i=1 to n, where n is the number of trials, and from j=1 to K, where K is the number of project's outputs, obtain $y_{j,i}$ according to Eq. (3).

$$y_{j,i} = \begin{cases} y_j^{\,0} + \dfrac{(x_i - 0)(y_j^- - y_j^{\,0})}{x^- - 0}, x^- \le x_i < 0, \\ y_j^{\,+} + \dfrac{(x_i - x^+)(y_j^{\,0} - y_j^{\,+})}{0 - x^+}, 0 \le x_i \le x^+ \end{cases}, \tag{3}$$

where

- x_i is the i:th generated random variate (see the step 6)
- x^- is the factor magnitude value representing the "worst-case" scenario, i.e. the lower bound (see the Step 2)
- x^+ is the factor magnitude value representing the "best-case" scenario, i.e., upper boundary (see Step 2)
- 0 is the factor magnitude value representing the "most probable" case scenario (mode), and equals to "0" by definition (see the Step 3)
- y_j^- is the factor impact on the j:th output value for the "worst-case" scenario, (see Step 3)
- y_j^+ is the factor impact on the j:th output value for the "best-case" scenario (see the Step 3)
- y_j^0 is the factor impact on the j:th output value for the "most probable" case scenario (see the Step 3)
- $y_{j,i}$ is the i:th trial's value for factor impact on the j:th output.

Thus, as an output of this step, for each involved factor $n{\cdot}K$ number of impact values are produced where n is the number of trials and K is the number of project outputs taken into analysis.

2.2.5 Step 7. Aggregate Outputs Impacts for Each Factor

It is necessary to aggregate individual factor impact values for each project output into one aggregated factor impact value Y_i, which shows the overall factor impact on a whole project for each trial. For this purpose the simple mean aggregator is employed (4).

$$Y_i(y_1, y_2, ..., y_K) = \frac{1}{K}\sum_{j=1}^{K} y_{j,i} \ , \tag{4}$$

where

K is the number of project outputs, $y_{j,i}$ is the i:th trial's value for factor impact on the j:th project output, and Y_i is the aggregated factor impact value for the i:th trial.

2.3 Analysis

2.3.1 Step 8. Analyse Samples

There are plenty of statistical measures suitable for analysis of the generated output of the Monte-Carlo simulation. Among most used are average, standard deviation, minimum, and maximum. However, while conventional statistical analysis usually takes the whole sample, for contextual factors analysis it is suggested to measure the downside (threat) and the upside (favour) of a factor separately. This is handled by partitioning the whole sample $S = \{Y_i\}_{1 \leq i \leq n}$ into the set S^- containing all negative values, and the set S^+ containing all positive values of S. This aligns the suggested approach with the contextual factor evaluation and ensures easier comprehension for decision-makers.

For the analysis of the aggregated sample set S the following indicators are suggested:

i) Expected level of threat calculated as a mean of negative values such that

$$\overline{S^-} = \frac{\sum\limits_{Y_i \in I^-} Y_i}{|S^-|} \tag{5}$$

where $|S^-|$ is the cardinality of S^-

ii) Probability p^- of the factor causing threat such that

$$p^- = \frac{|S^-|}{n} \tag{6}$$

where n is number of trials

iii) Expected level of favour calculated as a mean of non-negative values such that

$$\overline{S^+} = \frac{\sum\limits_{Y_i \in S^+} Y_i}{|S^+|} \tag{7}$$

where $|S^+|$ is the cardinality of S^+

iv) Probability of the factor causing favour such that

$$p^+ = \frac{|S^+|}{n} \tag{8}$$

where n is the number of trials.

2.3.2 Step 9. Classify Factors

Given specified thresholds for the two pairs of statistical measurement, i.e. i)-ii) and iii)-iv), each factor can be classified in terms of its influence on the ICT4D project at hand. For ease of perception, the plot area can be colour coded and hereby classified into different degrees of importance (classes). An example of a colour coded matrix with assigned thresholds is depicted at Fig. 5, where one of the factors is placed in corresponding cells.

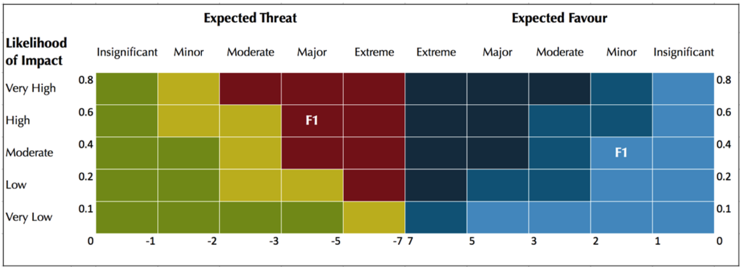

Fig. 3. Factor assessment matrix example

3 Implementing the Tool

The suggested method has been implemented as a tool of the decision-support system of the iMENTORS platform. iMENTORS is a one-stop-shop data warehouse on all ICT4D projects in Sub-Saharan Africa (see [15]). Besides of the contextual factors assessment, the decision support system enables multi-criteria evaluation of ICT4D project performance. The decision-support system has three key components: a web-based front-end implemented at the iMENTORS main platform, a cloud evaluation service, which performs all the computational tasks, and a data-warehouse, where the evaluation results are stored and can be retrieved from.

Following the scenario elicitation phase of the method, a step-by-step process is implemented as a series of web-based assessment forms with relevant questions and with color-coded linguistic scales for expressing experts' judgments (Fig. 5).

The captured data is sent in XML format to the cloud evaluation web-service, which performs the steps of the Processing phase of the method. More specifically, for the iMENTORS case number of trials n is set to 10 000. Finally, the computational service returns the statistical and classification results specified in the Analysis phase.

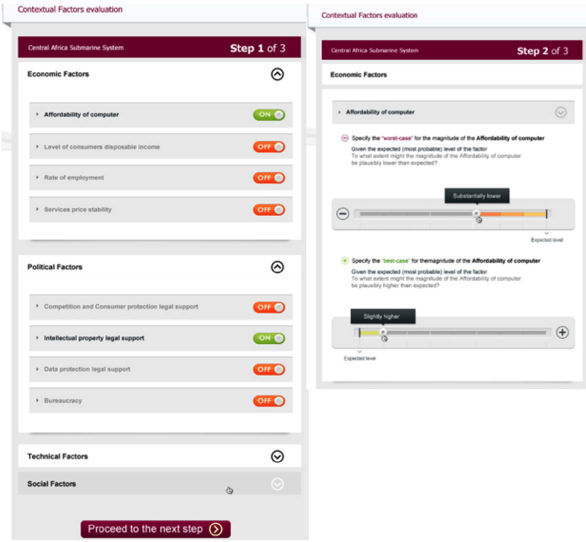

Fig. 4. Example screenshots of the assessment screens for the Steps 1,2

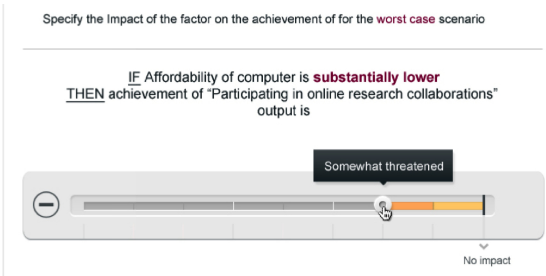

Fig. 5. Example screenshot of the assessment screen for the Steps 3

4 Conclusion

The notion of a contextual factor is rather general and qualitative for immediate decision analysis applications; thus, certain efforts need to be taken in order to operationalize the concept. The aim of the suggested analysis is to define a quantitative value for a contextual factor, its relative impact given intrinsic uncertainty about the factor magnitude, and hereby importance of a given contextual factor for results achievement of an ICT4D project.

For this we link RBM concepts with the contextual factors, generalize and translate them into quantifiable definitions, which enables approaching with prevailing risk assessment techniques, such as the Monte Carlo simulation. At the same time, the approach goes beyond traditional understanding or risks as threats, providing the stakeholders with a comprehensive and balanced overview of the external environment in which a given ICT4D project is to be carried out. In other words, it gives estimation of how sensitive a project success is to the aimed environment.

The key design features of the method include neutral indicator-like formulation of contextual factors with their quantification with respect to the currently assumed levels, a straightforward elicitation process supported by constructing the "IF-THEN" textual statements as a natural way for scenario formulation. The processing phase features representation of contextual factor impact as monotonically non-decreasing dependence on the factor magnitude. All of these features ensure higher usability and comprehensibility of the tool, along with its computational and overall efficiency.

At the same time the method is based on experts judgments rather than, as instance, statistical and historical data. While limiting the results validity and application scope, that was an inevitable design decision, since there is shortage on open and ready-to use historic data on contextual factors in Sub-Saharan Africa. Even if it were available this could be too demanding to employ by smaller ICT4D project teams. The tool is instead intended for "quick and dirty" evaluation of the environment and what-if analysis for any ICT4D intervention.

There are several future development directions. Since iMENTORS is meant to be a public service with capability to aggregate data on the whole region, the analysis could be done for each factor based on the multitude of evaluated proposals for a given area. As instance this could reveal a particular set of most impactful factors for each area. Also, the method could be adapted for the ex-post evaluation of the factors, which is to be helpful for the following-up of previously evaluated projects, as well as to reveal factors factually influential for achieving given project's results. Finally, the method itself can be applied to other areas beyond ICT4D, such as strategic management, investment evaluation, public policy assessment and others.

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Toward Evolutionary Nonlinear Prediction Model for Temperature Forecast Using Less Weather Elements

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Abstract. This paper presents the notion of evolutionary nonlinear prediction technique for temperature forecast based on GP (Genetic Programming). The linear regression method is widely used in most of numeric weather prediction model. Their performances are acceptable, but some limitation is existed for nonlinear natures of the weather prediction. We explain how to apply symbolic regression method using GP for the nonlinear prediction model using less weather elements. In order to verify the possibility of the proposed method, experiments of temperature forecast for the sampled locations in South Korea are executed.

Keywords: temperature forecast, genetic programming, nonlinear regression.

1 Introduction

As numerical techniques and computational power have been steadily improved, various scales and types of numerical weather prediction models are developed for the quantitative forecasting of various weather elements [1-3]. Most popular form of NWP (Numeric Weather Prediction) is based on a linear regression. However, a linear regression model is not adequate to represent non-linear behavior of the prediction problems. Also it does not guarantee to obtain optimal solutions for NP-hard problems although it can provide acceptable performances.

To overcome these problems of existing approaches, we have proposed a seemingly more efficient approach that optimizes a prediction model for temperature predictions through nonlinear combinations of potential predictors using GP (Genetic Programming) [4]. GP based nonlinear regression is enable to search open-ended space for order and coefficient of equations. It is also powerful to generate complex nonlinear forms using transcendental functions. This allows it to solve the limitations of search for a linear regression model, even though the evolutionary approach still has difficulties in search of enormous and complex space.

It is not easy to obtain correct data and maintain integrity for entire period and locations because the weather data is complex and extremely huge. Especially the number of weather elements are many, for example, 50 to 60 in UM (Unified Model) [5] and KLAPS (Korea Local Analysis and Prediction System) [6], there exists missing data for locations and/or period in the past weather data frequently. Therefore

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it is necessary to provide nonlinear prediction model with less weather elements. For offering nonlinearity for less elements, spatial and temporal relationship for the reference elements can be adopted in the proposed method.

In this paper, a generation technique of nonlinear regression model for a temperature prediction using Genetic Programming is proposed. GP based symbolic regression approach with less weather elements is investigated for sampled locations in Korean peninsula.

This paper is organized as follows. Section 2 explains genetic programming based non-linear prediction model. Section 3 describes construction method for non-linear model with less weather elements. Section 4 presents pre-experimental results of temperature forecast for Korean peninsula, and Section 5 concludes the paper.

2 Genetic Programming Based Numeric Weather Prediction

2.1 Genetic Programming and Symbolic Regression

Genetic programming [4] is an extension of the genetic algorithm [7] with variable-sized entities. It can be used to grow trees that specify increasingly complex solutions. One of the popular applications of GP is symbolic regression. It consists of finding a function that fits the given data points without making any assumptions about the structure of that function. It is possible to generate open-ended high order equations for complex nonlinear forms using a tree structure. Therefore GP based model can express nonlinearity much more flexibly involving multiplication, division and transcendental functions. Especially sinusoidal functions can represent periodicity well. Moreover, symbolic regression can include not only mathematical functions but also various conditional statements such as, min(a,b), max(a,b), and if(a>b).

Therefore it enables to solve the limitations of a linear regression approach using that powerful tool, even if high degree of difficulties still remain in evolutionary search due to enormous and complex space.

2.2 GP Based Nonlinear Prediction Model

The generation process of GP based prediction model is shown in Figure 1. For each grid of locations, the model of temperature prediction is generated by genetic programming method using tree structures. The tree nodes are composed of arithmetic functions and weather elements. Open-ended combinations of functions and weather elements can make any nonlinear equation models.

For example, the 15 kinds of total 49 weather elements are employed as potential predictors including temperature, humidity, wind speed and accumulated rainfall in Korea Meteorological Administration office.

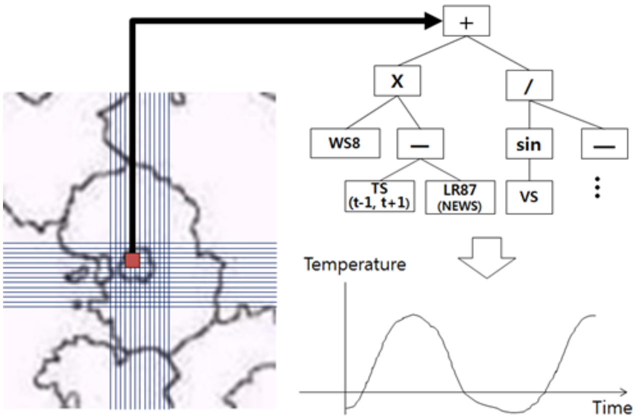

Fig. 1. The scheme of GP based nonlinear prediction

3 Constructing GP Based Prediction Models

3.1 Function and Terminal Sets

The set of primitive functions should be sufficient to allow solution of the problem at hand, but there are typically many possible choices of sets of operators that meet this condition. The function set for the proposed GP-based prediction can involve arithmetic, operators, transcendental functions and conditional statements. The terminal set can consist of several tens weather elements, spatial and temporal weather elements as follows. The spatial elements indicate the values of neighboring locations for the specific weather elements, for example, the WSS (wind speed) of eight directions of a reference location. The temporal elements represent the values of past time for the specific weather elements, for example, the WSS of previous times (-3h, -6h, …) of a reference time.

Function set = {+, *, -, /} ∪ {mean, sin, cos, log, exp} ∪ ∪{min, max, if}

Terminal set = {basic weather elements} ∪ {spatial and temporal weather elements}

The various combinations of function and terminal elements can be possible, but the spatial and temporal weather elements are selected for the preliminary experiments in this paper. Instead of using entire basic weather elements, spatial and temporal relation data for less weather elements is more efficient when only the data of major weather elements are available.

3.2 Natural Selection of Predictor Variables

Especially, the fundamental problem of pre-selection for potential predictors can be naturally solved in GP based approach, because dominant predictors are extracted automatically through the evolution process of genetic programming. That means all candidates of predictors are considered without excluding some potential predictors in advance, therefore the possibility of optimized selection of potential predictors is much better than fixed predictors.

Every solution of GP based model doesn't necessarily have same predictors, because not only the size and shape of GP tree for optimized solutions are different but also selected predictors are varied for each solution. Therefore, we can generate a tailor-made compensation equation for various locations in wide range of period which have different characteristics

4 Experiments

Preliminary experiments of GP based temperature prediction were executed using lil-gp [8] for the couple of locations in South Korea. The GP parameters used for the GP run were as follows:

Population sizes: 200
Max generation: 500
Initial Tree Depth: 2-5
Initial Tree Method: Half and Half
Max Depth: 10
Crossover Rate: 0.9
Mutation Rate: 0.1

The data of 2009 is used for training and the data of 2010 is adopted for verification. Performance index of ME (Mean Error) is calculated. The results show that nonlinear GP method is quite promising to apply temperature prediction. The one of temperature prediction results is shown in Figure 2.

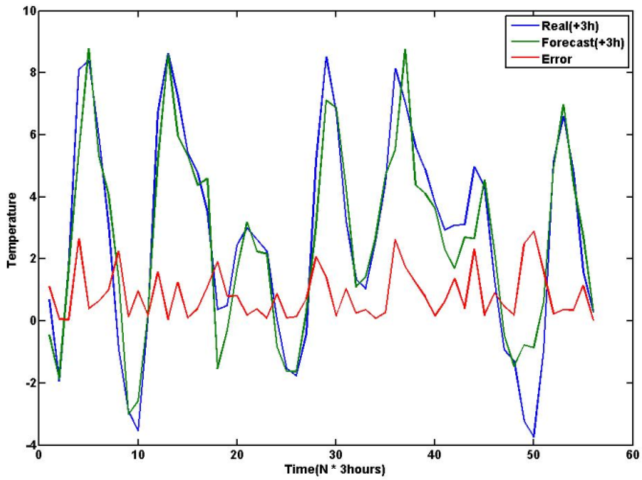

Fig. 2. The result of temperature prediction by the proposed GP model

5 Conclusions

New nonlinear prediction technique, based on symbolic regression using Genetic Programming, is proposed and validated to show the possibility as a prediction model. Experiments are executed for 10 stations in South Korea with 21 time intervals. Learning is performed for 2009 weather data and validation is processed for 2010 data. Although the experiments run to date are not sufficient to allow making strong statistical assertions, it appears that the GP based prediction method is enough to make feasible models for temperature forecast.

Further study will aim at refinement of the selection for spatial and temporal weather elements and the advanced GP search including the extended experiments for entire area of South Korea.

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Cartesian Genetic Programming Based Optimization and Prediction

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Abstract. This paper introduces a CGP (Cartesian Genetic Programming) based optimization and prediction techniques. In order to provide a superior search for optimization and a robust model for prediction, a nonlinear and symbolic regression method using CGP is suggested. CGP uses as genotype a linear string of integers that are mapped to a directed graph. Therefore, some evolved modules for regression polynomials in CGP network can be shared and reused among multiple outputs for prediction of neighborhood precipitation. To investigate the effectiveness of the proposed approach, experiments on gait generation for quadruped robots and prediction of heavy precipitation for local area of Korean Peninsular were executed.

Keywords: Cartesian Genetic Programming, gait optimization, heavy rain prediction, symbolic regression.

1 Introduction

CGP [1,2] is a different form of Genetic Programming [3] in which a program is represented as a network of nodes. The nodes are combined to express a function. Previous columns of nodes may have their outputs connected to a node in the current column. That means some useful building blocks can be connected to nodes in multiple times. Therefore, it can search more efficiently on some particular types of problems which require certain relationships among outputs.

This enables to represent the nature of optimization and prediction problems both. Two applications are selected to prove the proposed approach. We apply the special features to gait generation of quadruped robots and prediction of heavy precipitation.

First, automatic generation of gaits is especially important for walking robots because different environments and newly developed robots make it necessary to generate a variety of gaits in a short period of time [4]. Planning gaits for quadruped robots is a challenging task that requires optimizing the locus of the robot's paw and stance parameters in a highly irregular and multidimensional space. Efficient representation and search method are necessary for the complex gait optimization [5,6].

Second, prediction of heavy precipitation is very difficult, because it is complex and irregular also it depends on various elements, such as location, season, time and

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geographical features [8,9]. Because heavy rain is very unpredictable and ever-changing, not only statistics and learning from past data are necessary, but also propagation effects from adjacent locations should be reflected [10]. In order to consider those propagation effects, a special form of network based optimization or learning method is required.

In this paper, we propose a new CGP (Cartesian Genetic Programming)-based gait generation method for quadruped robots and prediction technique for heavy rainfall. To investigate the effectiveness of the approaches, gait optimization experiments are performed for the Bioloid quadruped robot in the Webots [10] environment and prediction of precipitation experiments for the KLAPS [11] data of 2006-2011 in partial regions Korean.

2 Cartesian Genetic Programming

CGP is a special form of evolutionary algorithm in which a program is represented as an indexed graph. The graph is encoded in the form of a linear string of integers. Each block of a CGP can be represented as 3 strings (inputs 1, 2 and operator 3) as shown in Figure 1 [1,2]. The blocks are combined to express a function. Nodes in the same column are not allowed to be connected to each other, and any node may be either connected or disconnected. Unlike standard GP using tree expressions, CGP can obtain multiple outputs using a linear string of integers, and additionally can have features that constitute re-usable modules.

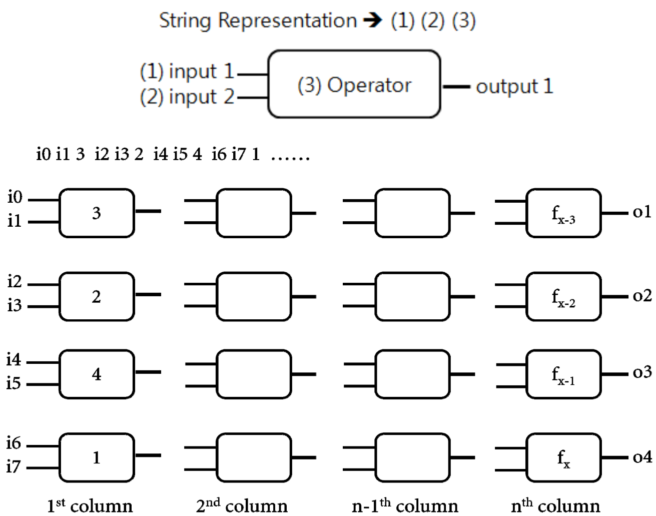

Fig. 1. Representation of Cartesian Genetic Programming

3 CGP Based Gait Control

This section explains how we develop a fast gait for a quadruped robot using Cartesian genetic programming (CGP) in joint spaces. In Figure 2, the value of the first input (i0) is X, which expresses time, and the other inputs are random constants. The output of the evaluation of a CGP genotype corresponds to trajectories of each joint. The cascade connections from inputs to outputs construct polynomial networks for representing a set of trajectories of gait.

One of advantages of CGP is sharing a trajectory graph with different phases in gait generation. As shown in Figure 2, the second and third row modules in the n-1th column can be used as common inputs of an arithmetic function in the last column that generates joint trajectories for each leg. Therefore, the CGP-based gait generation method can have a possibility to search more efficiently some useful modules and relationships among outputs being evolved for different legs.

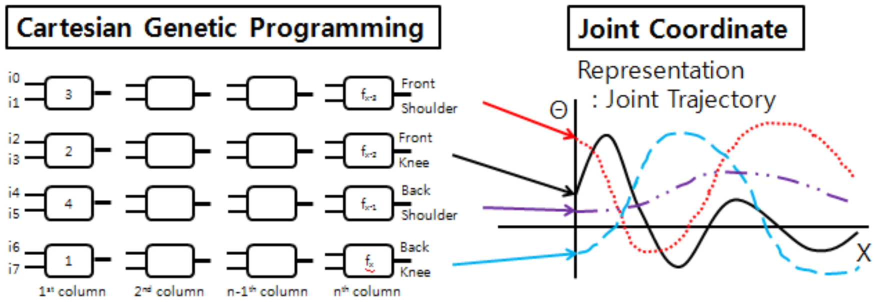

Fig. 2. CGP Based Gait Generation Method

4 CGP Based Heavy Rainfall Network

Prediction of heavy rainfall using Cartesian genetic programming (CGP) is described in this section. In Figure 3, the inputs are accumulated rainfall in intermediate results. The output of the evaluation of a CGP genotype corresponds to compensated values of prediction by cell network. The cascade connections from inputs to outputs construct polynomial networks for compensation by neighbor weather stations.

The CGP based heavy rainfall network produce compensated outputs of precipitation for multiple stations through cell network using inputs from multiple stations. The network consists of 9 inputs and outputs pairs of grids. In detail, 9 inputs (i0 – i8) represent 6 hours accumulated precipitation at time t-1, and 9 outputs (o0 – o8) represent 6 hours accumulated precipitation at time t. An expected advantage of CGP is propagating a rain band according to moving direction of precipitation affected by winds or pressures. As shown in Figure 3, the cascaded network can change or compensated original forecasts values by NWP model. Therefore, the CGP-based prediction method can find more useful modules and relationships among outputs being evolved for neighboring locations.

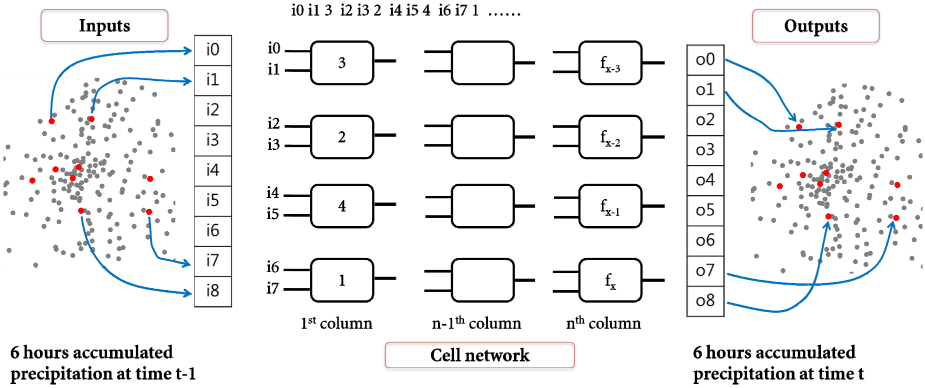

Fig. 3. CGP Based Gait Generation Method

5 Experiments and Analysis

This section describes how we evaluated the proposed approach to develop a fast gait for a quadruped robot and a prediction for heavy precipitation using CGP. The CGP parameters for both experiments were as shown below in Table 1.

For gait generation problem, a simulated model of Bioloid in Webots was used, The tabular results of velocities for generated gaits are provided in Table 2. Every run was repeated 10 times for each case. The max velocity value from CGP was 27.03 cm/s, obtained with population size 500 and it is very competitive.

Table 1. The CGP parameters

CGP Parameters for gait generation	CGP Parameters for prediction of heavy precipitation
Terminal set : Random Constants, X Function set : SIN, COS, +, -, *, / Number of generations : 100 Mutation : 0.5 Number of rows : 4 Number of columns : 200 Levels back : 200 4 number of rows 200 number of columns 200 levels back	Terminal set : Random Constants, X Function set : fabs, sqrt, +, -, *, / min(A,B), max(A,B), mean(A, B) if-then(A, B, C, D) Number of runs : 10 Number of populations : 100 Number of generations : 10000 Mutation : 0.5 Number of rows : 4 Number of columns : 10 Levels back : 10

Table 2. Experimental results of velocities for quadruped gaits by variation of the population sizes

	Popsize	Average Velocity(cm/s)	Max Velocity(cm/s)
Gait Generation	150	12.67	19.68
	250	13.24	23.70
	500	17.35	27.03

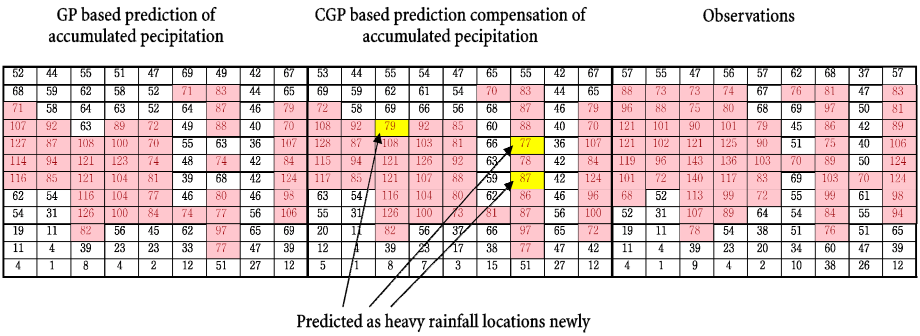

Fig. 4. An example of CGP based compensation of accumulated precipitation for partial locations

Experiments on local area of Korean Peninsular were performed for prediction of heavy precipitation. An illustrated result of compensation for precipitation using CGP network is shown in Figure 4. The false predicted stations in GP based prediction (left) are corrected by CGP based prediction (middle), which are indicated by arrows, compared to the case of observations (right). For reference, if 6 hours accumulated precipitation is above 70 mm, then it is forecasted as a heavy rainfall newsflash in Korea.

6 Conclusions

We have suggested new and efficient gait generation method for quadruped robots and prediction method for heavy precipitation based on CGP (Cartesian Genetic Programming). The main idea of the method is that CGP can generate multiple outputs through one genotype expression and can share some useful building blocks and re-used modules. Therefore, it can search more efficiently on some particular types of problems which require certain relationships among outputs, such as partially similar trajectories of single or multiple joints for gait generation and influences by neighboring stations for precipitation. The experimental results showed important possibilities of CGP based gait evolution for quadruped robots and of prediction for heavy precipitation.

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LASTC: Legal Advisory System for Thai Cheque Law

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Abstract. Legal information has been utilized increasingly for developing legal applications. We propose a decision support system to solve legal problems by inferring from knowledge base and interpreting the legal explanation to user. Given a legal case as an input, our system provides the court hearing scenario for each legal case. Our proposed algorithm namely EstoppelProofEngine simulates the court procedure using evidence law. Moreover, the system can conclude the court decision and give the legal explanation to user. This paper presents a decision support system called Legal Advisory System for Thai Cheque Law (LASTC). LASTC can simulate the burden of proof principle used in the court hearing process. Moreover, the system also provides the legal explanation to user. The module of LASTC was examined by various legal cases and compared with the benchmark.

Keywords: Decision Support System, estoppel principle, legal reasoning, Thai Cheque Law.

1 Introduction

Most legal applications are court sentences retrievals implemented on Supreme Court Web sites. In legal study, court sentences are considered as a source of law. There are two domains of law; procedural law and substantive law [1]. Procedural law comprises the set of rules that govern the proceedings of the court in lawsuits. The court needs to conform to the standards set up by procedural law during the proceedings. These rules ensure fair practices and consistency in the “due process”, especially the rules of evidence. Substantive law defines the rights and duties of the people. The limitation of the court sentences retrieval system is the lack of legal interpretation and the incomplete law domain. Legal users have difficulties applying the court sentences to their legal cases. Furthermore, the effect of procedural law to the case cannot be found in the court sentence.

In this work, we propose a new algorithm called *EstoppelProofEngine* which infers the set of rules obtained from substantive law (Thai Cheque Law) and procedural law (Evidence Law). A decision support system called LASTC is implemented to show the complete legal explanation. LASTC ensures the legal understanding for user since it provides the switch of burden of proof and the rule of evidence related to the specific case.

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The reason why we select this legal domain is because we found that a large number of legal cases related to Cheques were submitted to the court. LASTC acts as a legal adviser for general user who has question about his cheque. The system derives answer from a knowledge base automatically via the EstoppelProofEngine to formulate new conclusion. Furthermore the system can provide the specific legal explanation for user understanding. This is a strategic idea to gain user confidence and acceptance. For legal experts such as lawyer or judge, they can get information about the court procedure applied by evidence rules for the specific case. This is an advantage of LASTC since the lawyer will know in advance about the burden of proof so that he can prepare the appropriate evidence for the court hearing process.

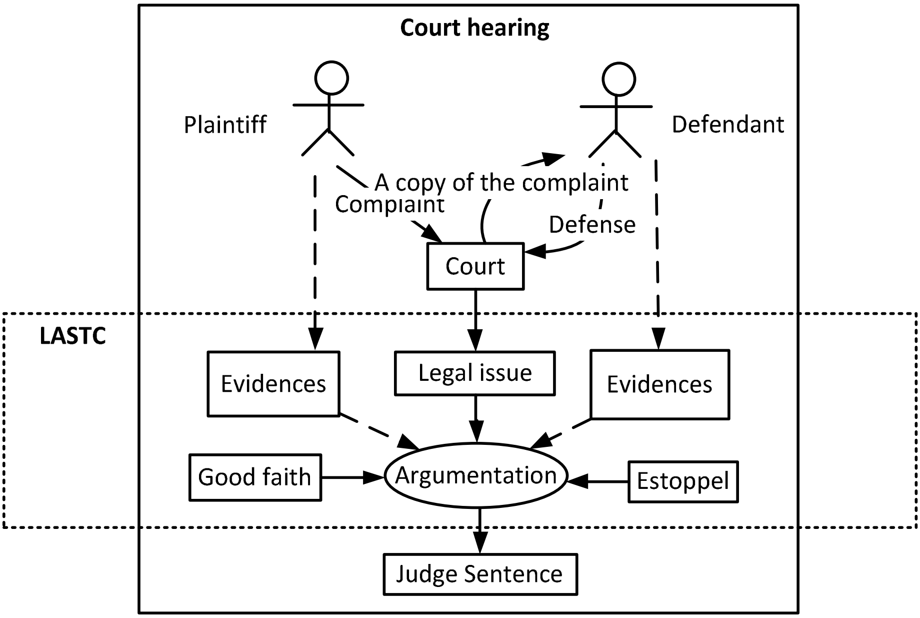

Fig. 1. Court hearing process

Legal reasoning is a part of Court hearing process involves in an argumentation between a plaintiff and a defendant. In this process, rules and facts are compared by the judge in order to give conclusions of the issues. To summarize the issues, the judge needs a set of evidences to support the court decision. Before the court hearing process begins (see Figure 1), a plaintiff must submit a complaint to the court. Then, the court considers the plaintiff's complaint and sends a copy of the plaintiff's complaint to a defendant. After that, the defendant must submit a defense to the court. Therefore, the court determines a set of issues related to the case.

2 Related Work

There are various legal applications found in the literature. In 1986, Sergot, M.J. *et al.,* proposed a system called APES [2] to determine whether a particular individual is or is not a British citizen. The British Nationality Act 1981 was formalized as the knowledge base. However, the application of the expert system shell is difficult for users because it is a command-line interface. Note that APES provided only the determination of British nationality; it did not simulate the court procedure.

Court in every country has its own retrieval system, such as the Supreme Court of Thailand [3], Supreme Court of the United States [4] and Supreme Court of Japan [5]. Typical keyword search technique and the theory of information retrieval (IR) are applied to develop the search engine. Boonchom, V. and Soonthornphisaj, N. proposed an algorithm called ATOB which uses ant colony to extend the legal ontology automatically [6]. The ontology was applied as a knowledge representation in order to complete the query expansion base on legal concept. They found that ATOB could improve the retrieval performance in terms of precision, recall and F-measure. In addition, there was another attempt related to the legal application which was done by Waiyamai, K. and Pongsiriprida, T. [7]. They applied data mining technique to select the law and articles for lawsuits. The technique can help the judge to select appropriate laws and articles from a very large database.

Saunders K.W. proposed a logic for the analysis of Collateral estoppel [8]. They developed the logic called FT and FS4 which were extended from the modal logic T. The principle of collateral estoppel focused on the estoppel of the judge that has to decides the legal case based on the doctrine of precedent. His work focused on the estoppels in macro level (case level) since it was applied to the common law system. However Thailand is the Civil law country so we apply the principle of estoppel to control the fact in each legal case. Another research related to estoppel by record was done by De Vos, et al. [9]. They employed the Answer Set Programming [10] to modify the event based model named InStAL. The contribution of their work was that they showed the set of legal states based on the sequence of actions between the plaintiff and the defendant. They focused on the implementation of estoppel that occurs in contract law in order to observe the legal status of both parties.

As mention above, those applications do not reflect the court procedure; the evidence law has never been applied to any systems. We found that some researchers tried to simulate the court hearing process but it still could not be developed as an application. Because using only the substantive law is not enough to provide the real scenario for users, we integrate the important legal doctrine named estoppel to complete the court procedure. It is a well-known legal principle which is typically applied in civil law cases. The concept is that a person wants to claim a fact but the law does not allow him to claim it. This principle is important in Civil law because it affects the final decision of the court to the case.

3 Framework of LASTC

LASTC consists of two modules which are legal expert module and legal explanation module. The legal expert module works by the proposed algorithm called EstoppelProofEngine which employs legal knowledge base during the inference process. The engine formalizes a switch of burden of proof and estoppel principle into a logic program. The legal explanation module extracts a set of rules related to the case for user. The overall framework of LASTC is shown in Figure 2.

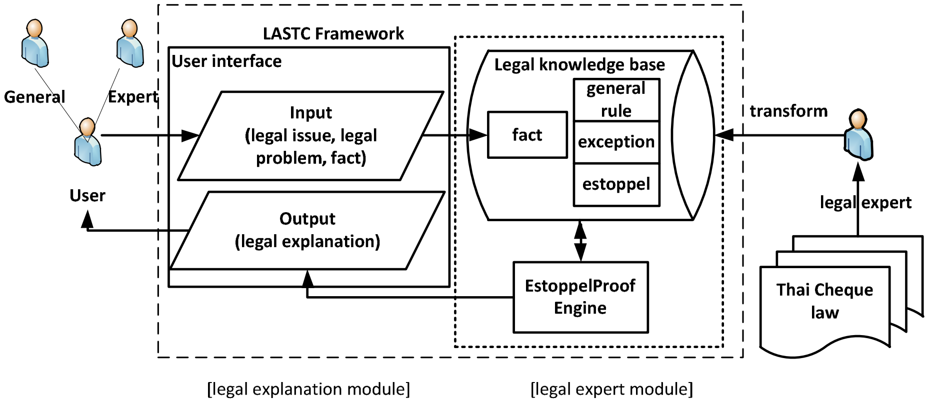

Fig. 2. Overall framework of LASTC

Thai Cheque Law is transformed into a set of rules in legal knowledge base by legal experts. The system starts with the data entry obtained from users which are legal issues, legal problems and a set of facts. Then, EstoppelProofEngine uses both sets of facts and rules to infer a legal conclusion and shows the legal explanation via output to the user.

3.1 Knowledge Base Design

The new structure of legal knowledge base consists of a set of facts and a set of rules obtained from users and legal experts. Two kinds of rule in legal knowledge base are general rules and exception rules (see Fig 3). Note that Prolog language is a declarative language for making a legal knowledge base and inference engine.

```
fact(Evidence).
Conclusion if Condition1, Condition2, …, Conditionn.
exception(Conclusion, ExceptionRule).
ExceptionRule if Condition1, Condition2, …, Conditionm.
estoppel(Person, Fact, Reason)
```

Fig. 3. A structure of legal knowledge base

3.1.1 Fact

For each legal case, a fact is evidence or a situation that supports the claim of a party. Before the beginning of court hearing process, the party inputs a set of facts to the system. Then, the set of facts is used in the inference process to draw a reasonable conclusion. All facts are assumed as ultimate facts which mean that the fact is accepted by the party, or the fact has been proved. Therefore, result of a fact is only true or false. In this work, predicate named `fact` is used to represent a fact.

```
fact(Evidence).
```

Evidence is a set of parameters that represents the truth of evidence or the truth of a situation. For example, `fact(put_signature(a,cheque))` means that a person, `a`, puts the signature on a cheque.

3.1.2 General Rule

A general rule is an important structure to represent legal knowledge base. It consists of two predicates which are `conclusion` and `condition` designed as a top-down model, called Horn clauses logic [11]:

$$\texttt{Conclusion if Condition}_1\texttt{, Condition}_2\texttt{, …, Condition}_n\texttt{.}$$

This structure is easy to understand and has a characteristic similar to legal rules. `Conclusion` represents a conclusion in legal case. Each $\texttt{Condition}_i$ represent a condition for proving the conclusion or represent a fact. If every $\texttt{Condition}_i$ is true, the result of `Conclusion` is true, otherwise false.

3.1.3 Exception Rule

Exception rule is typically found in every law. It is a kind of non-monotonic reasoning and is used as a counter argument. The structure of exception was introduced in several studies related to legal expert systems and legal reasoning systems [11, 12]. In this work, we propose a predicate named `exception` in order to identify the exception rule. The exception structure is as follows:

```
exception(Conclusion, ExceptionRule).
```

$$\texttt{ExceptionRule if Condition}_1\texttt{, Condition}_2\texttt{, …, Condition}_m\texttt{.}$$

The predicate `exception` consists of two parameters which are `Conclusion` and `ExceptionRule`. `Conclusion` is a general rule in legal knowledge base. Moreover, `ExceptionRule` is some rules that opposite party used to argue the `Conclusion`. If the party can prove the exception, the truth value of the `Conclusion` will be changed to opposite. For example, it is possible to have two distinct conditions with the same conclusion (`Conclusion`).

```
Conclusion:- Condition1.
Conclusion:- Condition2.
```

Then, the exception of `Conclusion` is as follows:

```
exception(Conclusion, E).
E:- Condition3.
```

`E` is an exception of both conclusions (`Conclusion`). When condition `Condition1` or `Condition2` is true, `Conclusion` is true. Later, `Condition3` is used as a condition of exception `E`. If `Condition3` is true, `Conclusion` is false.

3.1.4 Estoppel Rule

The condition of estoppel occurs when a person has done some action that the policy of the law does not allow him to deny. In certain situations, the law refuses to allow a person to deny the facts when another person has relied on and acted according to the facts on the basis of the first person's behavior. For example, it is possible to have two distinct rules with the same head (`R`).

```
R :- C1.
R :- C2.
```

Then, the estoppel of `C1` is as follows:

```
estoppel(C1,C3).
```

This is an estoppel of condition `C1`. When an estoppel is handled by condition `C3`, the rule of estoppel cannot be proven by the party. Therefore, the party cannot prove the first rule (`R :- C1.`). However, the second rule can be proven normally (`R:- C2.`). A predicate named `estoppel` consists of three parameters, i.e. `Person`, `Fact` and `Reason`. Estoppel is a kind of rule for checking the fact that cannot be used to argue. Thus, the logic of estoppel is designed in the Prolog form as follows:

```
estoppel(Person, Fact, Reason) :-
Reason = cause(Person, Fact, Action),
fact(Reason).
```

The logic starts from finding `Reason` that `Person` is estopped to claim `Fact` by considering `Action` that the `Person` did to the `Fact` from predicate `cause`. The cause predicate is as follows:

```
cause(Person, Fact, Action).
```

A predicate `cause` represents the action of a person that must be estopped to claim the fact. It consists of three parameters which are `Person`, `Fact` and `Action`. The estoppel is handled if the `Reason` matches some facts in legal knowledge base. This means that `Person` is estopped to claim `Fact` because of the `Reason` that he did to `Action` which was prohibited.

3.2 EstoppelProofEngine

EstoppelProofEngine is the main mechanism to drive the application. It consists of EstoppelChecking algorithm, Prove algorithm and Defense algorithm that work together during the inference process.

There are two parties involved in the legal case which are a proponent and an opponent. According to the Evidence law, the engine will switch the burden of proof between both parties using the Prove algorithm and the Defense algorithm. The plaintiff must prove his legal issue by proving all conditions of the goal and the defendant will defense by proving the exception rule of the goal. This process will switch between both parties until the party cannot prove the goal. However, estoppel is used for handing the fact that may be estopped. If the Prove algorithm returns true, then the engine will switch to the Defense algorithm. In the same way, the Defense algorithm will be switched if the Defense algorithm returns true.

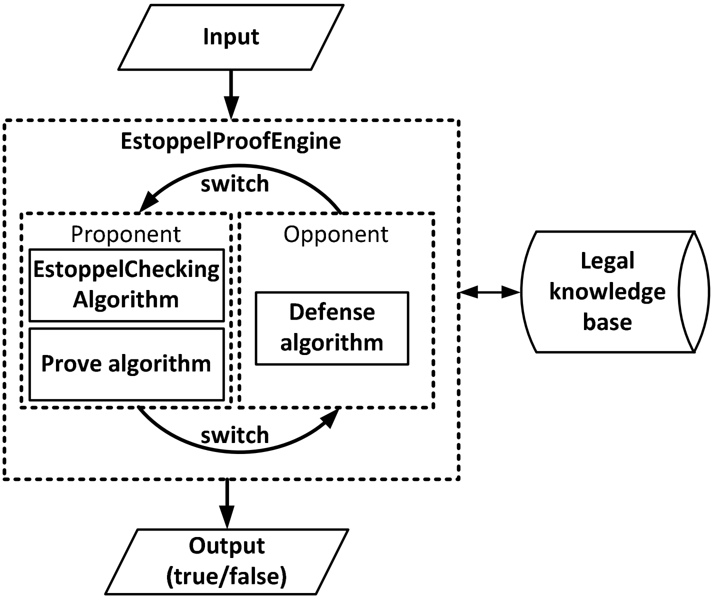

Fig. 4. EstoppelProofEngine framework

EstoppelChecking algorithm is proposed in this study. It starts with finding the estoppel fact in legal knowledge. If it found such fact then the party is estopped to claim the fact and the Prove algorithm cannot prove the fact. The advantage of using estoppel is that the truth value of the fact is different depending on the party who claims that fact, whether he is estopped or not. As mentioned earlier, the EstoppelChecking algorithm can automatically handle the estoppel.

In this paper, Prove algorithm and Defense algorithm are used to drive the switch of burden of proof (SBP). Note that the algorithm must identify the person who has the burden of proof (plaintiff or defendant) before the algorithm begins. Before using a fact in the step of proof, the fact will consider whether the estoppel occurs or not. If it occurs the logic should return the reason of the estoppel to the user.

4 The Application

We create the application named Legal Advisory System for Thai Cheque law (see Figure 5). Legal knowledge base consists of 32 rules and 74 conditions of Thai Cheque Law. LASTC requires users to indicate their roles so the user selects his role as a holder in the list of the parties (see Figure 6). The holder informs the system about the problem of forged signature (ลายมือชื่อปลอม). The system will generate a series of legal issues related to the problem. For example, "Does the cheque owner accept that signature is forged or not?" (ผู้สั่งจ่ายยอมรับลายมือนั้นหรือไม่). User has two options to answer which are Yes or No. Suppose that the answer is 'Yes' and there are no other legal issues from the system. Then, LASTC gives the result to user (see Figure 7).

Fig. 5. The main interface of LASTC

Fig. 6. User's role selection

Fig. 7. A result of legal reasoning of LASTC

LASTC shows the information obtained from user in the first panel (Fig 8). It also presents the legal explanation in the second panel and a set of rules that are used during the inference that match with the facts from user. LASTC shows the rule related to the problem that the drawer is liable if he accepts that forged signature ("Drawer ลายมือชื่อปลอมต้องรับผิดถ้าผู้สั่งจ่ายยอมรับลายมือนั้น"). Since the condition is matched with a fact obtained from user, therefore LASTC concludes that the drawer is liable for this cheque. Moreover, LASTC also provide the court scenario as shown in Fig.8.

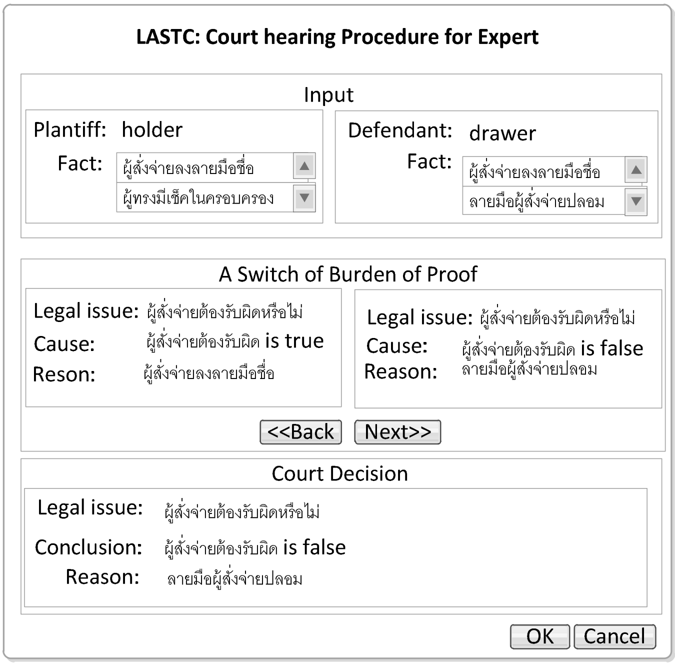

Fig. 8. Court scenario obtained from LASTC

5 Conclusion

LASTC is developed and tested with a set of real legal cases obtained from Supreme Court of Thailand. We found that LASTC provides correct advice to user and can reduce the steps of proof compared with SBP. In addition, LASTC has the capability to inference the legal case where estoppel occurs whereas SBP cannot deal with this problem. This is the contribution of the new structure of legal knowledge base and the EstoppelProofEngine module. Hence, LASTC is practical to use and gains high acceptance from users.

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Assessing the Quality of Thai Wikipedia Articles Using Concept and Statistical Features

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Abstract. The quality evaluation of Thai Wikipedia articles relies on user consideration. There are increasing numbers of articles every day therefore the automatic evaluation method is needed for user. Components of Wikipedia articles such as headers, pictures, references, and links are useful to indicate the quality of articles. However readers need complete content to cover all of concepts in that article. The concept features are investigated in this work. The aim of this research is to classify Thai Wikipedia articles into two classes namely high-quality and low-quality class. Three article domains (Biography, Animal, and Place) are testes with decision tree and Naïve Bayes. We found that Naïve Bayes gets high TP Rate compared to decision tree in every domain. Moreover, we found that the concept feature plays an important role in quality classification of Thai Wikipedia articles.

Keywords: Quality of Thai Wikipedia articles, Naïve Bayes, Decision tree, Concept feature, Statistical feature.

1 Introduction

Wikipedia website provides facilities for readers to anonymously edit the articles without approval. The number of articles is increase continuously, we found that English Wikipedia pages includes over 4.4 million articles[1] whereas Thai Wikipedia articles has over 85,871 articles[2]. The quality of these articles is the main problem of Wikipedia. Therefore several user-driven tools are developed in order to evaluate the quality of articles. However a small number of Wikipedia articles are evaluated in this way. For example, as of January 2014, only 109 Thai Wikipedia articles (less than 0.1%) were marked as featured articles and 101 articles were marked as good articles. We found that a large number of articles have not yet been evaluated.

Automated tools are required to assess the quality of articles in order to reduce the burden of user in determining the quality of articles. Many statistical features such as the length of articles, the total number of revisions, and the number of headers are

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[1] http://en.wikipedia.org/wiki/Special:Statistics

[2] http://th.wikipedia.org/wiki/พิเศษ:สถิติ

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explored in the research work. However, considering only these numbers is not enough to evaluate the quality of articles. We believe that good content should contain comprehensive concepts. For example the articles in Biography domain should include information about birth, death of the person, career, abilities and relationship information. We propose to use concept features and statistical feature set to identify the quality of Thai Wikipedia articles. The decision tree learning algorithm and Naïve Bayes are employed to learn the hypothesis of the high quality of Thai Wikipedia articles.

2 Related Work

Most researches focus on finding the suitable features that can effectively assess the quality of articles. There are three categories which are Review, Network, and Text features [1]. Review features are extracted from the review history of each article. The hypothesis is that the quality of a Wikipedia article is based on the quality of its reviewers. Recursively, the quality of the reviewers is based on the quality of the articles they reviewed [2].Network features are extracted from the connectivity network inherent to the collection. An example of this feature is the value of out-degree calculated from the number of links that point to other articles [3]. Text features are extracted from the textual content of articles. Examples of these features are Structure, Style, and Readability features. Structure features are indicators of how well the article is organized. Style features capture the way the authors write the articles through their word usages. Readability features aim to estimate the age or understandable level necessary to comprehend the text. The most frequent and second most frequent editors of the article are an example of this feature [4].

Several researchers applied various feature sets with machine learning algorithms. For instance, the combination of a large number of features was organized into three views which are the organization, the length and the readability as well as the revision history and network properties. These views were combined using a meta-learning strategy and Support Vector Regression [5]. Factual density was used to measures the relative number of document facts base on Naive Bayes [6]. A methodology for estimating the quality based on eight different ratios derived from counting the number of sentences, words, nouns, and other was proposed and run with decision tree[7]. The collaboration patterns of contributors were employed to identify the quality of Wikipedia [8]. They found that this pattern was a critical factor driving the quality of Wikipedia articles. A continuous quality scale based on Support Vector Regression was used to measure the quality of article in [5] and they found that the most useful feature is the text structure. The best results were achieved when structure features are combined with Network and Revision features. Writing style base on the character trigram feature and Meta features were compared. This method combines a linear SVM with a binarized character trigram vector. The performance measured in terms of F-measure for featured articles are 96.4% within a single Wikipedia domain and 88.0% in a domain transfer situation [9]. In addition, fuzzy logic was used to classify the featured articles from non-featured articles. They achieved 100% recall and 86% precision [4].

However, most researches mentioned above are based on English articles. English users evaluate English articles, according to the following quality taxonomy which are Featured Article, A-Class, Good Article, B-Class, Start-Class, and Stub-Class [10]. The quality taxonomy is different from the category of Thai Wikipedia. Since Thai Wikipedia manages the quality of articles as Featured and Good quality. We found that the number of users involved in English articles editing is more than that of Thai articles. There are over 20.5 million registered users on English Wikipedia, however only 191,994 registered users contribute to Thai Wikipedia. The average number of edits per page of English articles is 21.33 whereas the number of edits in Thai article is 12.34. The total numbers of words of English Wikipedia articles are 14.5 million whereas Thai Wikipedia are 13.6 million (http://stats.wikimedia.org/EN/ChartsWikipediaTH.htm) The percentage of articles having at least 0.5 Kb readable text of English Wikipedia articles are 62% whereas Thai Wikipedia are 81%. The total numbers of links to other Wikipedia's English are 1.36 million whereas Thai articles have 1.15 million links. The total number of images shown on English articles is 28,300 whereas Thai articles have 51,300 images. We found that Thai Wikipedia articles have more pictures. Therefore, some statistical features for classifying the quality of English articles may not be suitable for Thai articles.

3 Framework

Our framework consists of 4 modules which are (1) domain separation, (2) Data labeling, (3) Feature extraction and (4) Quality classification (see Figure 1).

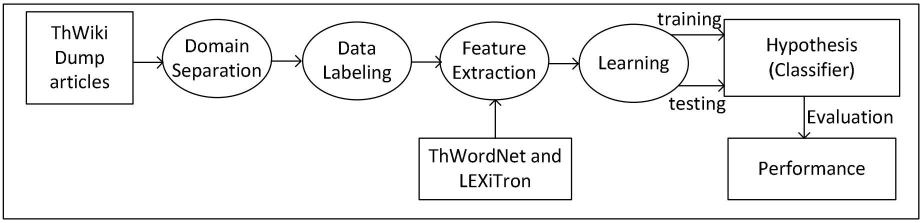

Fig. 1. The framework of Thai Wikipedia articles quality assessment

3.1 Data Set

The "thwiki dump progress on 20120719" data set are obtained from http://dumps.wikimedia.org/backup-index.html. This means that these Thai Wikipedia articles are created and updated until July, 19^{th} 2012.

3.2 Domain Separation

We split the data set into 3 domains using the predefined tags from the Wiki code. These domains are Biography, Animal, and Place. (see Table 1).

Table 1. Data set used in this study

Domain	Number of articles	
	High Quality	Low Quality
Biography	47	8,740
Animal	10	440
Place	21	9,228
Total	**78**	**18,408**

3.3 Data Labeling Process

Wikipedia articles in each domain are labeled as high-quality or low-quality. The Featured Wikipedia articles contain “Featured article star” symbol whereas the Good articles contain symbol. These symbols are converted from the tags “{{บทความคัดสรร}}” and “{{บทความคุณภาพ}}”. The low-quality articles contain the Broom symbol which is converted from the tags “{{เก็บกวาด}}”, “{{สั้นมาก}}”, “{{โครง}}”, and “{{ยังไม่ได้แปล}}”.

3.4 Feature Extraction

We believe that good content should contain comprehensive concept of that domain. For instance, the articles in Biography domain should contain information about the birth or the death of that person including the working information.

Therefore we extract the concept feature from the high-quality article of each domain based on the meaning words associated with the concept. We illustrate the meaning of concept in Biography, Animal, and Place domain as shown in Table 2.

Table 2. The list of concepts in data domains

No	Concept	Description
Biography domain		
1	Birth	Date of birth. Including the place of birth.
2	Knowledge	Education, training, aptitude and ability.
3	Occupation	occupation duty, job, and award
4	Relationship	Related persons, including parents, cousin husband, wife, son, friend and partner.
5	Death	Date of death and however.
Animal domain		
1	Character	Shape, elements in the body, and appearance.
2	Family and Taxonomy	About species and ethnicity.
3	Breed	The reproduction, reproduction period, including farming baby
4	Food	What is the food of the animal and behavior of prey.
5	Address	Habitat and areas where the animals can be found.
Place domain		
1	Site and Structure	Size, location and the components of that place.
2	Age	The relevant time period. Including the time that the history of that place.
3	Objective	The purpose of building the place and productivity have come out of that place.
4	Management	The management of the place. People involved. Methods of treatment. Including the budget.

From the Wiki code obtained from Wikipedia articles, we found that the content of each article includes various components as follows:

1) Headers representing the topics and sub-topics is detected by the == symbol in Wiki code.

2) Information box which contains the core concept of articles. For example, the information box in Biography domain contains the words {name, image, birth_date, birthplace, awards, and children, which correspond to the tags "{{กล่องข้อมูล…}}", {{ผู้นำประเทศ…}}, and "{{infobox …}}".

3) Wiki link is the text occurs on the links from the current page to other Wiki pages. The text is in [[…]] symbol from the Wiki code.

4) External links is a URL text links from the current page to external pages. Note that the Wiki code is [http://...] symbol.

5) References is the text reference to any data source. It is observed by the superscript text. We get the reference from by considering the symbol "< ref … &gt".

6) Pictures displayed on the article can be detected using [[ไฟล์: .jpg..]].

7) Number of characters occurs in the content of articles

Moreover, we also take advantage of the number of editings, since Wikipedia keeps history of all edits in the current version and the history version of articles. The revision tags can be observed from the tag <revision>…</revision>. The feature sets previously mentioned has been used in [4], except the Information box. Table 3 shows the meaning of features used in our work. We found that the average number of these features in high-quality class is a higher than that of the low-quality article in every domain (see Table 4).

Table 3. The meaning of features used in our work

No	Feature Name	Description
1	#Header	Number of headers found in the current page
2	#Infobox	Number of information boxes found in the current page
3	#Wiki link	Number of Wiki links from the current page that point to other Wiki pages
4	#External link	Number of URLs external links found in the current page
5	#Reference	Number of references found in the current page
6	#Picture	Number of images found in the current page
7	#Character	Number of characters found in the current page
8	#Revision	Number of editings
9	#Concept	Concepts associated with that domain and appear in the current page

Table 4. The average number of attributes in the data set

	Header	Info box	Wiki link	External link	Reference	Picture	Character /1000	Revision	Concept
High_Biography	21	1	315	35	99	8	112.8	328	4
Low_Biography	4	1	54	2	2	1	10.2	39	2
High_Animal	15	1	205	14	67	9	79.7	201	5
Low_Animal	3	1	69	2	1	1	8.5	45	2
High_Place	26	1	325	33	75	11	102.0	457	4
Low_Place	4	1	50	2	1	1	9.0	36	2
High_All	22	1	303	32	99	9	105.7	346	4
Low_All	4	1	52	2	2	1	9.6	38	2

3.5 Combination Domain

The combination domain is the aggregation of instances from every domain. The objective is to validate the contribution of proposed concept feature. The numbers of instances in this data set are 18,486 instances (78 high-quality articles and 18,408 low-quality articles) (see Table 1).

3.6 Classifiers

Decision Tree Approach. Decision tree learning has been studied in the areas of pattern recognition and machine learning. In this work, we use an enhanced version of C4.5 [11] which is J48 implemented in Weka software[3].

Given the labeled training data set, J48 constructs the tree by selecting the attributes that can reduce the entropy of the classes. Therefore, the attribute that has the highest gain ratio is selected and inserted into the tree.

$$Entropy\ (S) = \frac{-P}{P+N}\log_2\frac{P}{P+N} - \frac{N}{P+N}\log_2\frac{N}{P+N} \tag{1}$$

Note that S is the training data set, P is the number of positive class and N is the number of negative class.

$$Gain\ (S,A) = Entropy\ (s) - \sum_{v\in Values\ (A)} \frac{|S_v|}{S} Entropy\ (S_v) \tag{2}$$

Note that S is the prior data set before classified by attribute A, $|S_v|$ is the number of examples those value of attribute A are v, $|S|$ is the total number of records in the data set.

Naïve Bayes Approach. Naïve Bayes is a well known approach that performs very well on text categorization problem. Naïve Bayes computes conditional probabilities

[3] http://www.cs.waikato.ac.nz/ml/weka/

of the document's categories. Given a training set T containing M training instance $\{(X_1, y_1),...(X_m, y_m)\}$, where X_i is the feature vectors $\{x_{i,1},...,x_{i,n}\}$ (n is the number of features), and $y_k \in \{c_1,...,c_l\}$ (a set of l class).

The algorithm creates a model for the classifier, which is a hypothesis about the unknown function f for which $y = f(X)$. The classifier is later used to predict the unknown class $y_t \in \{c_1,...,c_l\}$ for a new instance (X_t, y_t) with the know vector X_t.

$$y_t = \mathrm{argmax}_{y_k} \left(\mathrm{P}(y_k)\right) \prod_{j=1}^{N} \mathrm{P}(x_j|y_k) \tag{3}$$

The prior probability, $\mathrm{P}(y_k)$, is estimated as the ratio between the number of examples belonging to class y_k and the number of all examples. The conditional probability, $\mathrm{P}(x_j|y_k)$ is the probabilities of seeing the number of x_j giving class label y_k.

4 Experimental Result

We measure the performance using True positive (TP), False positive (FP) as follows:

TP denotes the number of articles that are correctly identified as the High-quality class (true positives), and *FP* is the number of articles that are untruly identified as the High-quality class (false positives).

FN denotes the number of articles that are untruly identified as the Low-quality class (false negative), and TN is the number of articles that are correctly identified as the Low-quality class (true negative).

The experiment are done using 10-Fold Cross Validation. The decision tree and Naïve Bayes are used as classifiers in this experiment.

After the learning of decision tree algorithm is finished, we obtain the hypothesis of the Biography domain as shown in Fig. 2. We found that the Reference and Concept features are important attributes for determining the quality of articles in Biography domain.

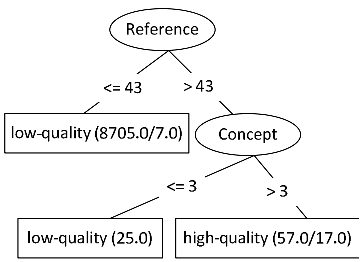

Fig. 2. Decision tree of Biography domain

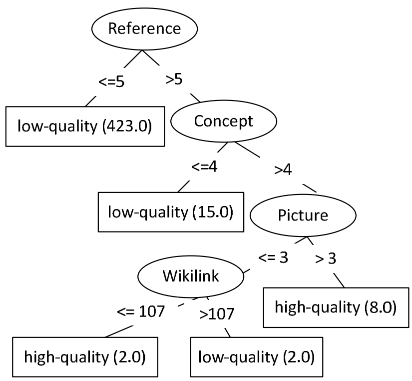

Fig. 3. Decision tree of Animal domain

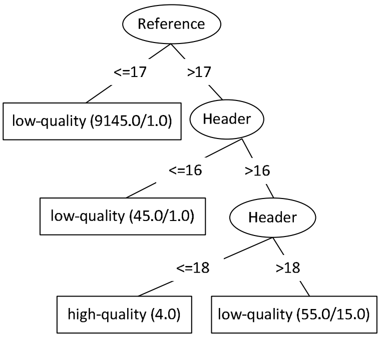

Fig. 4. Decision tree of Place domain

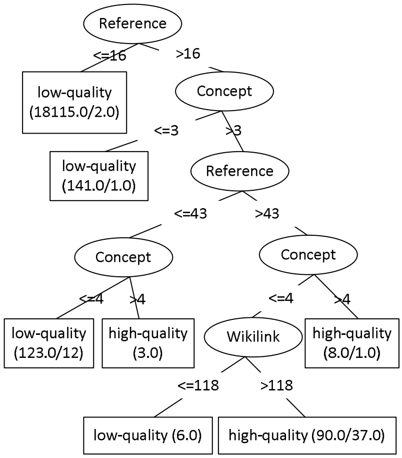

Fig. 5. Decision tree of Combination domain

Consider the tree obtained from the Animal domain (see Fig. 3), we found that the Reference, Concept, and Picture features are important attributes for determining the quality of article in Animal domain. Fig. 4 shows a decision tree obtained from the Place domain. We found that the Reference features and Header features are important attributes for determining the quality of article in Place domain.

We further investigate the potential of the decision tree in classifying the articles by discarding the article domain. Therefore all of articles in every domain are grouped together to evaluate the usefulness of the proposed features. Figure 5 shows a decision tree obtained from the combination domain. It infers that the Reference feature, Concept feature, and Wiki Link feature are important attributes for determining quality of every article. In the Biography domain, we obtained TP Rate at 76.6% for high-quality class and 100% for the performance of Naïve Bayes. Regarding the performance of decision tree, in Animal domain, we obtained TP Rate at 70% for high-quality class and 100% for performance of Naïve Bayes.In the Place domain, decision tree cannot predict high-quality class. The reason is that the number of high-quality instances is too small and highly imbalanced. (21 high-quality, 9,228 low-quality instances). However, we found that Naïve Bayes can achieve good performance, since we obtained TP Rate is 90.5% for high-quality class. For the high-quality class of the Combination domain, decision tree obtains TP Rate at 65.4% but Naïve Bayes gets 97.4%. Regarding the performance of classification for high-quality articles, we found that Naïve Bayes gets high TP Rate than decision in every domain. Since decision tree built trees from a few features which may not suitable for identifying the quality of articles (see Figure 2-5).

Table 5. The performance obtained from decision tree and Naïve Bayes

	Decision tree			**Naïve Bayes**		
	TP Rate	FP Rate	AUC	TP Rate	FP Rate	AUC
			Biography domain			
high-quality	76.60	0.20	80.50	100.00	2.30	99.40
low-quality	99.80	23.40	80.50	97.70	0.00	99.60
			Animal domain			
high-quality	70.00	0.20	94.90	100.00	2.00	99.40
low-quality	99.80	30.00	94.90	98.00	0.00	99.10
			Place domain			
high-quality	0.00	0.00	68.10	90.50	2.20	99.10
low-quality	100.00	100.00	68.10	97.80	9.50	99.30
			Combination domain			
high-quality	65.40	0.30	90.80	97.40	2.30	99.30
low-quality	99.70	34.60	90.80	97.70	2.60	99.40

The advantage of Naïve Bayes is that it only requires a small amount of training data to estimate the parameters (means and variances of the variables) necessary for classification. In addition, it also estimates the probabilities based on all features, which is appropriate for text classification. Moreover, we also want to verify the concept feature to see its contribution on classification performance. Therefore we remove the concept feature from the dataset and test with Naïve Bayes (see Table 6).

The experimental result in each domain shows that there is no difference in each domain. However the concept feature plays an important role in the Combination domain. The classification performance decreases from 97.4% to 94.90% when the concept feature is removed from the feature set.

Table 6. The performance of Naïve Bayes obtained from data set without the concept feature

	Naïve Bayes		
	TP Rate	FP Rate	AUC
	Biography domain		
high-quality	95.70	2.70	99.40
low-quality	97.30	4.30	99.50
	Animal domain		
high-quality	100.00	2.50	99.20
low-quality	97.50	0.00	99.00
	Place domain		
high-quality	90.50	2.10	99.10
low-quality	97.90	9.50	99.30
	Combination domain		
high-quality	94.90	2.40	99.30
low-quality	97.60	5.10	99.40

This scenario is consistent with the actual usage of Wikipedia website since we want to automatically identify the high-quality of Thai Wikipedia articles without the need of domain separation. For the combination domain, decision tree obtained TP Rate at 65.40% for high-quality class, 99.70% for low-quality class, and 99.60% for the weighted average. For Naïve Bayes we obtained TP Rate at 97.40% for high-quality class, 97.70% for low-quality class, and are 97.70% for the weighted average (see Table 5). These results show that using Naïve Bayes with the concept feature shows promising result for assessing the quality of Thai Wikipedia article.

5 Conclusions

We have investigated the concept feature combined with statistical features base on decision tree and Naïve Bayes algorithms. Our approach is based on the naming concept that needs a set of words related to the concept. Such process requires an expert to provide a set of words. Moreover, we use the terms associated with the concept from Thai WordNet (http://th.asianwordnet.org/). We found that our method provides promising results in assessing the quality of Thai Wikipedia articles. For future work, we will integrate an automatic concept extraction technique to produce a set of words. Moreover, we will explore other features and concepts in order to enhance the quality evaluation of Thai Wikipedia articles.

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On the Use of Ontologies to Guide Agents Answering Questions

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Abstract. The tasks related to answering a question or clarifying doubts are determined primarily by a good analysis of the question in order to identify the target subject of the response. This paper presents a question-answer system (QAS) that uses ontologies and information retrieval techniques in analyzing the question and thus improving the extraction of a relevant response, most importantly, from resources available on the Internet.

Keywords: question-answering system, ontologies, AIML Database knowledge and information retrieval.

1 Introduction

In recent years the Internet has accumulated a myriad of documents, which makes it an important potential source for finding answers to a large variety of questions. However, its use for this purpose has to deal with the difficulty that users have to formulate their questions in natural language consistent with the paradigm of search engines. Even experienced users all too often have problems formulating queries when working with fields of which they have little knowledge (Agissilaos *et al.*, 2005).

To deal with this problem, one possible approach is to use systems of questions and answers (henceforth, QAS) through which a computer automatically answers the questions formulated in natural language. QASs are especially useful in situations in which the user needs to know some very specific information and does not have time to read all available documentation related to the topic under study to solve a problem (Vicedo *et al.*, 2007).

Generally, the challenge of a QAS is to return the response that most closely matches the user expectation to a question posed in natural language. The whole process is quite complicated, as it requires a number of different techniques, working together in order to achieve the desired goal. These techniques include: rewriting and formulating of the query, the classification of the query, information retrieval, retrieval of textual excerpts, answer extraction, the ordination of the answer and, finally, the justification of the whole process (Akerkar *et al.*, 2009).

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It is also interesting to consider the multiple facets of a question and answer system. In the case of this project, our intention is to use the QAS within a knowledge construction environment where it is possible to fix or examine contents through questions and answers given its collaborative nature

This article presents a QAS that uses ontologies, among other techniques, aiming to improve the extraction of the answer for any knowledge domain. The paper is organized as follows: In Section 2 we present the features we consider important in QAS. In Section 3 we describe some important related projects. In Section 4, the problem is described. Section 5 presents the system architecture regarding its functioning and the software agents. Section 6 deals with some technological details of a prototype implementation as well as an ontology developed to support it and the results obtained from some concrete experiments. Finally, in Section 7, we offer some preliminary conclusions and point to possible future research related to the work in progress.

2 QASs

A QAS provides accurate answers to questions in natural language to a certain variety of topics. Here, we define the construct accuracy on a not very precise basis, i.e., subjectivity is acknowledged as inherent to the process. Therefore, a QAS distinguishes itself by trying to provide an answer that only contains the information needed to answer the question. For an answer to be accurate it must provide additional or supplementary information, including a justification or dialogue, explaining why it is correct (Ferrucci, 2009).

QASs seek to offer the same ease that occurs in dialogues between people, where questions are answered promptly. These systems go beyond the more familiar search based on keywords (like Google, Yahoo, and other search engines do) and they attempt to recognize what a question expresses thus presenting a correct answer to it. This simplifies the process to users in two ways. First, questions are not representable in a simple list of keywords and, second, QAS take on the responsibility to provide the desired answer instead of a list of potentially relevant documents (Clark *et al.*, 2010).

Problems of understanding and generation of natural language come to the surface in QAS because large databases of documents require a sophisticated linguistic analysis, including understanding of speech and text summarizing. The reasoning mechanisms for QASs are concerns for researchers. Because of this, approaches based on cognitive science, using the techniques provided by Artificial Intelligence, are concerned with simulations of question and answer by humans. (Burhans, 2002). In this context, the QASs have been approached from different perspectives.

Our proposal is to research the implications of the use of inferences in domain ontologies to enrich the extraction of an answer in a QAS. In addition to representing knowledge, ontology can be useful for (Noy *et al.*, 2001):

1) Sharing common understanding of the structure of information among people or among software agents;
2) Enabling the reuse of domain knowledge;
3) Making explicit assumptions of the domain;
4) Separating domain knowledge from operational knowledge and
5) Analyzing domain knowledge.

Balduccini *et al.* (2008) classified the QAS that incorporate knowledge representation and reasoning (or inference) based on three approaches: formal logics, the extraction of information, and the use of formal logics to extract information.

All three approaches, at some point, use logical languages to extract some new knowledge inferred. Systems using ontology for representing knowledge and reasoning are known to use qualitative modeling (or qualitative reasoning). One of the goals of qualitative modeling is to make tacit knowledge explicit, providing formalisms (Forbus, 2008). We found many studies in the literature that have used ontologies in their various aspects, and through experiments, they have shown good results. In the next section we detail some of these works.

3 Related Works

Here we present the results of a survey about the use of ontologies in QASs. For each system found, we give an explanation of its most interesting aspects.

The *Freya* system (Damijanovic *et al.*, 2010) translates a natural language query, or keywords, in a SPARQL query and returns the answer to the user, after executing a search in the ontology. The dynamics of the system can be summarized in the following steps: 1) identify and verify the concepts in the ontology; 2) generate SPARQL query; 3) identify the type of answer and 4) present the result to the user.

The algorithm to translate a question in natural language into a set of concepts of the ontology combines parsing with the ontology reasoning. Where the algorithm does not automatically infer conclusions, suggestions are then generated for the user. By engaging the user in a dialogue, we have a better chance of identifying information that is considered ambiguous.

In the identification phase of the concepts, the knowledge available in the ontology is used to recognize and record the terms of the ontology in the query. If there are ambiguous annotations in the query, a dialogue is conducted with the user. Tests have obtained a positive response rate of 92.4% in a total of 250 questions.

The PowerAqua (Lopez et al., 2011) is an evolution of another system called Aqualog, a system based on ontology. In PowerAqua architecture the component analyzing the question uses a linguistic component to process the query. The output of this component is a set of linguistic triplets, <subject, predicate, object> , that is mapped to the user's query. Thus it is possible to perform searches in OWL/ RDF databases. The results obtained in the tests showed 48 (69.5%) answered questions from a total of 69.

The OMED (Doucette et al., 2012) is a system that supports medical decision making by means of which answers are provided in real time. The OMED´s core components are: 1) the interface component that receives natural language queries and performs search of information; 2) the component of knowledge representation, which aggregates and translates information from a specific scenario of a semantic representation, to the appropriate use of OMED; 3) the component of semantic reasoning, which derives the answers to a user´s query by reasoning on relevant medical knowledge.

In one of the experiments, using five data sets containing 1000 records of patients and 20, 30, 40, 50, and 60 drugs (half of them were used as training data) 100% correct answers were produced.

4 Detailed Description of the Problem

Let us observe the following hypothetical situation: Perform a search on Google with the sentence " Which are the operating systems that are multitasking?". Although it seems simple, we will not find the answer even though it can be found in documents available on the Web. The search engines (e.g. Google) available cannot locate it by not implementing reasoning or inferences. Linux is a multitasking system, but no Web document mentions this. However, there are documents that mention the following: Linux is an operating system (1), Linux shares its resources with applications and users (2), Operating Systems that share features are multitasking (3). Information retrieval systems that use logical reasoning (eg ontologies) are constructed to answer these and similar types of questions (Damijanovic *et al.*, 2010).

Let us take another example: (1) Which country was visited by the Pope in 1960? The key words are: "country", "Pope", "visited", "1960". None of these words denote a particular country (such as "UK" or "United States"), or "Pope" (head of the Catholic church, for example), or the date within the interval of 10 years between 1960 and 1970. A much more complex set of keywords is necessary to approach the desired result. And to make matters worse, experiments show that people do not readily learn how to formulate and use this kind of set of keywords (Clark *et al.* 2010).

The QASs can improve a query, expanding it to include more terms than the initially suggested entries. Thus, they facilitate the search for related answers. For example, a system can expand a query "car" to search for synonymous such as "automobile" and its specialization, "sports". Ontologies can help to analyze, to refine queries, among other uses (McGuinness, 2004).

5 The Proposed Architecture

The proposed architecture differs from the ones mentioned earlier by its generality and also by combining a bank of ontologies with a family of software agents (Amorim et al. 2011 (a); Amorim et al. 2011 (b); Amorim et al. 2012). The use of these agents is intended to soften the architecture, thus favoring the use of specific intelligent mechanisms, in tune with the needs of each action of the system. Through this one can expect to obtain the capability of providing more accurate answers than the previous systems.

The specialty of the proposed architecture (Figure 1) is to resolve questions in English like WH-Question (What, Who, When, Where, What, Who). It consists of software agents having profiles adherent to their goals, i.e., a profile for analysis of the question, a profile for the selection and extraction of the response, a profile for the construction of knowledge, and a profile for the generation of the response. The architecture has a knowledge base, implemented in AIML, containing question-answer pairs. The profiles of the agents are described as follows:

- Profile *Analysis of the Question*: The agent is responsible for examining the question in natural language and generating a query (question analyzed) that enables the selection of candidate documents to answer the question. In this module, the agent will carry out the following activities: to extract the key words, words lemmatization (stemming), to remove stopwords, to enrich the query with synonyms from Wordnet, to make inferences about the ontology concepts, to solve the semantic type of the question, and to obtain the solved question from the bank AIML. This profile is typical of the agent "retriever".
- Profile *Selection and Extraction of Answers*: The agent is responsible for selecting candidates from Web documents and extracting answers. A check is performed on the candidate answer in order to make it a feasible answer (textual implication). This profile is typical of the agent "seeker".
- Profile *Construction of Knowledge*: The agent is responsible for organizing and managing queries for the ontology, for the knowledge base AIML, and the Web. In addition, the agent enables greater dynamism in that each knowledge base is augmented whenever new information or concepts are found. Furthermore, this architecture ensures an independent way of working, i.e., while some of the agents are solving the question, the others update the knowledge bases. This profile is typical of the agents "Learning Supporter", "Learner", and "Specialist".

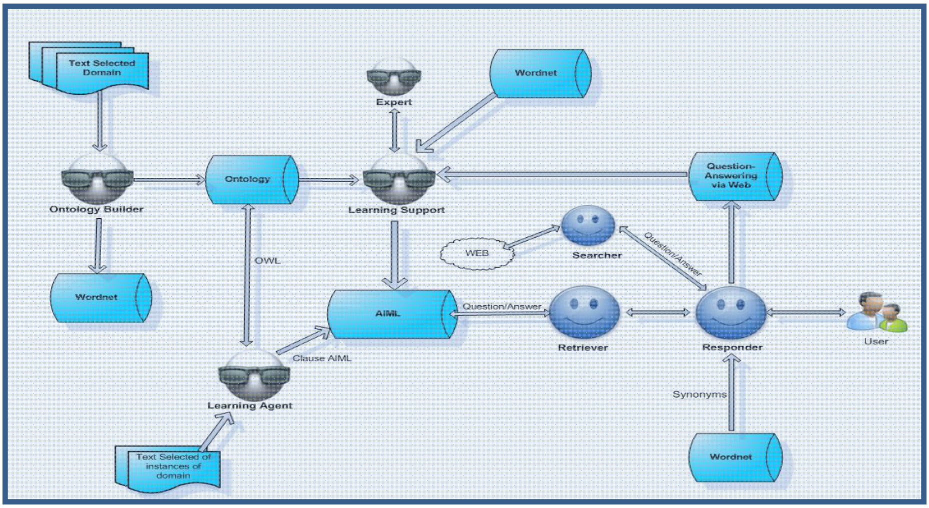

Fig. 1. The conceptual architecture of the QAS

- Profile *Generation of Responses*: The agent generates the answer in a textual format appropriate to the user's understanding. For future work we intend to extend the interoperability with other systems, i.e., to allow the exchange of questions and answers with other systems by means of semantic services. This profile is typical of the agent "Answerer".

6 The Prototype

To validate the architecture, a preliminary version that uses only a single software agent was implemented. At first, our aim is just to check the validity of the use of ontologies in QAS. The following subsections show the ontology developed for operating systems, the technological aspects of the prototype, and some experiments with their results.

The ontology of the basic concepts of operating systems was developed using Protégé and OWL. The ontology presented here was developed for a specific domain of knowledge to serve as proof of concept for the proposed framework. Thus, our choice of the domain of operating systems is due to the fact that it has already been developed and contains an initial AIML database (Teixeira 2009).

In the prototype implementation we used the Java language and many other components such as: Chatterbean (Chatterbean, 2012), LingPipe (LingPipe, 2012), Jena (Jena, 2012) and Lucene (Lucene, 2012), among others. A synthesis of the technological components of the architecture can be found in Table 1.

Table 1. Technological components used in the current prototype

Responsible agents	Component
"recoverer"	Wordnet, Lucene, LingPipe, Stanford
"searcher"	Venses, Jirs, Web-Harvest
"recoverer" e "learner"	ChatterBean, Pellet, Jena, AIML,
"answerer"	Regular expression

For the ontologies to refine QASs, it is necessary to structure the concepts properly. For example, if the question "Which of the operating systems are multitasking?" would cover other areas. So it could generate the valid answers: "32 bit", "64 bit" or "mobile". However, for the domain of the basic concepts of operating system, the answer should be "batch, multitasking, monotasking." To improve the extraction of the answer, new concepts, such as "multiprogramming", must be searched in the ontology. To find the correct concepts, it is important to expand the question to the intended domain. Therefore, the use of ontologies improves the amount of questions answered correctly. Table 2 shows results.

Table 2. Questions tested

Description	**Quantity**	**Percent**
Total number of questions	60	100%
Number of questions answered correctly with Ontology and RTE.	43	71,67%
Number of questions answered correctly without Ontology	26	41,67%

7 Preliminary Conclusions and Future Work

This work has shown a QAS aiming targeting questions like a WH-question in English language. This system is part of a larger project, namely Flexible Multiorganizer of Virtual Workspaces (Morpheus) (Menezes et al. 2008; Rangel *et al.* 2009; Rangel et al. 2010). Morpheus is a multi-institutional effort of research based on an innovative conception seeking for flexibility in virtual spaces. The focus of this project is fundamentally the development of pedagogical architectures for which many tools have already been developed and many others are being designed.

In developing the project, ontologies and a number of other useful techniques to improve the recovery of the answers have been added. Other studies that use ontologies as a means to improve information retrieval as well as many of the techniques mentioned here have been found in the literature revised [Ferrucci et al. 2012; Unger et al. 2011]. However, in QASs just a few studies use them all together combined.

So far we wonder in this context we are questioning, how to introduce ontologies to improve the recovery of the information? In order to For ontologies further to improve QASs, it is necessary, first, to structure the concepts properly and also make logical inferences. Besides Furthermore, there are many ways to expand the query using ontology, for example, by means of equivalent classes (concepts), super / subclass, denial of classes, mereology (part / whole) etc.

As future projects on the proposed system we propose:

1. Develop the system with multiagents, as shown in Figure 1.
2. Perform real experiments, i.e., create a database with questions and allow the system to interact with groups of users.
3. The system shall send to the experts the unresolved and the resolved questions. For questions resolved the specialist should evaluate the level of quality of the answer. For questions unresolved experts should respond them and ask the system to classify and store them in the base AIML.
4. A mechanism is needed to enrich the ontology with new concepts, relationships and instances of a domain from texts found on the Web. Adding new concepts must rely on the help of experts.

5. Expand the QAS communication with other systems through the semantic exchange of data. That way other systems could consume utilize the question-answer service without knowing the inner workings of the system. For example, virtual learning environments could use the question-answer method to test the student's knowledge.
6. Give the user the option to issue an opinion on the quality of the answer.
7. Use spellcheck on input interface of the question, thus enabling the user grammatically correct the question. And, at a later moment …
8. To develop another environment, similar to the one presented here, but where the knowledge base AIML is generated automatically from the ontology. Then, to compare the results obtained with the two versions.

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The Effects of Effort-Feedback on Time Spent for Information Processing in Multi-criteria Decision Making

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Abstract. When making decisions, many people tend to rely on their instinctive choices instead of trusting and adopting those suggested by decision support systems. Feedback interventions can be used to subliminally direct and assist decision makers' attention to increase the accuracy of the decision. This paper seeks to further develop our understanding of such persuasive decision aids for a preferential choice problem. For this purpose, we applied an experiment design with either enabled or disabled feedback interventions in a self-developed computerized decision aid with varying decision complexities. We applied continuous feedback mechanisms using normative rules to evaluate the participants' time investments during their information processing stage. Our findings demonstrate that normative effort feedback impacts both time spent on single items and time spent for overall decision processing. We conclude that effort feedback can be a viable feedback option to implement in decision aids.

Keywords: Decision Aid, Decision-making, Cognitive decision support, multi-criteria decision making, decision support systems.

1 Introduction

In our modern and increasingly technological societies, people often face complex situations, which would require abstract, systematic and decontextualized thinking in order to make sound decisions [1]. Humans, however, do not have the information processing capabilities to make complex decisions in accordance with normative models of rationality [2-3]. Instead, we rely on cognitively less demanding heuristics to make good, but not necessarily optimal decisions [4-5].

This insight led to the idea that human decision making can be improved by outsourcing the decision process or some of its elements to some kind of technology [6]. Such technologies offer methodological support for analytical decision making through so called decision aids (DAs). DAs automate computation-intensive activities and thereby can reduce the effort needed to make analytical decisions [7-8]. Despite of such advances, Smith and von Winterfeldt [6] reported that many practitioners do not utilize analytical decision making techniques. This informal observation has been recently confirmed by a study on the use of decision aids in the context of IT decisions [9]. The analytic hierarchy process [7], which is one of the most researched

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multi-criteria decision making methods, was, for example, reported to be known by only 21% of IT-managers and used by only 5%.

These results call for new alternative approaches to improve human decision making. Traditional DAs try to support decision making by enforcing decision making processes in compliance with principles of rationality. A problem of this approach is that humans do not like to be restricted in their freedom how to make decisions [10-11]. A new form of "persuasive" DAs may be able to overcome this problem. Instead of relying on coercion, such DAs build, for example, on feedback, praise, rewards or reminders through which they "persuade" decision makers to review their decision behavior, and turn to more reflective, effortful and analytical decision making.

In this study we aim to further develop our understanding of such persuasive DAs for specific multi-criteria technology decision contexts. More specifically, we investigate whether feedback regarding decision making effort can be used to influence technology decisions. For this purpose, we conducted an experiment in which 40 participants, divided into two groups, solved a multi-criteria smartphone selection problem with a piece of software applying real-time feedback mechanisms. Our findings demonstrate that normative effort feedback can be a most viable feedback option to implement in decision aids.

2 Theoretical Foundations

In this section we briefly discuss theoretical foundations of persuasive decision aiding. This is followed by a short discussion on what feedback interventions are, why they can influence human behavior and how computerized feedback interventions can be used as techniques in persuasive systems design to influence human behavior. The final sub-section addresses specific research hypothesizes on how feedback interventions can be used in persuasive decision support systems.

2.1 Descriptive Realities of Human Decision Making

In the cognitive sciences various descriptive models of human decision making have been proposed. Out of these models, the cognitive effort-accuracy framework of Payne et al. [4] received considerable attention within the literature on DAs and within IS research in general [12]. The cognitive effort-accuracy framework posits that the human mind comes with a variety of decision making strategies, ranging from simple heuristics to analytical procedures [4]. Humans consciously or unconsciously choose one of these strategies to adapt to the complexity (amount of available information) of the given decision problem [13]. This selection of a decision strategy is based on trade-off considerations between the perceived costs required to apply the strategy (cognitive effort) and the perceived benefits resulting from using the strategy (accuracy).

The cost-benefit model suggests that human decision making can be improved if decision makers are willing and able to spend more of their cognitive resources on decision problems. The willingness to increase effort is necessary for thinking harder, but usually also for thinking smarter [4]. Thinking smarter should improve the benefits resulting from the more accurate decision. Both, thinking harder and thinking smarter, might improve the quality of the resulting decision. However, this presumes that suboptimal decision making results at least partly from lack of effort, and not entirely from lack of knowledge, because the latter cannot be substituted by more effortful thinking [14].

Trade-off considerations depend not only on the complexity of the decision problem, but are also affected by the decision context. Factors such as information presentation format, time pressure and accountability to others alter cost and benefit considerations, and thus the way we make decisions (e.g. [4], [15], [16]). Therefore, these factors influence whether we use non-compensatory or compensatory decision making strategies. The former comprises all strategies which evaluate criteria isolated from each other, and therefore do not apply trade-offs between dimensions. In contrast, compensatory decision making considers several criteria at once. Thus, a positive impact in one dimension may compensate a negative impact in another [4]. Usually, compensatory decision making considers more information, requires more cognitive effort and is more compliant with normative models of decision making than non-compensatory strategies [4], [17].

2.2 Feedback Interventions

Feedback interventions are "*actions taken by (an) external agent (s) to provide information regarding some aspect(s) of one's task performance*" [18].

Feedback interventions can be used to influence a broad range of human behaviors, for example behavior related to energy conservation or alcohol misuse [19-22]. Feedback affects behavior because once people note a discrepancy between their current and standard performance, they usually strive to overcome this discrepancy. The mechanisms underlying discrepancy-reduction are the protection of the positive self-concept and the wish to become positively evaluated by others [18]. The latter is related to accountability: if we know what others want, we are likely to adopt social norms to become positively evaluated and to avoid criticisms [16], [23]. From this perspective, feedback mechanisms provide information about a dimension, which could be used by others to evaluate one's performance. Hence, feedback mechanisms work because humans fear to become negatively evaluated by others based on feedback information.

Feedback interventions can also be used to enable the self-monitoring of users [24]. By enabling users to track their own performance, a behavioral change can be induced by the system. For example, computerized feedback interventions significantly affect alcohol drinking behavior of college students [25].

For changing user behavior, not only the provision of feedback information is important, but also the design of the computer-human dialogue communicating the feedback information. Seven principles for designing this dialogue in a way which supports behavioral change [24]: praise the user, provide rewards, remind the user of the intended behavior, offer suggestions, imitate the user, adopt a social role and design the dialogue in a visually appealing way. These principles may be applied in systems design to make feedback interventions more effective. Selected prior studies on different feedback interventions are contrasted in Table 1, which mostly relate to compensatory multiple attributive decision making [26].

According to these studies, decision accuracy feedback seems to be effective to induce more accurate decision making [27-28]. A limitation of accuracy feedback is that many decision contexts do not provide the information needed to evaluate the accuracy of a decision [29]. In such contexts, the costs of providing accuracy feedback are usually prohibitive. Effort feedback, in contrast, is easier to implement because effort information is usually easily available. Two studies listed in Table 1 considered effort feedback. One study found that effort feedback can lead to reduced decision making effort [30], the other one did not find such an effect [27]. As both studies focused on effort feedback as mechanism to reduce effort, it remains unclear whether effort feedback can be used to induce more effortful decision making.

Table 1. Studies on effort and accuracy feedback for decision support

Feedback dimension	Aim of feedback	Time of feedback	Decision Task	Finding	Ref.
Accuracy	Increase accuracy	After choice	MADM*	Increased accuracy	[27]
Effort	Reduce effort	Continuous	MADM*	No effect	[27]
Accuracy	Increase accuracy	After judgment	Judgment	Increased accuracy without decision aid, decreased accuracy with decision aid	[28]
Accuracy	Increase accuracy	After choice	MADM*	Increased accuracy	[30]
Effort	Reduce effort	After choice	MADM*	Decreased effort	[30]
Accuracy	Increase accuracy	After prediction	Judgment (time series)	Increased willingness to use accurate decision models	[31]

* MA=Multiple attribute decision making.

2.3 Research Hypotheses

The given theoretical background suggests that persuasive decision aids may be able to improve decision making by convincing users to engage in more effortful thinking and without substituting human information processing. Such decision aids can utilize different types of feedback interventions to achieve the persuasion necessary to improve human decision making. This study focuses on feedback interventions, which continuously inform decision makers regarding the effort they spend compared to a normative standard. The aim is to persuade decision makers to spend more effort for processing the information they acquire and thereby to reduce shallow thinking.

As humans try to maintain a positive self-concept and wish to become positively evaluated by others [18], normative effort feedback should increase the willingness of decision makers to engage in more effortful decision making. Accordingly, and based on the finding that decision making behavior is susceptible to feedback interventions [27], [31], we hypothesize that

H1: *Effort feedback has a positive impact on the time decision makers spend per information element.*

According to the effort-accuracy model, an increase in information processing effort per information element does not necessarily lead to an increased overall effort for decision making. As decision makers' trade-off accuracy and effort of decision making, they may try to keep the overall effort constant by adapting their information processing strategy. Users of decision aids try to maintain a low overall effort expenditure for decision making [17]. If the effort spent per information element increases, the only way to keep the overall effort constant is to reduce the number of elements considered. Of course, such adaptive behavior might fully or partly offset the advantages of more effort per information element. To test whether decision makers respond to increased effort per information element by acquiring less information, we hypothesize that

H2: *Effort feedback has an impact on the time decision makers spend per decision task.*

H3: *Effort feedback has an impact on the total amount of information searched.*

The absolute effort of decision making naturally increases with task complexity. In contrast, the effort relative to the amount of available information usually decreases with complexity [13]. Again, this can be interpreted as the result of effort-accuracy trade-offs. Decision makers adapt to higher complexity by applying a more heuristic information processing strategy. The effort-accuracy framework does not provide an answer to the question how such adaptive behavior interacts with effort feedback. However, it can be argued that the motivation of decision makers to keep effort per information element high decreases as task complexity increases. The reason underlying this assumption is that decision makers adapt to increasing complexity by applying simpler decision strategies, which do not profit from more effort per information element. In sum, this would mean that effort feedback is only effective for small decision problems. To test for such an interaction of feedback and decision complexity, we hypothesize that

H4: *The impact of effort feedback is related to the complexity of the decision task.*

3 Research Method

This section describes firstly how the experimental "persuasive" decision aid and its feedback mechanism were designed and implemented. Secondly, the methodological aspects of the experiment to test our research hypotheses are given.

3.1 Design of the Decision Aid and Feedback Mechanism

We needed to develop a software platform capable of tracing user behavior with regard to information search and processing. Process tracing was based on click-stream data. For gathering such data we adopted the approach suggested by Payne [4]. The software displays a matrix with boxes containing detailed item descriptions, which are relevant for a decision. The information in the boxes is hidden and only displayed if the user clicks on the respective box. As soon as the mouse is moved out of the box, the information is hidden again. The software records all user interactions with the information display, e.g. the timing and sequence of clicks.

The software platform is capable of showing two different information displays: one with and one without normative feedback. Feedback is implemented by a visual cue, a numerical performance indicator and a text message. The visual cue is a smiley representing a happy face, which is green as long as the performance indicator is above a specified threshold. If the performance indicator is below the threshold, the smiley is replaced by a red-colored sad face. The performance indicator shows the average effort over the last 6 information boxes and changes its color along with the smiley symbol. The text message below the happy face is a short statement that the user's performance is good, and below the sad face it is a reminder to comply with the norm set by the threshold. Thus, the main principles of persuasive dialogue design utilized by the interface are praise and remainders [24].

To parameterize the behavior of the smiley, we conducted a small pre-test with 4 staff members of our research group. Without effort feedback, they spent about 0.6 seconds per information box. For the main study, we set the threshold value to one second to ensure that the difference in time per information box between control and program group is large enough to detect a treatment effect (if existent).

3.2 The Experiment, Setting and Participants

We targeted the students of WU Vienna as participants for the experiment. The target group, was limited to a total number of 40, and fits the purpose of the research project to study the influence of decision aid feedback mechanisms on decision behavior in the context of consumer technology decisions. We offered a monetary incentive for participation (5 Euro per experiment). The subjects were randomly assigned to a control and to a program group. Both groups used the software platform described above for making multi-criteria decisions, however, only for the latter group effort feedback was displayed.

All subjects were asked to solve a series of four preferential choice problems. Each decision problem consisted of a number of smartphones and a number of criteria describing these smartphones. The complexity of the decision problems was varied, ranging from 16 information boxes for task 1 (4 alternatives x 4 criteria), 36 boxes for task 2 (6 alternatives x 6 criteria), 84 boxes for task 3 (8 alternatives x 8 criteria) to 100 information boxes for task 4 (10 x 10). The smartphones were partly based on real phones, but were "anonymized" to avoid bias due to prior experiences and/or prejudices towards brands.

Each subject conducted an individual session lasting about 20 minutes in a laboratory on the campus of the WU. At its beginning the session also included a training task with 4 information boxes to enable the participant to get familiar with the information display. After the last decision task, the participants were asked to answer an additional short paper-based questionnaire for gathering demographic information.

4 Discussion of Results and Limitations

Before testing our hypotheses, we reviewed our dataset for any abnormal or invalid entries. This led to the identification of three participants who did not finish all 4 decision tasks. After removing these 3 subjects, 37 valid participants remained within the sample (19 subjects in the control group and 18 subjects in the program group). We used Welch's t test to analyze the final dataset. Table 2 lists the results for all 4 decision tasks as well as the results of an overall analysis, where all tasks were pooled in one data record.

Relating to hypothesis 1, the program group spent more than twice as much time per information box than the control group. For the overall analysis, the difference in the average time spent per information box for the control group (M = 0.61 seconds, SD = 0.19 seconds) and the program group (M = 1.3 seconds, SD = 0.47 seconds) is significant (t(x) = 5.72, $p<0.001$). Hence, hypothesis H1, stating that effort feedback increases the time decision makers spent per information element, is well supported.

Relating to hypothesis 2, the participants in the control group spent less time to choose smartphones (M = 305.60 seconds, SD = 124.76 seconds) than the program group (M = 495.05 seconds, SD = 185.06 seconds) taken all tasks together. As this difference is significant (t(x) = 3.44, $p<0.01$), hypothesis H2 stating that effort feedback has an effect on the time decision makers spent for making decisions is supported. These results do not confirm the finding of Todd and Benbasat [17] that decision makers try to maintain a low overall effort expenditure for decision making. Within this study, the participants increased both, the effort per information element and the overall effort for decision making. This finding implies that decision makers do not fully offset the increased effort per information element by processing lesser information.

Relating to hypothesis 3, it can be seen from Table 2 that the program group spent in average more than twice as much time per information box than the control group, while the average overall effort increased only by around 40%. This means that the increased effort per information box is at least partly compensated by visiting a lesser amount of information boxes. For all 4 decision tasks, the data indicates that the program group clicked on fewer information boxes than the control group. For all tasks together, the difference in the average number of clicks for the control group (M = 218.68 clicks, SD = 114.74 clicks) and for the program group (M = 183.33 clicks, SD = 58.63 clicks) is not significant (t(x) = -1.19, not significant). Hence, hypothesis H3, stating that decision makers compensate the increased effort per information box by searching lesser information, is not supported.

Relating to hypothesis 4, Table 2 shows that the average time decision makers spent per information box did not vary much with decision task, although the tasks differ regarding task complexity. To formally test for an interaction effect between effort feedback and task, we conducted a repeated measures ANOVA with effort feedback as between-subjects factor and with tasks as within-subjects factor. The analysis showed neither a significant effect for the task factor (F(2,3) = 0.97, not significant) nor a significant interaction effect between task and effort feedback (F(2,3) = 0.04, not significant). Hence, hypothesis H4, that the effect of effort feedback depends on task complexity, is not supported.

Table 2. Correlations between initiation triggers and resource investments

		Control group		Program group		Independence
Variable	Tasks	Mean	SD	Mean	SD	t-value
Average time spent per information box (seconds)	Task 1	0.66	0.35	1.37	0.55	4.64***
	Task 2	0.60	0.18	1.28	0.58	4.80***
	Task 3	0.63	0.33	1.30	0.51	4.78***
	Task 4	0.58	0.22	1.29	0.44	3.76***
	Overall	0.61	0.19	1.30	0.47	5.72***
Average time spent for decision making (seconds)	Task 1	38.54	21.66	55.91	26.11	2.19*
	Task 2	65.72	40.38	94.79	55.1	1.82
	Task 3	88.02	52.56	144.15	71.2	2.71*
	Task 4	102.00	54.42	185.42	77.78	3.76***
	Overall	305.60	124.76	495.05	185.06	5.72***
Average number of clicks	Task 1	25.21	13.8	19.11	7.38	-1.68
	Task 2	48.79	39.44	36.67	17.47	-1.21
	Task 3	88.02	52.56	54.39	26.94	-1.07
	Task 4	76.42	42.27	73.17	36.98	-0.25
	Overall	218.68	114.74	183.33	58.63	-1.19

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

In sum, the results reported here show that effort feedback can be used to increase the time decision makers spend for processing single information elements as well as to increase overall decision making effort. This suggests that effort feedback might be an effective mechanism for persuading decision makers to engage in more effortful decision making.

5 Conclusions, Limitations and Further Research

This study has shown that normative effort feedback can be used to overcome the tendency of decision makers to keep decision making effort low. The findings clearly suggest that this kind of feedback increases the decision makers' willingness to spend more effort, not only on the level of single decision elements, but also with regard to the entire scope of the decision. Theoretically, such an increased effort is linked with more accurate decision making (e.g. [4]).

The most significant limitations of our research study are the hypothetical decision context and the use of student self-selection as sampling method. Regarding the former, the decision criteria were based on real consumer technology artifacts but the decision problem did not feature real risks and payoffs. In situations with real risks and payoffs, the effect of normative feedback on decision making behavior might be stronger or weaker than the effect observed in our experiment. Regarding the latter, the use of a student sample is not per se problematic because all humans have similar natural decision making capabilities. However, students are used to receive and follow instructions and hence might be more susceptible to change behavior due to normative feedback than an average decision maker.

Future work should not only address these limitations, but might evaluate other feedback mechanisms and alternative interface designs regarding their ability to induce analytical decision making. Besides feedback interventions, there are many other techniques and principles of persuasive systems design, which could also be evaluated regarding their ability to change decision making behavior and to increase decision making performance. Such research efforts would help us to better understand under which conditions and contexts effective decision support purely based on the idea of persuasion is viable.

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A Survey on Intelligent Wheelchair Prototypes and Simulators

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Abstract. Nowadays more than 700 million persons around the world have some kind of disability or handicap. During the last decades the elderly population in most of the European countries and across all the most civilized countries is also growing at an increasing pace. This phenomenon is receiving increasing attention from the scientific community, during the last years, and several solutions are being proposed in order to allow a more independent life to the people belonging to those groups. In this context Intelligent Wheelchairs (IW) are instruments that are a natural development of the scientific work that has been conducted to improve the traditional Wheelchair characteristics using health informatics, assistive robotics and human computer interface technologies. Some of the most important features of the IW are their navigation capabilities and automatic adaptation of their interface to the user. This paper presents the evolution and state of art concerning IWs prototypes and simulators and intelligent human-computer interfaces in the context of this devices. Our study enabled us to conclude that although several Intelligent Wheelchair prototypes are being developed in a large number of research projects, around the world, the adaptation of their user interface to the patient is an often neglected research topic. Thus, projects aiming at developing new concepts of Intelligent Wheelchairs are needed mainly using multimodal interfaces and wheelchair interfaces adapted to the user characteristics.

Keywords: Health Informatics, Human-Computer Interfaces, Simulation, Intelligent Wheelchairs, Wheelchair's Simulators.

1 Introduction

Nowadays more than 700 million persons around the world have some kind of disability or handicap [1] [5]. During the last decades the elderly population in most of the European countries and across all the most civilized countries is also growing at an increasing pace [2][3][4][5]. This phenomenon is receiving increasing attention from the scientific community, during the last years, and several solutions are being proposed in order to allow a more independent life to the people belonging to those groups.

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A wheelchair may be seen as a wheeled device that may be propelled either manually or using motors. Wheelchairs are instruments that were initially developed in order to give mobility to handicapped human beings. Currently the wheelchairs are seen as powerful resources to overcome severe limitations and disabilities resulting from several types of handicaps and illnesses. Moreover the concept of intelligent wheelchair (IW) is a natural development of the scientific work that has been conducted to improve the traditional Wheelchair characteristics. Some of the most important features of the IW are their navigation capabilities and automatic adaptation of their interface to the user.

This paper presents a brief description of the history of wheelchairs and their evolution and the state of art concerning IWs. Based on the state-of-the-art, a definition of intelligent wheelchair is presented. An overview of simulators used for testing and training in the context of wheelchairs and intelligent user interfaces and especially several adaptive interfaces applications is also presented.

2 Intelligent Wheelchairs

Although there are illustrations of wheelchairs in ancient Greek culture, it is considered that the first wheelchair is the one made for Phillip II of Spain in 1595. Then, in 1655, Stephen Farfler, a paraplegic watchmaker, built a self-propelling chair on a three wheel chassis [6]. The concept evolved from simple manually powered wheelchairs to electric wheelchairs and today new developments are presented in so called intelligent wheelchairs or “smart chairs” or even “robotic chairs” [7] [8].

The first intelligent wheelchairs were basically typical mobile robots to which seats, capable of accommodating user, were added [8]. Nowadays, science allows having intelligent wheelchairs, very similar in shape to traditional wheelchairs, with high manoeuvrability and navigational intelligence, with units that can be attached and/or removed and with high power independence.

In fact, definitions of Intelligent Wheelchair can be found at the works of Braga et al. [9] [4] and Simpson et al. [8]. Basically, an IW is a locomotion device used to assist a user having some kind of physical disability, where an artificial control system augments or replaces the user control [8]. The main objective is to reduce or eliminate the user's task of having to drive a motorized wheelchair. Typically, an IW is controlled by a computer, has a set of sensors and applies techniques derived from mobile robotics research in order to process the sensor information and generate the motors commands in an automatically way or with a shared control. The interface may consist of a conventional wheelchair joystick, voice based control, facial expressions or even gaze control, among others. The concept of IW is different from a conventional electric wheelchair, since in this latter case the user takes manual control over motor speed and direction via a joystick or other switch, without intervention by the wheelchair's control system. Thus, it is possible to enumerate the main characteristics of an IW [9] [10]:

- Interaction with the user using distinct types of devices such as joysticks, voice interaction, vision and other sensors based control like pressure sensors;

- Autonomous navigation with safety, flexibility and obstacle avoidance capabilities;
- Communication with others devices such as automatic doors and other wheelchairs.

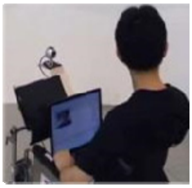
3 Prototypes of Intelligent Wheelchairs

In the last years several prototypes of IW have been developed and many scientific work have been published [9] [4] in this area. Simpson [7] provides a comprehensive review of IW projects with several descriptions of intelligent wheelchairs from 1986 until 2004. Table 1 presents a list of some IW prototypes and describes their main characteristics.

Table 1. Intelligent Wheelchairs Prototypes

	**Madarasz** Autonomous wheelchair presented in 1986. It had a micro computer, a digital camera and an ultra-sound scanner.		**Omnidireccional IW** Hoyer and Holper presented in 1993 an omnidirectional IW.
	**Two legs' IW** In 1994 Wilman presented a hybrid wheelchair which was equipped with two extra legs.		**NavChair** The NavChair was presented in 1996. It was equipped with 12 ultrasonic sensors and an on board computer.
	**Tin Man I** Tin Man I, in 1995, presented 3 operation modes: driving with automatic obstacle avoiding; moving on a track; moving to a point.		**Tin Man II** Tin Man II, in 1998, presented more advanced characteristics: store travel information; return to starting point; follow walls; go through doors and recharge battery.
	**FRIEND's Project** Robot presented in 1999 which consists of a motorized wheelchair and a MANUS manipulator.		**LURCH** LURCH project (Let Unleashed Robots Crawl the House) started in 2007 aiming at developing an autonomous wheelchair.

Table 1. (*continued*)

	**RoboChair** In 2009 Robochair aimed to be an open framework for assistive applications, design modular and based in open standards for easy extension and low cost.		**VAHM** In 2010 the VAHM project presented a new prototype of an intelligent wheelchair with a deictic interface.
	**Intellwhells v1** In 2008, the 1st Intellwheels prototype was developed with high-level control through a multimodal interface (voice, head movements, joystick, keypad and simple facial expressions).		**Intellwheels v2** In 2012 a new prototype was developed at IntellWheels project with improved multimodal interface and ergonomics and automatic patient adaptation capabilities.

The first project of an autonomous wheelchair for physical handicapped was proposed by Madarasz [11] in 1986. It was planned as a wheelchair with a micro computer, a digital camera and an ultra-sound scanner with the objective of developing a vehicle that could move around in populated environments without human intervention. Hoyer and Holper [13] presented a modular control architecture for an Omni-directional wheelchair. The characteristics of NavChair like the capacity of following walls or obstacles deviation are described in [14] [15] [16]. Miller and Slak [17] [18] developed the system Tin Man I with three operation modes: one individual conducting a wheelchair with automatic obstacles deviation; moving throughout a track and moving to a point (x,y). This kind of chair evolved to Tin Man II which included advanced characteristics, such as, store travel information, return to the starting point, follow walls, pass through doors and recharge battery. Wellman [19] proposed a hybrid wheelchair which was equipped with two extra legs in addition to its four wheels, to allow it to climb stairs and to move on rough terrain. FRIEND is a robot for rehabilitation which consists of a motorized wheelchair and a MANUS manipulator [20] [21]. In this case, both the vehicle and the manipulator are controlled by voice commands. Some projects have a solution for quadriplegic people, where the recognition of facial expressions is used to guide the wheelchair [10] [22] [23]. In 2002, Pruski presented VAHM a user adapted intelligent wheelchair [24].

Satoh and Sakaue [25] presented an omni-directional stereo vision-based IW which detects both the potential hazards in a moving environment and the postures and gestures of a user using stereo omni-directional system, which is capable of acquiring omni-directional color image sequences and range data simultaneously in real time. In 2008 John Spletzer studied the performance of LIDAR based localization for docking an IW system [26] and, in 2009, Horn and Kreutner [27] showed how the odometric, ultrasound, and vision sensors are used in a complementary way in order to locate the wheelchair in a known environment. Currently there are several active international projects such as: RADHAR [28] that has the objective of developing a driving assistance system involving environment perception, driver perception and modelling and robot decision making, MAIA [29] project that aims the development of non-invasive prosthesis, the LURCH project [30] active until 2015, ARTY project [31] with the focusses in developing an intelligent paediatric wheelchair and a project from the University of Zaragoza [32] that is focused on mobile robot navigation and brain-computer interfaces.

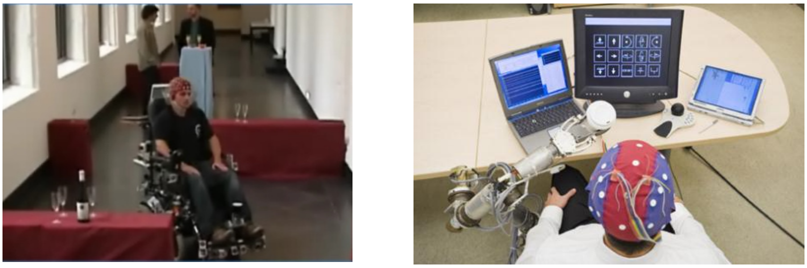


Fig. 1. Wheelchair and arm controlled by thoughts (Adapted from [33] [37])

In fact the research in IW has suffered a lot of developments in the last few years. Some IW prototypes are controlled with "thought" (Figure 1), this type of technology uses sensors that pick up electromagnetic waves of the brain [33] [34] [35] [36] [37].

Although there are several research projects in the area of intelligent wheelchairs and some business models that use new information technologies and robotics in support of a profound disability, there is a lack of wheelchairs with real capabilities of intelligent actions planning and independent navigation. Thus, one of the objectives of current research [4] [9] in this area is the integration into the intelligent wheelchair of ways to implement, in a semi-autonomous mode, commands of its users, in particular, using methods such as high-level command languages, navigation, semi-automatic, intelligent planning of actions and communication with other intelligent devices.

Another aspect that has been exposed to limited attention is the evaluation of the performance of the IW and long-term studies of the effects of using an IW or even studies using real patients and demanding constraints like low illumination, small areas or uneven floors. The CALL Center [38] [39] has a research group which studies which are the necessary skills to use a standard IW with young users. The CALL Center uses a standard power wheelchair equipped with bump sensors and line tracking sensors as an instructional tool for children learning to operate an IW [8] [39] [40]. Other interesting projects include the ENIGMA [41], an omnidirectional wheelchair from the University of Minho. Recently it is being used for the study of some applications of gestures commands. The Magic Wheelchair which is a gaze driven IW is part of the MagicKey Project from the Polytechnic Institute of Guarda [42]. In Coimbra, Portugal, a group of the Institute for Systems and Robotics developed a wheelchair steered with voice commands and which could be assisted by a reactive fuzzy logic controller [43].

There is also the project PalmIber [44] which is the continuation of Project PALMA (Support Platform Playful Mobility Augmentation) Ibero-American Program for Cooperation and Development (CYTED), which developed an IW prototype that has been tested at the Rehabilitation Center for Cerebral Palsy Calouste Gulbenkian in Lisbon. It has a multi-detector system of obstacles, composed of ultrasonic sensors; a set of interfaces for the user, which will allow controlling the vehicle through direct selection or selection by scanning and a programmable interface, allowing assigning different levels of complexity to the vehicle (speed, acceleration, and different ways to avoid obstacles, among others). However, only a few of these devices really had their performance tested with real users.

Most of the wheelchair projects presented did not include any reference to the user adaptation to the wheelchair or how to improve the IW interface based on the user interaction with the device. Therefore, an important project named IntellWheels [10] proposed an intelligent wheelchair with a multimodal interface. The interaction of the user with the IW and how an intelligent/adaptive interface can help and improve the user mobility was part of the study of this project [45][46][47][48][49][50][51].

4 Wheelchairs Simulators

The description of several simulators projects can be found in literature [52] [53]. The objectives of these simulators are concerned with the improvement of driving intelligent wheelchair and general manual/electric wheelchairs as can be observed in Table 2. The simulators have different objectives and fulfil important mission for testing the behaviour of humans and wheelchairs.

Table 2. Wheelchair's Simulators

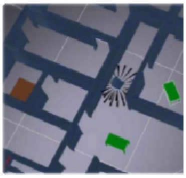
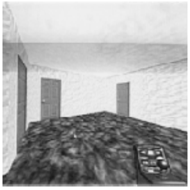
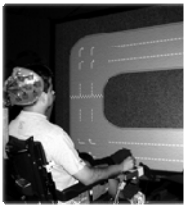
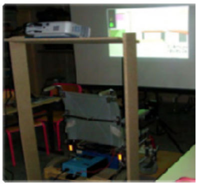
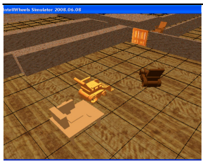
	**VAHM** The project VAHM of an intelligent wheelchair presents a simulator for testing the driving performance in 2000.		**Virtual Int.Wheelchair** In 2007 from the Mediterranean Univ. it was presented a simulator for evaluation of an intelligent wheelchair.
	**ITESM - CCM** In 2009, ITESM CCM presented an intelligent wheelchair and in 2012 a simulator was proposed for the user to get familiar with the controls.		**Powered Wheelchair Mobility Simulator** In 1993 from State University of New York a simulator of manual wheelchairs was proposed.
	**User Proficiency through Virtual Simulation** In 1994, a virtual structure prototyping system was proposed that allows navigation by a person using a powered wheelchair.		**Oregon Research Institute Simulator** In 1994 a simulator of an electric wheelchair using virtual reality was proposed by the Oregon Research Institute.

Table 2. (*continued*)

	**Simulator of Powered Wheelchair** In 1998 a wheelchair simulator was presented by the research team from National Rehabilitation Center for the Disabled in Japan.		**Royal Hospital for Neuro-disability vs University of East** In 2002 a join project used the role of virtual reality technology in the assessment and training of inexperienced powered wheelchair users.
	**Univ. of Strathclyde** In 2004, the University of Strathclyde presented a manual wheelchair controlled on a platform linked to a virtual reality screen.		**Virtual Env. Mobility Simulator** In 2005 a study was conducted in the virtual environment mobility simulator. Children could drive an electric wheelchair in different virtual environments.
	**Virtual Real. Wheelchair** In 2005, the Clarkson University presented a simulator that was also used by insure companies to give facilities for users to acquire wheelchairs.		**Univ. of Pittsburgh** In 2008 a study was published with tests performed by users with traumatic brain injury. A 2D virtual simulator was used to test the driving ability and measure the performance of alternative controls.
	**ISIDORE** In 2008, Toulon Univ. presented a simulation project to have a better evaluation of the user and more efficient information to therapists and doctors that prescribe wheelchairs.		**University of Florida** In 2009, a wheelchair simulator was proposed in the University of Florida.
	**McGill simulator** In 2011, McGill simulator was proposed using the Unreal Development kit and a comparison in real and virtual environments were conducted using an electric wheelchair.		**WheelSim** The WheelSim © Life Tool is a commercial simulator. The wheelchair can be commanded with a joystick, the keyboard or with the rollerball.
	**IntellWheels Simulator** In 2009 it was proposed the first simulator of an intelligent wheelchair with a multimodal interface.		**IntellSim** In 2012 Intellwheels project upgraded into a more realistic simulator based on USARSim and tested it with cerebral palsy patients.

The study of this kind of instrument has focused mostly in real electric wheelchairs. However, there are also some projects of intelligent wheelchairs that are concerned in presenting a simulator to perform tests [24]. There is also a work from the Mediterranean University (Virtual Intelligent Wheelchair) that presented a 3D intelligent wheelchair simulator where a wheelchair had an automated movement at a given trajectory [54]. The main constraint of this project was the lack of real users' participation. In 2009 the ITESM-CCM (*Ingeniería en Telecomunicaciones y Sistemas Electrónicos, Tecnológico de Monterrey, Campus Ciudad de México*) presented an intelligent wheelchair that could be commanded with voice commands and eye tracking [55]. In 2012 it was developed a simulator with the objective of enabling users to get familiar with the wheelchair's controls [56].

The Powered Wheelchair Mobility Simulator (PWMS) was a project developed in a center for assistive technology from USA and the objective was to develop an evaluation and training instrument for people with physical and cognitive constrains [57]. The performed tests allowed to conclude that the behaviour with the simulator has similar results as with the real wheelchair. The Virtual Electric Power Wheelchair Driving (VEPWD) was a project devoted to test speed control in outside/inside and with static/dynamic environments [58]. The Wheelchair User Proficiency through Virtual Simulation (WUPVS) project has the objective of provide a tool to overcome the limitation of users to real wheelchair training [59]. It is composed of an electric wheelchair linked to a workstation to simulate speed and orientation. The problem of providing disable people with accessibility to public buildings was one of the motivations for the development of this system. In fact, architects and conceivers could use this platform to test the environment accessibility. The Oregon Research Institute (ORI) has its focus in providing a wheelchair training simulator for children [60] [61]. Sound feedback has been integrated in the system in order to inform the impact when a collision occurs. The Assistive Technology Access Interfaces (ATAI) tested the capacity of basic driving simulator software to evaluate and train disabled children to command an electric wheelchair [62]. They tested two different groups of children one with and other without experience of driving wheelchairs. The results showed that after an initial training the group without experience could improve significantly the driving performances. The research institute on the National Rehabilitation Center for the Disabled in Japan proposed a Simulator of Powered Wheelchair (SPW) [63]. This system is composed with two computer screens and a mobile platform. The platform is connected with six actuators producing accelerations and decelerations similar to those in the real electric wheelchairs. The results demonstrated that users found similarities between real and virtual driving although the difficulties were higher when using the simulator. Another study that presented similar results about the differences between the experiments in virtual and real environments was evaluating and learning to drive an electric wheelchair from Royal Hospital for Neuro-disability and University of East [64]. From the University of Strathclyde a manual wheelchair being controlled on a platform linked to a virtual reality screen was proposed [65]. The users' motion is translated through an electromechanical platform to drive coordinates based on encoder takeoff at the wheels. From the University of Portsmouth, a research group worked on wheelchair obstacle avoidance by using virtual reality for elderly population [66]. The Virtual Environment Mobility Simulator (VEMS) provides a virtual environment where simple tasks are proposed to motivate the users [67]. The first conclusion of this project passes over the necessity of adaptation of the virtual environment to the user, since their incapacities are very diverse. The Virtual Reality Wheelchair (VRWC) is a simulator to test and train potential users of electric wheelchairs [68]. This simulator is also used for demonstrating to insure companies the ability in driving a wheelchair in order to obtain facilities for acquiring a wheelchair. From the University of Pittsburgh a Wheelchair Virtual Driving Environment was proposed in order to test the driving ability, the performance and to train users with brain injury with different controls such as the comparison between a standard motion sensing joystick and an experimental isometric joystick [69]. The ISIDORE (*Interface d'aide à la Simulation, à la DécisiOn et la REéducation*) from the Toulon University is a project that combines behavioral, visual and sound information to have a better evaluation of the user and more efficient information to therapists and doctors that prescribe the wheelchairs [70]. A wheelchair simulator was also proposed by a research team from the University of Florida. The simulator can simulate a manual and an electric wheelchair [71]. The McGill simulator was proposed using the Unreal Development kit (2011) and a comparison in real and virtual environments were conducted. The study allowed concluding that the performance in the simulator was similar to the real electric wheelchair; however in some tasks the driving in the simulator was more difficult [72]. A commercial wheelchair simulator is also available on the market: the WheelSim © Life Tool. This simulator aims at making easier the learning process of driving a wheelchair and also as a tool for diagnosis software or just a game to play [73]. The wheelchair can be commanded with a joystick, the keyboard or with a rollerball. The IntellWheels project developed two simulators were it was possible to drive an intelligent wheelchair with a multimodal interface. Several inputs

5 Conclusions and Discussion

The main focus of this paper was on the state of the art on Intelligent Wheelchairs and simulators as important instruments for testing and training. This survey may be quite useful for anyone researching on the areas of adapted user interfaces, intelligent wheelchair health applications for handicapped users or simulation of health devices. Although several Intelligent Wheelchair prototypes are being developed in several research projects, around the world, the adaptation of their user interface to the patient is an often neglected research topic. Typically the interface is rather rigid and adapted to a single user or user group. Thus, projects aiming at developing new concepts of Intelligent Wheelchairs are needed mainly using high-level commands, multimodal interfaces and wheelchair interfaces adapted to the user characteristics.

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A Generalized Scalable Software Architecture for Analyzing Temporally Structured Big Data in the Cloud

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Abstract. Software architectures that allow researchers to explore advanced modeling by scaling horizontally in the cloud can lead to new insights and improved accuracy of modeling results. We propose a generalized highly scalable information system architecture that researchers can employ in predictive analytics research for working with both historical data and real-time temporally structured big data. The proposed architecture is fully automated and uses the same analytical software for both training and live predictions.

Keywords: predictive analytics, temporal data, system-level design, self-adaptive systems, runtime models.

1 Introduction

Development of big data analytics enabled solutions are being driven by unstructured data, surprisingly little is done in open sourced development of processing structured big data. Structured data is often considered, mischievously so, as data at rest perhaps due to its usual implementation as a state storage. In the world of big data analytics, it is not enough to simply analyze historical or at rest data, instead this must be done in a (near) real-time environment. The term real-time environment means something slightly different depending on the context, here we refer to an event being triggered when new data exists and how the system consequently handles that data automatically. We concur with the argument that a big data model's excellence can only be shown after it has been employed in an online environment [1][2]. In [3] it is claimed that "Advancing the cloud from a computation and data management infrastructure to a pervasive and scalable data analytics platform requires new models, tools, and technologies that support the implementation of dynamic data analysis algorithms." The process of integrating disparate data sources (external and/or internal origin), continuously preprocessing data for validity or other purposes, and transporting data to processing nodes is such a delicate and often limiting step in the workflow that a model's performance can only be known after this step has been completed. Quite few predictive models exist that have an ability for online learning; this adds a

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requirement for models employed in a live environment to be re-trained if/once their effectiveness diminishes. This self or auto tuning is an integral part of any real-time automated analytical system.

We propose a generalized scalable software architecture based on predictive analytics for working with structured (near) real-time and historical data. The structured data we refer to can originate from a multitude of sources like sensor data, machine or user interface, financial data or any other source of online data with a temporal structure, commonly referred to in programming terms as data tuples. The proposed architecture will be able to take advantage of resources from both a public cloud infrastructure and private cloud providers [4]. We set a requirement that data processing activities should be fully automated once the system user has initiated model training. The architecture should automatically handle scaling on available resources, perform feature extraction, carry out model training, initiate auto tuning, and do live prediction.

We focus on the information system architecture and make the assumption that global memory is not usually required for analytical models that consume temporally structured big data. The contribution we bring is an understanding of a generalized light-weight scalable architecture for designing actual analytical information systems that can be used in collaboration with modern decision support systems. Our architecture allows the researcher to take almost any off-the-self model that can be encapsulated as an executable binary and deploy it as a scalable predictive analytics information system. By making extensive use of cloud computing in order to be able to scale sufficiently, we can employ an ensemble of ensembles of different machine learning models to achieve a good prediction rate [5]. We primarily narrow the type of forecasting models we use to those using supervised learning, e.g. Support Vector Machines [6] or Neural Networks [7]. This does not however exclude the use of unsupervised or reinforcement based learning methods provided a model and training error calculation can be automatized.

2 Related Research

Analytical Information Systems have recently received a great deal of attention from academics, open source community, as well as industry [8][9][10][11][12]. Also standardization steps in big data analytics have been taken [13]. The driving force behind related software design has been the Service Oriented Architecture (SOA) [14] approach, which has become an industry de-facto standard for building cloud based, loosely-coupled "X as a Service" enabled data sharing software modules.

The open source community tools for processing and storing big data [15], e.g. technologies such as Hadoop [16] and PIG [17], are mainly focusing on unstructured data and on extending the MapReduce programming model [18]. The MapReduce programming model assists the developer in segmenting data into smaller pieces and process them on the node were data resides, instead of moving data to a second node for processing. This consequently reduces processing time for large data sets.

In the case of handling structured big data, as temporal data often is, more traditional methods are still often applied, such as queuing methods and clustered relational databases, with data then moved to separate nodes for processing. The field of structured data analytics is dominated by proprietary software companies such as IBM [19] and SAP (e.g. SAP HANA [20]). From the perspective of start-ups, small and medium enterprises and academics the cost structure for such solutions is a significant barrier. Recommendations in [3] for future cloud-based data analytics research include development of "scalable higher-level models and tools" and the use of the Web and cloud services for "worldwide integration of multiple data analytics frameworks".

3 Defining a Scalable Analytics Architecture

Scalable architectures usually refers to an ability to add and employ either more processing power in a parallel fashion or adding more storage capacity. In this paper we mainly refer to adding more processing power by adding more computing instances, i.e. scaling horizontally. Scalable architectures have been used by academics (in particular) in natural sciences for a long time, predominantly using data at rest as input data. For example weather forecasting is often based on a time interval update frequency instead of being data driven, hence considered being a batch driven architecture requiring manual operation or a scheduler [21].

Scalable architectures exist for both grid computing and for cloud computing [22][23], here we focus on cloud computing. A cloud computing architecture is built upon several layers. On the top there is an application layer containing the user defined software, and at the bottom there is a fabric layer providing access to compute resources, storage resources, and network resources. Under the application layer there is a unified resource layer containing "resources that have been abstracted/encapsulated (usually by virtualization) so that they can be exposed to upper layer and end users as integrated resources" and a platform layer adding a collection of specialized tools, middleware and services on top of the virtual resources that provide a development and/or deployment platform [24]. Our architecture integrates with Amazons platform layer often referred to as Amazons Platform as a Service (PaaS) [25].

From an information system point of view the architectures required for handling event driven systems and batch driven systems are quite dissimilar. When a system is event driven it is assumed that computations are only and always initiated when new events, e.g. data, exist. However, when developing analytical systems the definition is not always so clear cut. Consider e.g. predicting a high volume financial instrument, here the model input update frequency can be measured in nanoseconds. Thus, preformatting data into more manageable update cycles is often a requirement as model throughput (i.e. forecasts) is usually measured in times order of magnitudes greater. There are different techniques for adapting the update cycle; often the simplest form is that data points are combined for a certain time resolution, e.g. 0.1 seconds and only updated values are sent forward. This case requires the real-time processing part of the system to be a data listener and allows for an event based programming model. However, the model training part is still driven by a type of command collection, due to that most forecasting models are not trained in an online manner. The training process itself is pre-determined by the system user when defining the model setup. As the requirement on a typical analytical system is to be able to handle both data at rest as well as real-time data, we defined two separate work flow processes: model training workflow and live prediction workflow.

3.1 Model Training Workflow Using Data at Rest

In the following sub-chapter we discuss a workflow for how machine learning models learn a behavior without manual assistance, based on historical data. Our training workflow includes four main phases, namely model creation, data feature extraction, model learning and model verification. In Figure 1 we show the model training process for using historical data. Data as represented in Figure 1 (accessed from the Data Gateway) has been pre-processed for validity and other preformatting techniques such as time boxing and adjusted for required granularity, i.e. time resolution. The data feature extraction block refers to techniques such as component analysis, technical analysis or normalization as required by the system user. While data is being prepared, an asynchronous flow initializes contact to the worker nodes in the public or private cloud (hereafter referred to as cloud when no differentiation is needed). These worker instances will be started manually with a pre-prepared image containing required software (e.g. correct software versions, security and our base client service that starts automatically with the instance), in order for the system user to have full control over all simultaneously running instances.

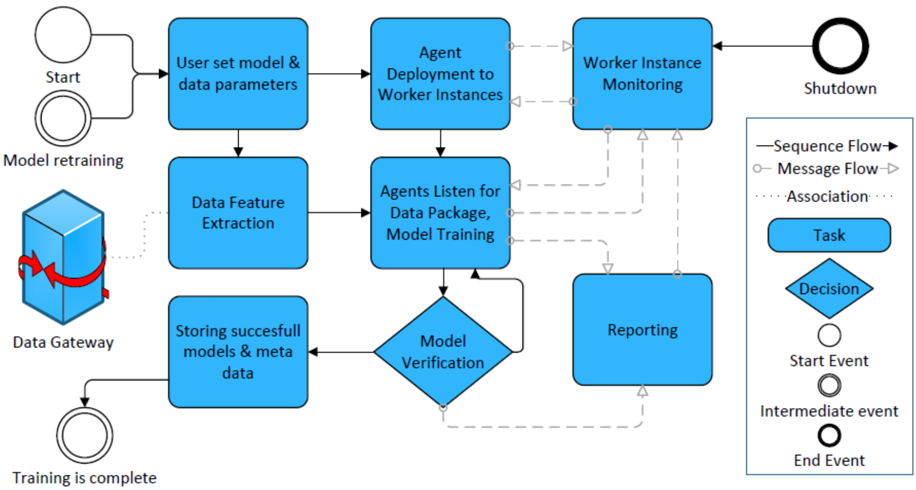

Fig. 1. Model training workflow using data at rest

We have defined two identification means for initiating contact to worker instances depending on if they are in the cloud subnet of the model or not. In the former case the new instances are detected when they come into existence and consequently initiate handshaking. Once the initial handshake is performed necessary binaries defined by the developer and used by worker instances to process data are transferred to the worker nodes. We refer to these binaries henceforth as agents. In the latter case, when worker instances are outside the cloud subnet of the model, they contact the model through a predetermined address. The agents automatically subscribe to the worker instance monitoring service in order to receive jobs.

Here we define one type of agent, but this construct allows us the possibility to use different types of agents. Assume that the underlying worker instances are different, one instance having a powerful Graphical Processing Unit (GPU) and other don't, then we can assign different binaries to each, optimized for the specific hardware. Once an agent receives its data, the process of training a model commences. The primary reason to differentiate between model, agent and worker instance is that the worker instance represents the virtualized cloud instance (including our base client service), the model is the serialized network representation, while the agent is the generic binary with ability to report status, listen to data events and execute models as defined in the data event. A data event refers to a new or updated input variable, however, the actual data packages sent to the worker instances vary depending on type of job. In the case of a training job the data package includes all the input data a model needs in a fully preprocessed format as well as model metadata. The input data for training can be of considerable size and is therefore transferred in a compressed format.

Given that the training process is fully automated we make use of both a verification data set and an evaluation out-of-sample training data set for calculating model error rate. The verification data set is usually a pre-training data sample. We continue training till we can confirm that a certain training iteration delivered the lowest in- and out-of-sample training error, in order to minimize the risk of overfitting. We perform a comparison of the verification and training error to determine the convergence point, when they combined reached their minimum. Once the model training is considered to have reached its minimum training error we perform a second out-of-sample test of the best iterations found that we refer to as evaluation, using data from post in-sample data to determine the models most recent performance and ultimately which iteration to choose. See Figure 2 for a graphical representation of data segmenting. The evaluation is also performed continuously and as a part of the second workflow process to determine the model's continued health. The trained models are then serialized along with their respective metadata. Status messages (identified by dotted lines in Figure 1) are also continuously sent from certain process blocks to a reporting user interface.

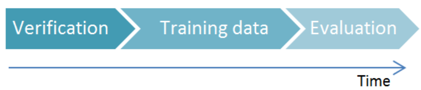

Fig. 2. Data segmenting

3.2 Live Prediction Workflow Using Real-Time Data

This chapter describes the differences in processing based on real-time data compared to historical data. Figure 3 shows the workflow for live prediction using real-time data. Once the system user has chosen a certain model set (ensemble) to be deployed and agents are available, the jobs are distributed randomly among the spare agents. To achieve this we implement a queue of jobs (i.e. new data events) that are sent along to agents that indicate they are free. In case the queue contains jobs that are outdated, which implies we have a performance bottleneck, the job gets canceled automatically.

Jobs become outdated once the point in time they are supposed to be forecasting to has passed. A data event during live prediction includes, in addition to the input data needed for prediction, network weights and metadata required for processing.

When a job has been processed the result is collected centrally for both calculating a new ensemble vote as well as to determine if a certain model has been performing badly and needs to be retrained. For automation purposes (i.e. not requiring human intervention during training, live prediction and model retraining) we consider using an ensemble of models as a requirement. This technique is also known as voting by committee. Considering the reported success of deep learning and convolutional networks [26] we employ an analogous type of network specialization, although not hierarchical, called ensemble of ensembles. This machine learning technique enables developers to use both different models as well as feature inputs, and then combine them through a voting mechanism. This network specialization can be used in order to enhance weak signals or characteristics in data that otherwise might disappear as noise or in significance to other more prominent data features. There are several techniques for calculating an ensemble vote, we chose to use out-of-sample evaluation data for determining the relevance of each model. This allows us to evaluate each model's performance in regards to its recent forecast and based on the evaluation error rate determine its voting rights.

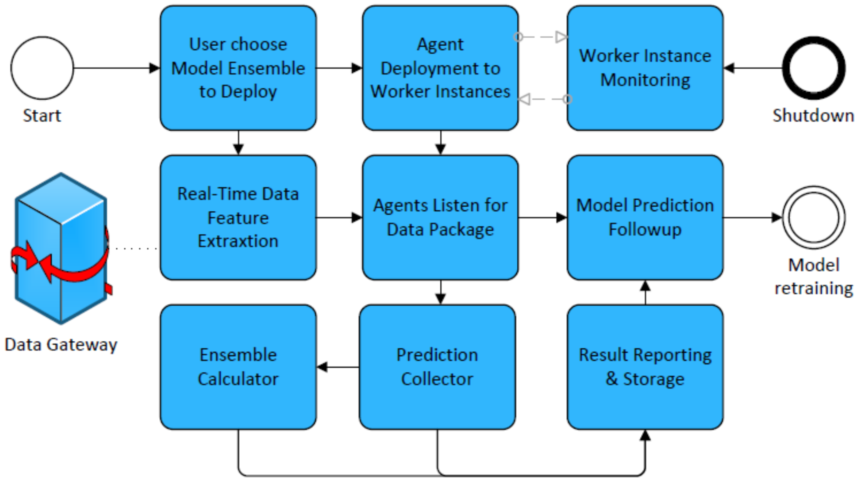

Fig. 3. Live prediction workflow

Our architecture's ability to continuously update and improve itself is based on the decision of retraining a certain individual model as a result of its recent performance. We use a number of previous predictions and define a threshold for how large the error rate is allowed to be. E.g. if >50 % of the last 1000 predictions are faulty we initialize the training of a new model based on the same input variables and model parameters, but with the most recent data. For a theoretical background of employing ensembles and the various setups and combination techniques used, see [27].

4 Proposed Architecture

Based on the two workflow models we can derive three different components that will be central for the system. First we identify a client component which allows the system user control over model training and execution as well as management of cloud instances. The client can be run locally outside the cloud and takes the form of a graphical user interface. The second component we identify is a server component. The server component acts as a central node responsible for interfacing with the client component, extracting features from data sources, maintaining efficient distribution of new jobs and collecting and processing of modeling forecast results as defined. The third identified component is the agent, responsible for performing various jobs sent to it by the server component.

4.1 Component Identification

Based on the analysis we can define a component diagram, identifying the sub-components and interfaces for the server component, see Figure 4. Our goal is to create a unified design for both the training process and live predictions and through a polymorphic interface switch between them. One of the challenges faced was to solve how feature extraction is handled in both cases, here defined as Data Generator. More on this presented in next subchapter. The Job Engine component handles the job queue and allows for two types of jobs to be entered into the queue. It also maintains a current list of available agents. When an agent disappears without notification, it will be detected once the monitoring service stops receiving updates from the agent. The agents send status messages continuously that are used to determine the health of each agent. When a disappearance of an agent is detected the job queue is notified. In case of an unreported job that had been associated with the disappeared agent is discovered, the job is resent to another agent.

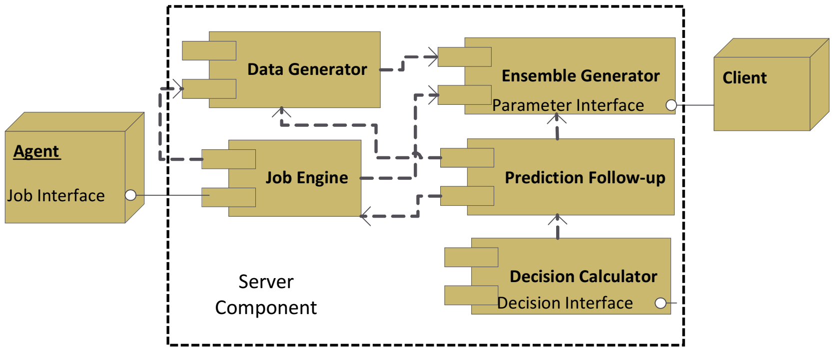

Fig. 4. System component diagram

4.2 Data Processing

As can be seen from the component diagram the server component defines the network topology as a star network and not a fully distributed network. The reasoning for creating a star topology is that network training is such a computationally dominating task that from a parallelization perspective we assume there is not much gain by creating a fully distributed network. It's important to remember that when working with structural big data the data volume compared to unstructured big data is much smaller. Historical temporally structured big data is usually confined to sizes less than 10GB. Most current forecasting models struggle in training when presented with too much data, so researchers often want to reduce this even further.

When exceeding a data volume size of 10GB feature extraction becomes a more time consuming task that might be sped up by distributing the processing to agents. As we are using ensembles it means we can typically have about 20-30 models of the exact same setup sharing the same input data. Therefore feature extraction activity should be connected to the models and only performed once. In a fully distributed network were all activities such as model training, live forecasting and feature extraction are distributed to worker instances we recommend using an indexer with a lookup service for connecting the different types of tasks.

Performing feature extraction on both historical and real-time data with the same underlying algorithms requires that data is always formatted using predetermined data tuples that include a required amount of data elements and using the same time resolution. For certain algorithms, e.g. normalization algorithms, previous scaling values used for historical data must be employed during live prediction as well. These types of values must therefore be stored as model metadata during training as they are used as well during live prediction.

4.3 Risk Assessment and System Security

Defining and implementing a secure system architecture is always important and challenging. By prioritizing the type of security risks one wants to avoid, it is possible to define the security objectives of the system [28]. The risks identified with highest priority were unauthorized access to the system, exposure to physical attacks and malicious resource consumption. Therefore our main security objective is to avoid financial exposure of an attacker being able to highjack our account resources to run their own services. As a consequence we employ the following security controls:

1. Each system user is required to use a personalized cloud account.
2. System passwords required for instance control are only entered during runtime (through a secured remote desktop connection).
3. Communication between instances is always encrypted over HTTPS/TLS.
4. Each instance must use a certificate that is unique for each system user.

We point out that this type of risk assessment must always be performed on an individual basis. It should also be noted that if the system is to be handling sensitive data then protecting that data from possible exposure should be a prioritized risk.

5 Conclusion

Our main research target is to create a general architecture for predictive analytic modeling. The architecture should be flexible both regarding underlying infrastructure as well as the software used for data manipulation and modeling. We consider we have achieved this by implementing support for both Amazon's [25] PaaS solution (supporting both regular and spot instances) as well as our own private cloud. The architecture allows us to extend support to any cloud provider that offers a basic API for launching and stopping multiple instances from the same image. We can extend our modeling software to use other machine learning libraries by adding a new wrapper class. This is possible since we make extensive use of internal interfaces between the different software layers and modules. Currently we make use of the Encog machine learning framework [29] which scales well on a single node and exists in versions for both CPU processing and a limited beta for GPU processing. We implemented support for a worker instance to run simultaneous agents sharing its processing resources. When having access to powerful instances this becomes a useful feature. Consider when the instance has more than one GPU that the underlying analytical software cannot take advantage of in a co-operative mode, then two agents can co-exist instead. Another similar case is when the machine has both powerful CPU and GPU processing, then a desired number of agents can be run on the same instance.

The contribution of the proposed architecture is in unifying the automatized processing of both historical and real-time data for predictive purposes, by utilizing a cost-effective cloud computing solution. Working with both historical and real-time data allows the researcher to not only determine the statistical significance of the forecast on historical data, e.g. when forecasting financial time series the result is often compared to the random walk. Forecasting both on historical and real-time data allows for a confirmation that correlation in the model error occurs in a separate setting. This reduces the significance of the critique that results are not repeatable when forecasting dynamic time series. Albeit, this critique can never be fully met as we are dealing with future information, still this type of research has the potential to be more trustworthy by industry than before. Perhaps the most prominent promise this holds for the science community is that researchers can with greater certainty verify that the results do not contain common errors that occur by including future data as input to the models.

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Collaborative Training Tools for Emergency Restoration of Critical Infrastructure Systems

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Abstract. Large-scale disasters can produce profound disruptions in the fabric of critical infrastructure systems such as water, telecommunications and electric power. The work of post-disaster infrastructure restoration typically requires close collaboration across these sectors. Yet the technological means to support collaborative training for these activities lag far behind training needs. This paper motivates and describes the design and implementation of a multi-layered system for use in cross-organizational, scenario-based training for emergency infrastructure restoration. Ongoing evaluation studies are described in order suggest directions for further work.

Keywords: disaster response, critical infrastructure, computer-based collaboration.

1 Introduction

Recently, considerable attention has been devoted to opportunities for minimizing the impact of large-scale disasters on the services provided by infrastructure systems such as electric power, telecommunications and water [1, 2]. Pre-disaster, this may involve training exercises developed around anticipated hazards; post-disaster, this may involve collaboration across the organizations tasked with restoring the services which these infrastructures typically provide. Yet progress in understanding and supporting organizational in infrastructure restoration is hampered by the rarity of large-scale disruptive events, and the difficulties inherent in observing those that do occur [3, 4], thus reducing the potential for systematic observation and comparative study. Taken together, these conditions present considerable barriers to the development of tools, techniques and training approaches for achieving organizational *resilience*: that is, an ability to retain control, to continue and to rebuild [6].

The work described here concerns the development of techniques and technologies to support training in the emergency restoration of infrastructure systems. These immediate post-disaster activities are undertaken to provide services through water, electric power, telecommunications and other critical infrastructures. Laboratory research in this domain faces a two-fold challenge: on the one hand, to develop and test experimental apparatus that will provide a credible representation of the domain

Á. Rocha et al. (eds.), *New Perspectives in Information Systems and Technologies, Volume 1*, Advances in Intelligent Systems and Computing 275,
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of application; on the other hand, to incorporate tools for measuring and analyzing data associated with emergency restoration. New technologies—such as human-computer interfaces for multi-person interaction, as well as advanced simulation techniques [7] and analytic tools—offer the potential to address this challenge.

The technologies discussed here, combined with a physical platform for its deployment, are being used to create a *synthetic environment* in which phenomena associated with organizational resilience may be investigated. A synthetic environment is defined by the Defense Modeling and Simulation Office as an "environment within which humans may interact through simulation(s) and/or simulators at multiple networked sites using compliant architecture, modeling, protocols, standards, and databases." The technology consists of a database representing an existing system of critical infrastructure systems—together with the capability for multi-person interaction with this database—mediated by a simulation engine that provides feedback on decision making. Following a brief discussion of the research objectives (Sect. 2), work to date (including a pilot evaluation) is presented (Sect. 3), along with a discussion and concluding comments (Sect. 4).

2 Background and Objectives

An examination of post-disaster infrastructure restoration shows that disasters continue to be sources both of system renewal and of system redesign. Indeed, in the immediate aftermath of a disaster, infrastructure systems erected on an emergency basis rarely mirror pre-event systems. Instead, their design is likely to be provisional, and may even precipitate modification of the design of pre-event systems. For example, in one well publicized example from the response to 9/11 in New York City, normal ferry service from Manhattan was suspended after the event, primarily due to the ferries themselves being used to carry thousands of injured and other persons to New Jersey as part of an improvised waterborne evacuation. The ferry system is now an essential component of the evacuation function with the emergency services infrastructure.[1]

Emergency restoration of services provided by critical infrastructure systems typically requires deployment of multiple decision makers [8] acting under time constraint and under multiple (and possibly conflicting) objectives. These personnel may be deployed to an emergency operations center (EOC), where the number of personnel may vary, but are typically drawn from management rather than operations staff. Activities within the EOC include monitoring operations during normal conditions, selecting an appropriate procedure when planned-for contingencies arise, and revisiting the appropriateness of these procedures as other potentially disruptive events occur [9]. These procedures are intended either to restore service (thereby resolving the emergency), or to enable a return to planned-for procedures [10]. If no planned-for procedure applies to the current situation or if an appropriate planned-for

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[1] Pérez-Peña, R. (2001). "A Day Of Terror: The Government: Trying To Command An Emergency When The Emergency Command Center Is Gone," *New York Times*, New York, p. A7.

procedure cannot be executed, EOC personnel must develop and deploy new procedures [11]. Given their centrality to the emergency restoration process, EOCs are data-rich hubs of interpersonal communication and collaborative decision making [12].

Resources available to EOC personnel for responding to the event may be under the control of a diverse set of stakeholders. Consequently, personnel may have incomplete information locally but complete information globally, requiring them to seek information across organizational boundaries in order to meet emergency restoration goals. Additional factors such as time constraint may further influence decision making processes. When there is a time limit for a task, time constraint exists; when a person feels stress associated with time constraint, time pressure—defined as the "subjective perception of stress or of being rushed" [13]. Another salient feature of the work of EOCs is the complexity of their task [17], particularly with respect to the degree of interconnectedness of their organizational resources.

The first objective of this work, therefore, is to develop and analyze an emergency restoration task which can be used to examine EOC decision making in response to planned-for and unplanned-for contingencies, under varying degrees of task complexity and time constraint.

In the post-11 September world, data on actual physical infrastructure systems are, somewhat paradoxically, more difficult to obtain than in the past—despite the urgent need for ensuring the resilience of these systems. As a result, researchers are now employing realistic (as opposed to real) data for use in observational and training studies. One project [14], whose data have been adapted to the work described below, employs realistic data associated with four infrastructure systems in New Hanover County, North Carolina (USA). This database was created through extensive collaborations with the managers of the infrastructure systems in New Hanover County, as well as collaborations with the county's emergency management office.

The data are organized at the level of U.S. Census tract, and consist of information on electric power, telecommunications, transportation and water infrastructures. Nodes are fixed components in the system that occupy points (e.g., transformers in the electric power network). Arcs are fixed components that occupy lines or line segments (e.g., power lines in the electric power network). The database is expressed within commercially available softwares (ArcGIS and Microsoft Access), coupled with purpose-built programs for forecasting damage from an emergency event and for assessing the quality of emergency restoration decisions [14]. The database may be explored using built-in tools, enabling users to examine properties of the various infrastructures and to conduct limited what-if analysis (e.g., "what if a particular trunk line in the electric power network is removed?").

The database is embedded within a system—denoted MUNICIPAL, for Multi-Network Interdependent Critical Infrastructure Program for the Analysis of Lifelines—containing three decision analytic modules: (1) a *vulnerability* module, which models the impact of hurricane scenarios by converting weather information into hazards caused by the hurricane such as wind gust, flood and storm surge and estimating the impact of these hazards on interdependent infrastructure systems [15], (2) an *optimization* module, which does the computational work to find the best scheduling and assignment for recovery and restoration [14, 16], and (3) a *geographic information system* (GIS) module, which provides a visual representation of layers of the infrastructure systems, the interdependencies among them, and the results produced by the optimization module.

However, it should be noted that the MUNICIPAL system cannot be employed interactively, and is thus suited to training in planning rather than decision making activities. As one example, the contents of the database cannot readily be modified. Moreover, MUNICIPAL is expressed within two “closed” (commercial) softwares, thus limiting the extent to which it can be transferred to other uses. The second objective of the research described seeks to addresses these limitations, as follows:

The second objective of this work is to develop a synthetic environment in which the emergency task may be embedded, and which may be exercised with emergency restoration personnel.

3 Results

This section reports on the results of research completed on the design and implementation of infrastructure restoration tasks and the environments within which these tasks are embedded.

3.1 Task Design

The task of EOC personnel is to allocate scarce resources (here, work crews) to repair non-functioning infrastructure components and thus to restore the services they provide. This task must be undertaken under time constraint: EOC personnel are given a time limit in which to complete restoration, and repair tasks take time to execute. Personnel must also consider their decisions in light of the complexity of the systems [17] and of the repairs themselves. Interdependencies designed into the systems (e.g., electricity is required to run water pumps) require EOC personnel to collaborate in order to restore system functionality. Because resources are insufficient to solve all non-functioning components simultaneously, EOC personnel typically seek to prioritize response efforts and to make subsequent decisions in light of feedback received on prior decisions.

Representation of the data for the task relies on a network abstraction of the infrastructure systems involved: most of the relevant information about each case is embedded within a network structure, so that inspection of the network via direct manipulation is required in order reveal this information. Other information (e.g., time remaining, available vs. committed work teams) is presented through text which is continually visible on a large-scale computer screen visible to all participants, as discussed below. In these terms, work crews are allocated to nodes or arcs in the system. Nodes are facilities, such as power generation stations, hospitals and water distribution centers; arcs are the links within and across these systems, such as power and water lines.

3.2 System Architecture

This work includes the design and evaluation of a synthetic environment in which performance on the above task (and others like it) can be measured and evaluated. The architecture of the system is depicted in Fig. 1, and consists of the following elements: a *flexible physical environment* in which to situate personnel and supporting technologies; a group of *EOC personnel* functioning as decision makers, interacting with each other and their *staff*, and a *database/simulation engine* which is accessed by participants via a multi-user interface; and a range of *instrumentation* (embedded within users' tools) for capturing the dynamics of interaction between decision makers and the simulation.

The *data* within MUNICIPAL have been normalized, verified and exported to mySQL, an open source database software package. The database is currently running on a Linux-based computer. The result is a more robust database architecture, with data that may now be accessed via other open source applications. Multiple client machines connect to this database through standard networking protocols both to pull data for visualization and to update and edit data (e.g., hurricane damage, proposed repair to existing and addition of new elements, service coverage analysis, etc.)

A kernel *simulation engine* processes participants' decisions and provides them with feedback on the consequences of restoration decisions. The simulation operates on the basis of a decision cycle which begins with participants submitting work crew assignments to their staff, who then submit them via an interface to the simulation. Once the work of a crew is completed, new service levels are calculated and the database updated. The simulation builds on work on MUNICIPAL through the inclusion of its programs for calculating initial damage from an extreme event (via the vulnerability module) and calculating the effects of those decisions on level of service (via the optimization module, which serves to optimize the distribution of work crews in order to maximize service provision for affected infrastructures) [14, 16]. Finally, the display presenting the information is redrawn. Time runs continuously through the simulation.

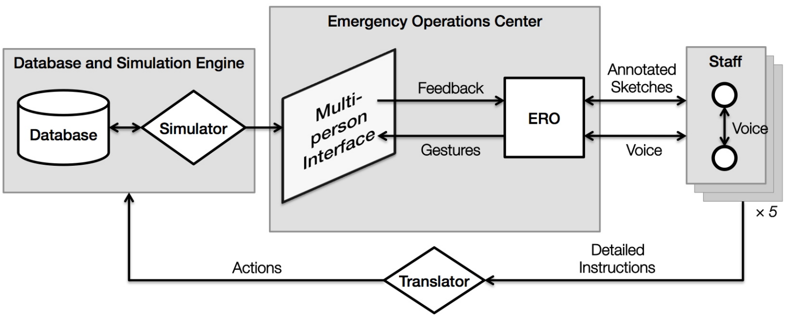

Fig. 1. Architecture of Synthetic Environment

3.3 Interaction Design

The current system includes a number of tools to support simultaneous, multi-person interaction and visualization of the scenario. The use of both novel and established tools enables logging of interaction with the system, focusing on visualization of network structures [18] at larger scales [19, 20]. EOC personnel interact with a 10mX6m projection of the infrastructures (along with various map layers) via a gesture-based system utilizing common laser pointers. Advanced computer vision capabilities are used for tracking these gestures [21]. The current prototype is depicted in Fig. 2. Personnel may choose which infrastructures to depict on the screen by using the laser pointer to circle (and thus "click") the corresponding button on the left of the left-most screen. Their gestures are read and interpreted by ceiling-mounted cameras (not shown), and an update sent via the server to the computer running the projector, which then refreshes the display. Additional infrastructures may be overlaid, and personnel may use a variety of gestures to zoom and scroll through views on the screen, as well as to make elementary edits by selecting the appropriate mode on the right of the screen. Pilot testing has shown that it is possible to take advantage of differential frequencies in the laser pointers in order to identify the corresponding user in an unobtrusive, unsupervised way.

Decisions on work crew allocation are input via a form-based interface available to EOC staff (shown in the right-most screen in Fig. 2). This screen also provides information on current level of service for different infrastructures, as well as committed vs. available work crews for each infrastructure. Interactions with these tools are time-stamped and logged for each participant. Interaction with a visualization client is at real-time rates (approximately 30 Hz). Communication with the database (pulling or pushing updates and new elements) is at interactive rates.

Fig. 2. Visualization and Interaction System

The interfaces have been developed using a flexible and modular programming design. The visualization client software written in C++ and OpenGL provides fluid display of the complex geometric position and inter-connectivity of the infrastructure elements in the database. The team used a standard software version control system (e.g., *svn*, *git*) to share updates and new features between programmers, and to allow other members of the research team to test and provide feedback on the most up-to-date iteration of the system.

3.4 Flexible Physical Space

The physical space in which the system is being deployed is easily reconfigurable, and can accommodate the required number and configuration of participants (approximately ten), associated computer hardware and software, and other tools (e.g., telecommunications capability). The system is installed in a “black box” studio space with an area of 232m^2 and a completely open floor plan. An overhead grid spans the entire surface of the floor at a height of 5.5m. Lighting, cameras and sensors can be positioned anywhere in the space above and below this grid. The studio is acoustically of the highest quality and includes a lighting system driven by sine-wave dimmers. The information technology, video and audio infrastructures are laid out to latest technology and bandwidth requirements. The space is located within Rensselaer Polytechnic Institute's Experimental Media and Performing Arts Center, a 2044m^2 facility that includes several different large physical spaces, all with both fixed and re-configurable seating, large format projection screens, high-resolution projection equipment, multi-channel audio, wired and wireless networking, video recording capabilities, and a full production and technical support staff.

3.5 System Evaluation

System evaluation is ongoing. This section reports on the results of a pilot study to test instrumentation and interaction capabilities, as well as the scenario itself.

Instrumentation. Data are logged both periodically and on the execution of key events such as work crew allocations. The periodic data, which is collected every ten seconds, contain the zoom level and location of the map and all expanded nodes and edges. It also shows which infrastructure layers were active. This allows analysis of the search process as nodes are expanded to query their status. The events included node and edge expand/collapse and layer visibility toggle. Each event is associated with a user and given a time stamp. All other mouse actions (e.g., pan) are also captured, but not analyzed here.

Participants. Five experienced participants (all with backgrounds in emergency services) took part in the pilot test. Each participant was provided with a laser pointer. An additional individual served as a staff member implementing the group’s decisions. Participants first gave their informed consent, then took part in a training scenario which gave them an opportunity to learn the interface, ask questions, and become familiar with the types of problems they would be solving. The training scenario took 53 minutes to complete. They were next given the full scenario, which took 111 minutes to complete. An informal debriefing was then held.

Scenario. The full scenario—an infrastructure restoration task—is built around two issues: a small outage in the water infrastructure and a larger outage in the power infrastructure. The water outage is caused by two downed power lines which affect two water wells. However, the wells are not connected to the water infrastructure due to a broken pipe. This portion of the water infrastructure is isolated by other parallel sources due to a broken pipe and damaged water storage tank. The power outage is caused by a damaged distribution station. Several additional downed power lines to waste pump stations are also present as well as broken pipes. In contrast to the first set of problems, all of these issues must be fixed in order to restore service. The damage by area and initial service levels is shown in Table 1. For example, two instances of damage to power arcs are associated with the first issue, and four with the second issue. The seventh instance of damage to power is associated with the second issue. The problem can be solved by repairing either (i) the water storage tank or the second broken pipe or (ii) either of the power lines and the first broken pipe.

Table 1. Total Damage and Initial Service Levels

Infra	Nodes	Arcs	Service	Total
Power	0 + 1	2 + 4	98%	7
Water	1 + 0	2 + 0	82%	3
Waste	0 + 3	0 + 3	89%	6

Interaction. The users are able to continuously interact with the map and submit service requests. All requests remaining from the prior decision cycle are executed at the beginning of the current decision cycle. For this group, a total of 50 service requests were issued. After each decision cycle, participants were presented with a status of their crews for each infrastructure type as well as an update on the service levels. As described previously, inquiries on the status of nodes and arcs can be made via laser pointer-based gestural interaction with the map display.

Group Processes. Considering only at the events directly related to information seeking (node/edge expand/collapse), the number of each type of event was tabulated for each user. These cross tabulations are shown in Table 2. Participant 1 appeared to focus more on edge exploration (55.9%), while participants 2 and 3 focused more on node exploration (64.0% and 80.9%, respectively). The workload was predominantly carried by participants 1 and 2 (88.32% of the total number of events). Participant 4 did not initiate any events (he later reported that he preferred to defer to the other participants). Ongoing research is exploring how these data relate to problem solving.

Table 2. Count of Events by Participant

Participant	Node Expand	Node Collapse	Edge Expand	Edge Collapse
1	146	153	193	186
2	178	177	119	73
3	69	62	14	17
4	0	0	0	0

4 Discussion and Conclusions

Modern society depends on the operations of critical infrastructure systems—such as transportation, energy, telecommunications, and water—now recognized as dependent on one another. The work discussed here focuses on novel computational tools to support emergency restoration of services provided by these infrastructures immediately following the onset of a large-scale disruptive event. This paper has motivated and described a set of prototype tools for investigating and supporting post-disaster restoration of critical infrastructure systems in training exercises. The system employs large-scale displays, novel interaction capabilities, realistic data and a discrete event simulation to enable monitoring and assessment of group decision making processes. All software is built using open source tools and deployed within a flexible physical space. The parameters of the scenario-based simulation may be tuned to alter the time available for task execution, as well as the complexity of the networks.

Future work is proceeding along two parallel tracks. In the first, additional interaction modalities are being developed and tested. These include additional and/or refined gestures for querying the information presented on screen. The interfaces themselves are under continuous development to provide greater usability. Second, the functionality of the simulation engine and database is being extended, particularly to provide greater realism. For example, future work is likely to include more precise estimation of time and effort required to repair different types of damage in the system.

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Simulating a Dynamic Transport System to Enhance the Transportation Performance in Road Crisis Condition

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Abstract. This paper studies the effects of the real-time information about transport network conditions as a key for constructing routes in an Advanced Travelers Information System in terms of traveled distance. It does so by an experiment that aims to simulate an ordinary transport logistics operation given by a set of 2 synthetic scenarios, where interruption events were randomly generated over the transport network. The results found were analyzed as well as compared to the no interruptions benchmark scenario. It has shown that if there was information available for all road users it would result in best route decisions and consequently would save resources for the whole transport system.

Keywords: Dynamic Transport Network, ITS, Transport Simulation, Transport Crisis.

1 Introduction

It is widely known that the information is important not only for who depends on the transport system but also for many others knowledge areas. In addition, the evolution of telecommunication and computation technologies is transforming our communication behavior and is increasing the possibilities in which information can be achieved. At the same time, as the Internet's popularity grows up, it has been helping us figure out new insights on how to communicate ourselves. The new computer based social media helps us to maintain our social networks more effectively and keeps us up-to-date with information from topics and people. Furthermore, it is also embedded into our mobile devices offering a natural ubiquitous channel for social interactions [1].

Added to these resources, the popularization of technologies and tools of global positioning system (GPS) are enabling new possibilities for services and solutions for transport problems and have become essential for Intelligent Transport Systems (ITS) operations [2, 3]. ITS employ modern technologies and methods of computation, control and communication, with the purpose of solve problems in transport and

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logistics [4, 5]. As they can provide several aspects and technological approaches in order to assist in making decisions before and during travels [6, 7], it has been motivating several solutions for vehicle routing problems based upon computing and telecommunications in order to anticipate or facilitate transport crisis reaction [2]. So, by influencing the behavior of road users it can increase the efficiency of the transport system.

Amongst categories of ITS the Advanced Travelers Information Systems (ATIS) provide services with real-time information to its users and they help to make more efficient distribution of routes as well as the choice of modals [8, 9]. This technology focuses on user needs through communication channels such like in-vehicle route guidance systems devices, mobile devices, information kiosks and the Internet which will enable the broadcasting of information in addition to getting feedbacks from users at the same time.

In this paper we are considering the study of how real-time information can enhance the performance of the transport services in term of accuracy in route construction and delivery when it faces a crisis situation. Crisis on road transport happens when unexpected events change the expected conditions of transportation system and the drivers' planned routes as well. Such events could be traffic congestion, crashes, natural disasters, roadway maintenance, and others. This means we have to analyze the conditions of the transportation network frequently in order to check if any route should be recalculated. Thus, knowledge about the current state of the network is important to make decisions which will save transport operations from day by day dynamics.

As drivers can be connected into a collaborative large social network they might share online routing and location resources as well as information about existing travel barriers. This could be a way which road users could collaborate in order to maintain the network condition updated and would allow the planning of paths and their updates while traveling. Therefore, our first objective is simulating how the information could enhance the transport performance if the information were always available, in other words, provided there was an ATIS able of delivery calculated routes through users' collaborative behavior. Our second objective is compare the results obtained from the simulation in order to measure the impacts caused by the travel barriers dynamics in the transport network.

In the next section, we briefly describe the theoretical background that supports the simulation. The following section details our experiment design and formalization provided to study the benefits of this kind of system. Finally, after the results section, the final considerations and references are presented.

2 Dynamic Transport Information System

In this paper we are considering the existence of something we are calling Dynamic Transport Information System (DTIS) [10]. This is a kind of ATIS to assist the transport logistics management by reducing negative outcomes caused by the transport network dynamics. Inside this DTIS there is a Dynamic Transport Network Model (DTNM) which is based upon information provided by system's users and is able to solve route construction problems as well as guiding users through the road transport network as a Dynamic Route Guidance (DRG) service.

DTNM aims to use the space representation of roadway system with dynamic behavior, including highways or roads that link different geographical points. The dynamic term is used in this context to determine that the network changes due to several events emerging during a continuous time interval [10]. Consequently, it promotes the updating of all existing paths in the transport network. These events would be sent to users by users in a computer based social network in which they could share, validate, and use information about the transport network.

So, could it assist the transport logistics management by reducing negative outcomes caused by the transport network dynamics?

Regarding to ITS, telecommunication and computation technologies are essential for its operation, however, more important than the information is the end-to-end full and reliable information. [11] says the information which has to be correctly disseminated can be generated by both vehicles and transport infrastructure and this author also describes some examples of these sources and its communication interfaces, where the vehicles are the greatest group of both information sources and receivers. Thus, the information acquired by some driver will be able to change his/her choices that will result in best route or modal decisions [11, 12].

3 The Simulation Design

As our objective is measure how the information about the transport system conditions could be useful in practice, we had implemented a simulation framework and so have designed an experiment that aims to simulate an ordinary transport logistics operation given by a set of scenarios where interruption events were randomly generated over the transport network and the results found were analyzed as well as compared to one no interruptions benchmark scenario. The objective of the simulation was also to study if the knowledge about the current transport network dynamics is really helpful and can save resources in benefit of the whole transport system. Thus, we have analyzed the efficiency of each scenario in terms of the overall traveled distance.

We have constructed a model which reproduces the road users' movements through two different levels of information. In the first level, we suppose the drivers have an in-vehicle GPS device allowing them know all available paths, but they do not have any information about the travel barriers. For second information level, drivers not only know all existing paths but they also have knowledge about all travel barriers that take place during the simulation time. In both levels drivers cannot stop their movements. Therefore, their only acceptable behavior is moving on.

3.1 Model Formalization

We have defined a weighted directed graph $G = (V, A)$ that represents the road network where there is the cost c_{ij} for each user $u \in U$ traveling the arc $(i, j) \in A\ \forall\ i, j \in V$ and U is the set of system users (drivers). Each driver who corresponds to one vehicle in the system have t_u as its simulation arrival time; $p_u^t = (x_u^t, y_u^t)$ is its position at the time unit t; its origin and destination cities are respectively o_u and d_u; finally, r_{od}^u is its current path between its $o_u d_u$ points calculated by $r_{od}^u = \Psi(o_u, d_u)$, where Ψ represents any selected algorithm to execute paths' calculation.

A set B have been also defined containing geographical objects representing areas affected by road interruptions. For every $b \in B$, h_b defines its validity; d_b is the estimated life time of a travel barrier; t_b and p_b^t are also the simulation arrival time and the position $p_b^t = (x_b^t, y_b^t)$ of b respectively. Thus, any valid travel barrier over a link $(i, j) \in A$ transforms the cost $c_{ij} = \infty$ while b is not removed or d_b be achieved.

All costs c_{ij} are considered as the distance in kilometers for all drivers. Thus, we have implemented 2 processes to guide the drivers' simulated behaviors.

Pre-trip Planning Step. Assuming that each vehicle has its origin and destiny cities defined before it arrives in the simulation, this step calculates $r_{od}^u = \Psi(o_u, d_u)$ before any vehicle starts its travel. In case of having some $b \in B$ which intersects r_{od}^u, another path must be calculated and the pre-trip step will be repeated, but now considering the cost $c_{ij} = \infty$ like we showed previously.

En-route Path Recalculation. If a new travel barrier $b \in B$ takes place after a vehicle has started its travel and b also intersects its path, a new path r_{od}^u must be calculated. We did it by the following $r_{od}^u = \overrightarrow{op_u} \cup \Psi(p_u, d_u)$ where $\overrightarrow{op_u} \subset r_{od}^u$ is a partition of r_{od}^u such that it contains the path between the origin point o_u and the current position p_u of vehicle u. Consequently, $\Psi(p_u, d_u)$ calculates the remaining path to arrive at the destiny d_u.

3.2 How the Simulation Works

We have implemented a main thread working as a loop to control the simulation clicks, i.e. the increment of simulation's time units (t). It also manages the vehicles' queue and the travel barriers' queue. Both vehicles and travel barriers are ordered by their scheduled simulation arrival time (t_u or t_b) and they start their activities in the simulation after leaving their queues when $t_u = t$ or $t_b = t$. Then, each vehicle executes its movement as the simulation time is incremented and a randomly defined tax that represents velocity varying between 60 km/h and 80 km/h controls the new vehicle's position. This variation was used because it represents the variation of the road maximum speed limits in the selected scenarios. Finally, both travel barriers and vehicles leave the simulation when they reach their life time d_b or they arrive at their destination d_u respectively. In order to calculate Ψ aforementioned we have employed the Dijkstra's algorithm [13] for obtaining all paths between the origin and destination cities as well as the distances presented further in the results.

The simulation program had been implemented in Java 1.6 and has run in one Intel Core i5 processor computer with 4GB RAM and Windows 7 64 Bits operational system.

3.3 Scenarios

Regarding the construction of our geographical database we used information about the Brazilian State of Santa Catarina from maps available by IBGE's website [14]. For constructing the network's representation graph we selected maps of the federal and state roadways available at the SISCOM project website [15]. As points of origin and destination for routes, we have chosen 7 cities near the middle of the State. Fig. 1 shows the used network with its available roads and cities. We had created 10 vehicles and their origin and destinations points were generated randomly between the available cities. The Table 1 shows their parameters such like its origin and destination points and its scheduled simulation arrival times (described in terms of the simulation time unit). The position of 5 travel barriers was also generated randomly, all of them over the transportation network. It can be also seen in Fig. 1.

Table 1. Vehicles simulation parameters

Vehicle	Origin	Destiny	Departure Time
1	Ituporanga (I)	Alfredo Wagner (A)	6
2	Rio do Sul (R)	Lages (L)	21
3	Lages (L)	Petrolandia (P)	29
4	Rio do Sul (R)	São Cristóvão do Sul (S)	40
5	Ituporanga (I)	Bom Retiro (B)	49
6	Petrolandia (P)	Alfredo Wagner (A)	61
7	Lages (L)	Alfredo Wagner (A)	65
8	Lages (L)	Bom Retiro (B)	79
9	Alfredo Wagner (A)	Ituporanga (I)	88
10	São Cristóvão do Sul (S)	Lages (L)	90

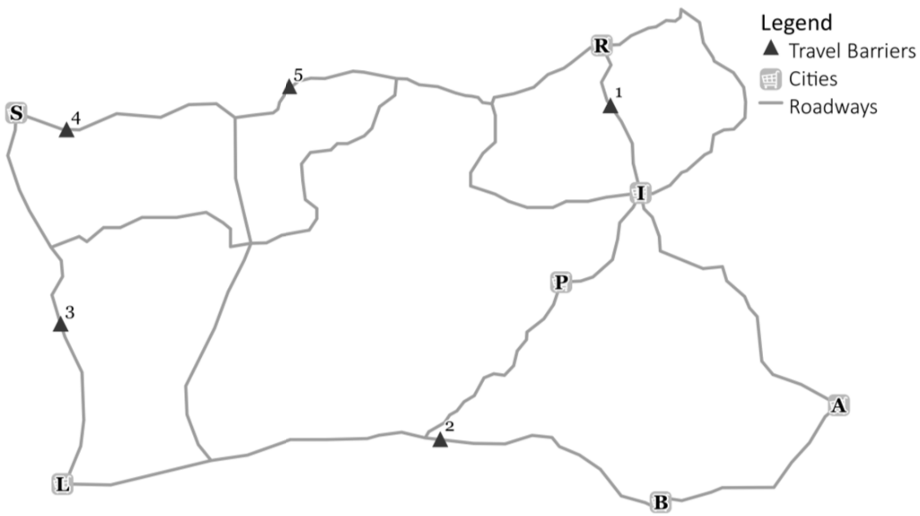

Fig. 1. The used road network and travel barriers for simulation scenarios

For the simulation we have designed a benchmark static scenario where has not had travel barriers. It means that all calculated paths had not considered any barrier ($B = \emptyset$) and the vehicles did not change their routes when they were traveling. In the second scenario the vehicles has taken all the travel barriers into account during their movements, but we have not implemented the en-route recalculation step completely to simulate the fact that the barriers were unknown by drivers. I.e., drivers only changed their routes after reach a travel barrier. In the third scenario both pre-trip planning step and en-route recalculation were implemented, as we described previously, in order to simulate the propagation of information through the system users.

4 Results and Discussion

As important as the simulation is the number of replications we take in account in order to achieve a reasonable and accurate result. Therefore, we have used the technique described in [16] to define how many replications would be necessary for our experiment. So we have produced 20 samples of both scenarios 2 and 3 for obtaining a better estimate of mean performance. It was necessary to ensure that enough output data have been found from the simulation in order to estimate the model performance with sufficient accuracy. For each sample we have randomly built t_b and d_b of every $b \in B$. As a result we have found that the numbers of 11 replications for the scenario 2 and 8 replications for the scenario 3 are sufficient with 95% confidence interval and around 3,5% of deviation. The corresponding mean distances traveled for each vehicle are show in Table 2 and plotted in Fig. 2.

Table 2. Mean distances (in km) resulting from the simulation

Scenario	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10
Benchmark	43,57	118,01	78,78	85,56	73,13	61,32	113,83	84,27	43,57	53,36
Scenario 2	43,57	124,79	78,78	142,19	73,13	61,32	136,95	142,12	43,57	103,95
Scenario 3	43,57	120,61	78,78	118,86	73,13	61,32	131,55	114,14	43,57	94,16

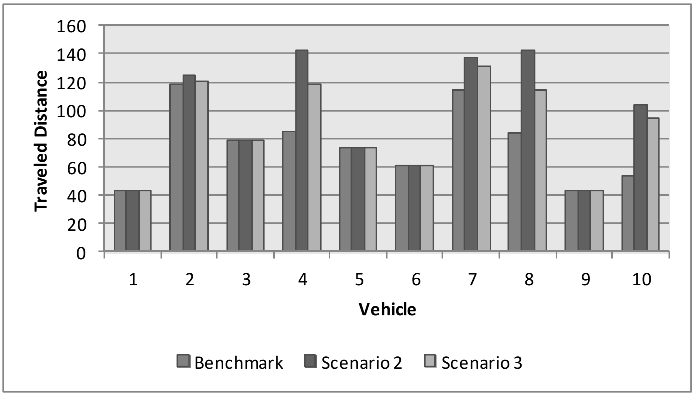

Fig. 2. The traveled distance mean (in km) of each vehicle by scenario

Comparing the results given by the 3 scenarios, the total average of travelled distance from scenario 2 is about 25,8% more than benchmark scenario. In contrast, third scenario shows an increase of about 16,5%. Considering vehicles affected by travel barriers (vehicles 2, 4, 7, 8 and 10), scenario 3 saves 12,2% of the total average of travelled distance compared to scenario 2.

The simulation has also brought as a result that the information regarding travel barriers can affect some drivers drastically. As we can see in Table 2, the vehicle 4 is one of the most affected. Compared to the scenario 1, its travelled distance increases a mean of 66,2% in scenario 2 whereas it increases to around 39% in scenario 3. It means an average economy of 23,33 km with a standard deviation of 5,55 km by scenario 3 related to scenario 2 for the vehicle 4 (considering all replications). A graphical example is shown by Fig. 3 where it is possible to see how the paths were affected for each scenario in a replication. Although there are 2 travel barriers in Fig. 3(b) and Fig. 3(c), only barrier 5 was active when the vehicle has arrived at the affected arc.

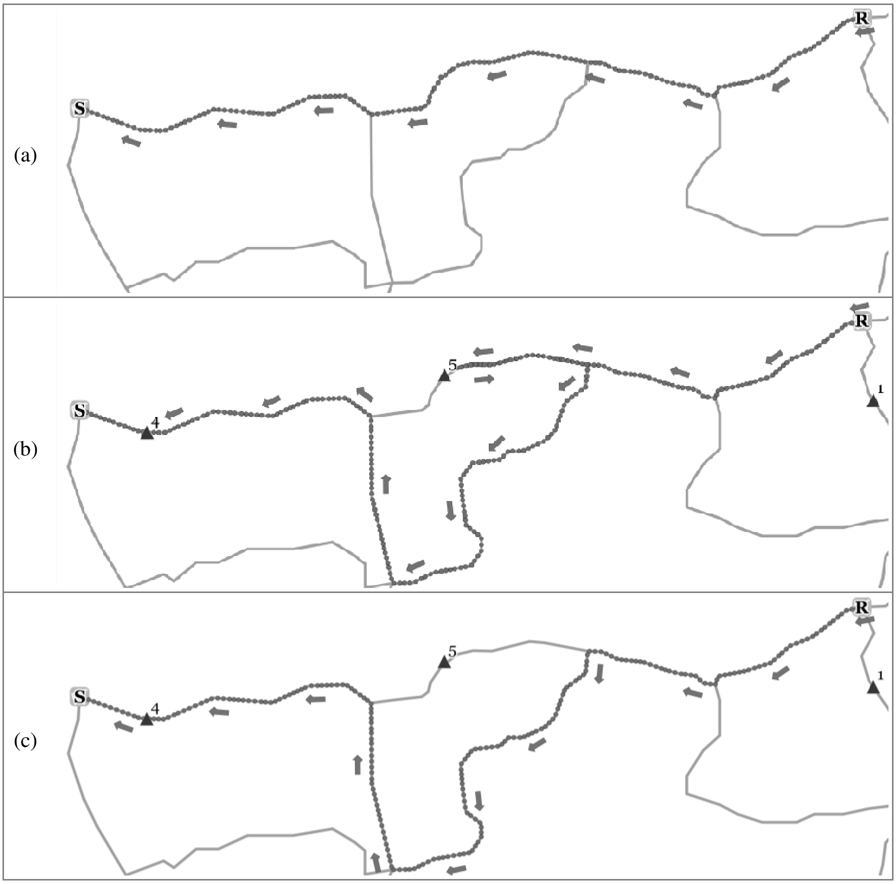

Fig. 3. Paths for vehicle 4 to traveling (a) the benchmark scenario (no travel barriers), (b) scenario 2, and (c) scenario 3 (the triangles are travel barriers, the arrows point the vehicle's movement direction, and the dots are the positions of the vehicle at each click simulation time)

5 Conclusion

Nowadays, other example of a popular source of information is the modern mobile devices which people can use to stay connected with their relatives and exchange varied kinds of information. Thus, thinking about these new technologies as a channel for sharing real-time information on travel barriers, we have studied how it will affect the transport system performance in an ordinary transport logistics operation through a simulation modeling. In spite of drivers' limited behavior actions in the simulation model, the experiment has shown that, in terms of the overall traveled distance, if information are at hand it could save resources and would optimize the transportation chain too. In addition, it not only could be useful for solving transportation problems but be also used in emergency situations and humanitarian relief.

As a future work, this study could be expanded to simulate the information flow to study the data volume in order to dimension the computer architecture size needed for this kind of system, as well as evaluate other algorithms for paths calculation and faster delivery based upon this size. Moreover, other drivers' behavior could be studied in order to analyze the presented scenarios using travel times and traffic volume to support drivers' decisions. Finally, the information about the estimated life time of a travel barrier could be used to create complete information scenarios, where users should use it to estimate their optimized travel patterns.

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Robot Control and Online Programming by Human Gestures Using a Kinect Motion Sensor

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Abstract. Monitoring and controlling of robots are key competences for robot producers and many research and development projects are carried out to increase robot performance and add new functionality. The paper presents a concept and implementation of online programming, controlling and monitoring an industrial robot using a Kinect sensor as a HMI part. Presented innovative solution is based on human gestures. A communication interface for gestures analysis performed by the robot operator was created using LabVIEW applications. Communication between the kinetic motion sensor and the robot was carried out through PLC Siemens S7-300 inside a flexible manufacturing system. The connection between the logic controller and the robot controller R30iA was realized in the ProfibusDP network. The connection between the controller and LabVIEW application has been established using the MPI protocol. A hardware communication protocol used by PLC was converted into the OPC protocol. NUI was used to communicate the Kinect with LabVIEW.

Keywords: industrial robot, control, online programming, HMI (Human-Machine Interface), PLC (Programmable Logic Controller), MPI, Profibus, OPC, Kinect, NUI (Natural User Interface), LabVIEW.

1 Introduction

Nowadays instrumentation of industrial robots is composed of diverse types of sensors for tracking information about any changes in the workspace. Sensors are used for processing and analyzing process data and in monitoring of the environment surrounding the robot. Due to the increasing level of complexity and various applications of industrial robots its manufacturers are still looking more and sophisticated solutions. Robot manufacturers offer additional modules to increase its functionality but the costs offered by them are many times higher than the costs of their existing equivalents.

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The industrial robots programming for a specific application is still very difficult, costs and time-consuming. For instance, manually programming a robotic arc welding system for the manufacture of a large vehicle hull takes more than eight months, while the cycle time of the welding process itself is only 16 hours. Coming to the conclusion, the time of programming time is much longer than the cycle time of operation. In such a case, SME (small to median sized enterprises) are not able to be benefit from robotic automation due to this programming time overhead. [12]

Nowadays, in practical industrial applications, there are two main categories of robotic programming methods: the online and offline ones. In the online programming, the teach pendant is used to manually move the wrist or joints to the intended position and orientation at each stage of the robot task. Appropriate positions and orientations are sent to the robot control system and a robot programme is then written. [1, 12, 13]

An automated flexible production cell is a very interesting technical solution for SMEs in the global market conditions but the major weakness of such a type system is the complexity of programming. In the paper [2] authors provide a comprehensive review of the recent research progresses on the programming methods for industrial robots, including online programming, offline programming, and programming using Augmented Reality (AR). The fast development of 3D CAD/PLM software [5], vision systems and new type of sensors leads to new controlling, monitoring and programming methods that will be more and more suitable for SMEs. [2, 12]

Human motion analysis using depth imagery was concerned in many scientific publications e.g. [2]. The topic was considered in terms of analysis of human behaviour through visual information. Previously, analysis of human behaviour was achieved via images from a conventional camera, however in recent times depth sensors have made a new type of data available. In survey [2] authors describe the advantages of depth imagery and present the new sensors for this purpose. Among other sensors, they present the Microsoft Kinect advanced motion sensor that has made high-resolution real-time depth and is relatively cheap. The survey summarizes the current state of the art on depth imagery, and shows future research directions. Many of the existing literature positions concerning the use of depth imagery for analysing human activity focus on body part detection and pose estimation. Some of them concentrate on the recognition of human actions. Today many scientific research are focused on multi robot control, safe control, force control, 3D vision, remote robot supervision and wireless communication. Brogardh in his work [1] discuss and present the technical challenges that the robot manufacturers meet. He claims that model-based control is now a key technology for the control of industrial robots and models. Many developers show engineering applications of the system related with their 3D imaging possibilities [4, 6, 7, 11, 14, 18]. Very promising depth camera technologies are time-of-flight depth cameras [6, 7, 11] and structured light depth cameras, such as the Kinect depth camera [6, 17]. At present, imaging devices are often called RGB-D due to their ability to provide depth information along with typical color images [15]. The kinect motion sensors are very often used for human posture and movement analysis [3, 9]. The depth measurements are also used for making 3D maps [3, 8, 14]. In the work [4] a metrological geometric verification of the systems was performed using a standard artifact for two different sensors: MS Kinect and Asus Xtion. The obtained results shown that considered sensors can be used in many engineering applications when the measurement range is short and accuracy requirements are not very strict. Furthermore in paper [18] the omnidirectional robot with Kinect performs pattern recognition and measures the depth and direction of the marker quite well by using the Log-ab controller. In paper [16] authors presents comparative evaluation of sensors accuracy in robotics and automated logistics applications. They compare several novel sensors using a holistic method for accuracy evaluation of the measurements. The article [16] presents an evaluation of three novel depth sensors: the Swiss Ranger SR-4000, Fotonic B70 and MS Kinect. It was stated that the Microsoft Kinect sensor has an accuracy closer to the actuated laser sensor and can be directly used as a high data rate, especially when considering smaller environments.

2 Innovative Human-Machine Interface

The purpose of this work is to present the concept and implementation of the online programming, controlling and monitoring of the industrial robot motion space. The concept is based on the human gestures control.

In Fig. 1 the simplified scheme of the integrated control systems by mean of human gestures is presented. It is an innovative way of providing human-machine interface in the industrial robots application, that could be also adpoted to other machines.

In Fig. 2 the simplified closed algorithm of the integrated control systems by mean of human gestures is shown. The process is composed of several steps. Gestures performed by the operator are captured and analyzed, then processed into digital binary variables and grouped. In a further step the variables are sent via an OPC server to the controller, which controls the inputs and outputs of the industrial robot moving in a cycle.

2.1 Communication Protocols, Sensors and Interfaces

Inside the control system of the FMS (flexible manufacturing system) communication protocols (OPC, MPI, Profibus, TCP/IP, NUI) were integrated. Profibus DP (Decentralized Peripherals standardized in IEC 61158) was used to operate a kinetic motion sensors, other system sensors and actuators via a programmable logic controller. The Profibus DP network was chosen to automatically adapt the communication between devices of different generations and types. This type of communication provides more flexibility and no limitation according to the choice of supplier. In this way all necessary devices could be combined each other. The OPC (Object linking and embedding for Process Control) protocol was used to convert a hardware communication protocol to process data. The

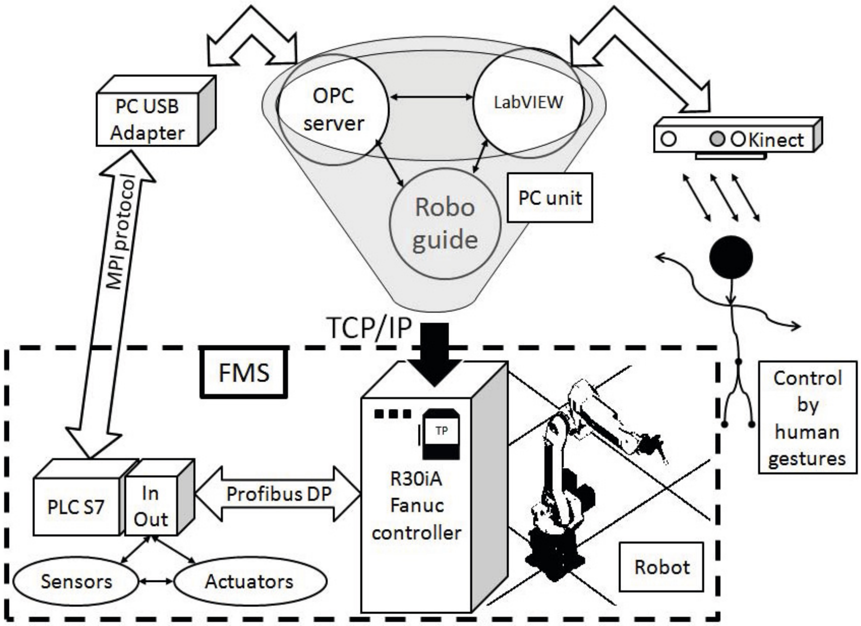

Fig. 1. Scheme of the integrated control system by means of human gestures

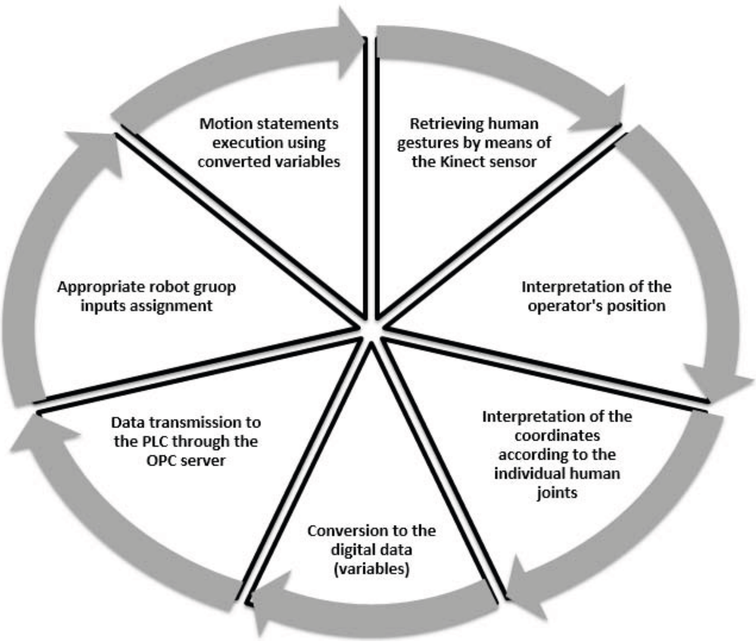

Fig. 2. Closed algorithm of the integrated control system by means of human gestures

MPI protocol was used to communicate the PC unit with the PLC (by PC USB ADAPTER). The Natural User Interface (NUI) is the foundation of the kinect motion sensor for Windows application programming interface (API). In the project it was used to access the following sensor data in LabVIEW application. The kinect motion sensor driver implements a stream that can recognize and track the human motion. The system recognizes depth information and converts it into the skeleton joints in the human vector model. The Kinect for Windows Developer Toolkit is provided with Kinect Explorer - WPF C# Sample, which describes the algorithm of displaying tracked skeletons from the skeleton data. The concept and implementation of the online programming, controlling and monitoring of the industrial robot motion space is based on the integration of elements (hardware and software) of the flexible manufacturing system in the one laboratory stand (Fig. 3 shows the laboratory stand).

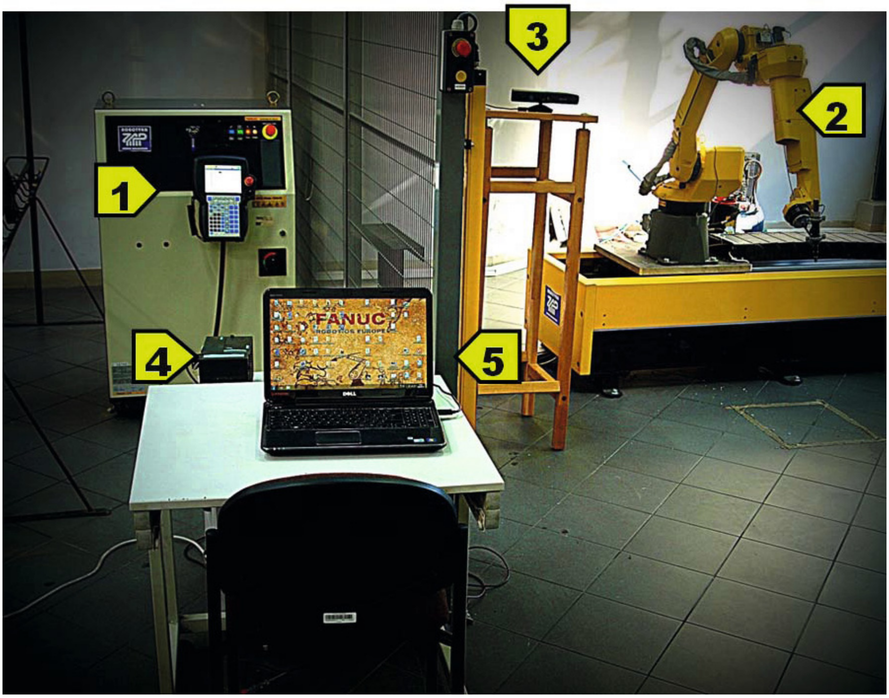

Fig. 3. Laboratory stand for human gestures robot control. 1 - Robot controller, 2 - Industrial robot, 3 - Kinect motion sensor, 4 - PLC, 5 - PC unit

The laboratory stand (Fig. 3) consists of:

- R30iA controller equipped with: the Profibus slot, teach pendant, and network card.
- Robot FANUC ArcMate 100iC with the robot track.
- Microsoft Kinect with the USB adapter.

– PLC Siemens S7-300 CPU 315 2DP.
– Personal computer unit (PC).
– Safty light curtains.
– Simatic USB Adapter.
– Wires (robot cables, Profibus cable, MPI to USB, Ethernet, etc.).

2.2 Software Requirements

For proper operation the following versions of applications and libraries were necessary: Windows 7, LabVIEW 2012 (LabVIEW 2012 English, LabVIEW 2012 Control Design and Simulation Module, LabVIEW Datalogging and Supervisory Control DSC, LabVIEW Internet Toolkit 2012, LabVIEW FTP Toolkit, Kinesthesia Toolkit for Microsoft Kinect), Roboguide 7 (Robot drivers v. 7.40, Robot Neighborhood), S7/S5 OPC Server Deltalogic (Configuration: 3.4.2.0, OPC server - application: 4.10.2.9117, OPC server - service: 4.10.2.9.9117), Siemens Step 7, Hardware drivers, Internet Explorer, Kinect for Windows SDK ver. 1.7.

2.3 Labview Interface

In 2012 at the University of Leeds there was developed the Kinesthesia Toolkit for Microsoft Kinect [10] that helps NI LabVIEW programmers quickly access the popular functions of the Microsoft Kinect camera such as RGB video, depth camera, and skeletal tracking. The toolkit was designed as a hardware driver and was packaged using JKI's VI Packet Manager to install in LabVIEW palette. The toolkit was initially developed for medical rehabilitation and surgical tools but can be also adopted for industrial purposes. During the integration with other resources in the control system additional applications such as: Microsoft .NET 4.0 Framework, Microsoft Kinect SDK 1.5 and .NET 4.0 Assemblies LabVIEW Hotfix were required.

In Fig. 4 the kinematic visualisation tab is shown. It is presented a video conversation to a vector human model. After starting the applications in the left window traditional RGB camera image (built-in Kinect) is displayed. On the right side of the screen the created kinetic model consisting of nodes corresponding to 20 human characteristic points (head, spine, hips center, left and right hip parts, center arm, left and right: arms, elbows, wrists, hands, knees, ankles, and feet) are shown. The nodes are connected by vectors that form the human skeleton.

The user interface (UI) was developed in LabVIEW applications. The UI allows the operator to perform calibration (Fig. 5) and monitoring of the whole control system. It consists of fragments that have been highlighted in the form of the following tabs: Visualization (Fig. 4), User position (Fig. 5), Tool position, Tool rotation, Tool setting, Manual control (Fig. 6), System status, Download (Transfer program). Calibration allows to use of the system by people of different height. Moreover, it facilitates the use in a variety of conditions such as changing the users distance and orientation in relation to the Kinect sensor. According to

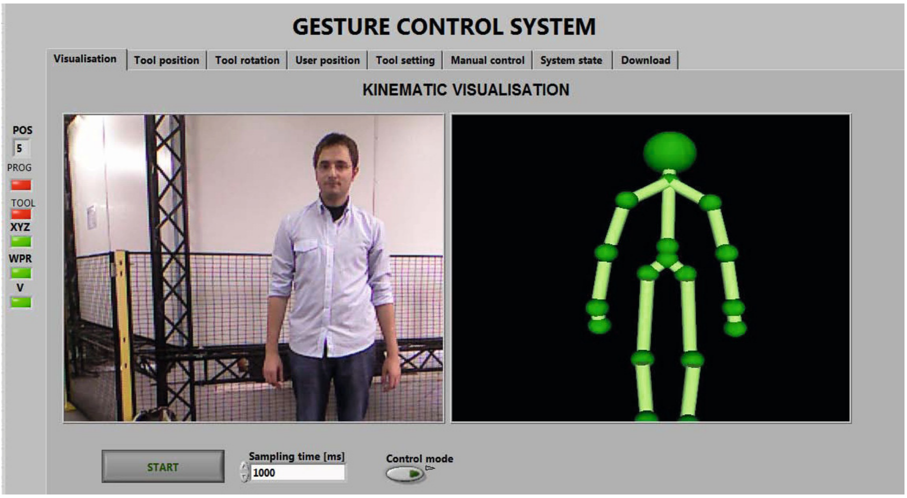

Fig. 4. Visualisation tab in LabVIEW application

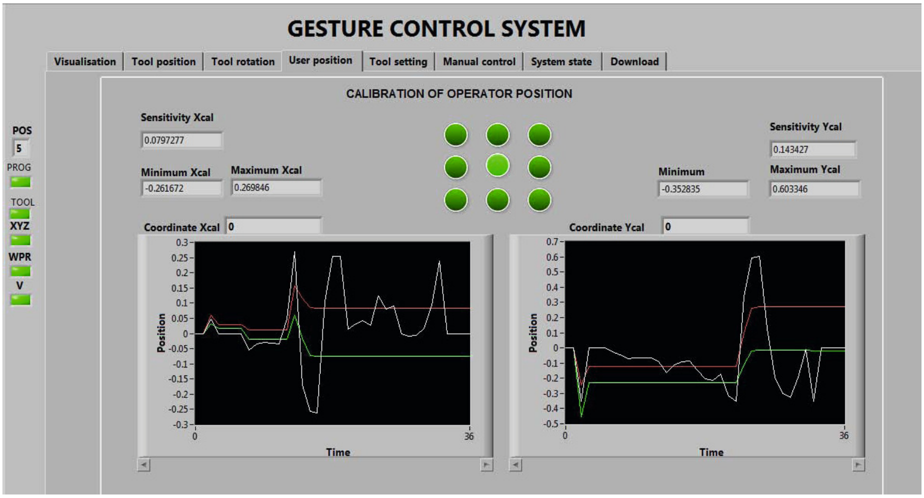

Fig. 5. Calibration mode tab in LabVIEW application

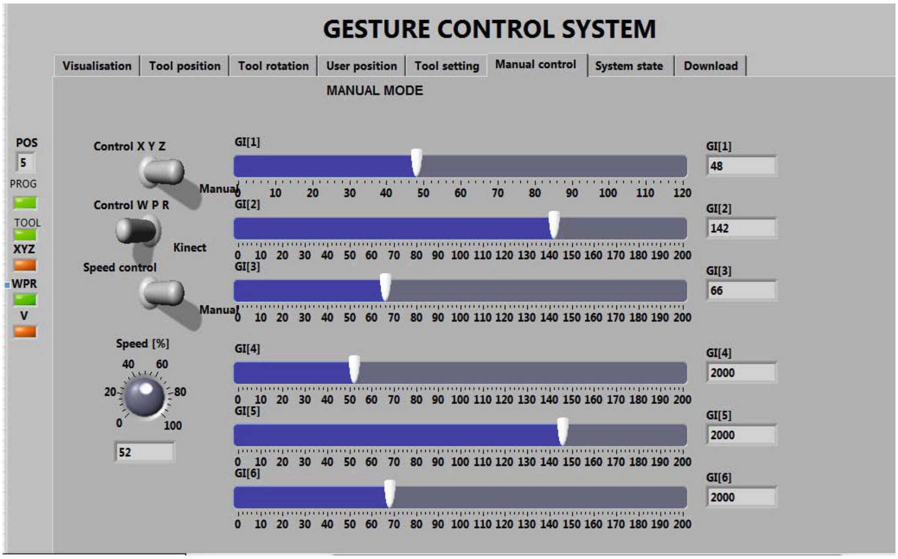

Fig. 6. Manual control tab in LabVIEW application

the program assumptions the calibration takes place automatically. In the center of the screen (Fig. 5) there is a set of nine LEDs representing the relative changes in the human positions (distance from Kinect). As a point of characterizing the coordinates the node of a human spine was assumed.

To enable the change of group variables from the virtual panel, the manual control tab was created. The panel is shown in Fig. 6. The variables were divided into three groups: Control of the position in relation to axes X, Y, Z, Control of the tool rotation in relation to the axes W, P, R and Robot velocity control.

2.4 Exemplary Robot Program Code

In this subsection an exemplary program code of Fanuc robot is presented. The program code was used in the integrated control system to share the resourses and cooperate with the kinect motion sensor.

Example of a Fanuc ArcMate Robot Program Code

```
/ATTR (...) %Automatic code generation
/MN %Program instruction start marker
  1: UTOOL_NUM=8 ; %Activation of a tool coordinate system
  2: UFRAME_NUM=7 ;
   %Activation of a specific robot coordinate system
  3: RO[1]=OFF ; %Switch off a milling cutter electrovalve
  4: WAIT 1.00(sec) ; %Wait
  5: J P[1] 100% FINE ; %Move to the safe position
```

```
6: R[8]=.1 ; %Distance or angle setting
7: LBL[1] ; %First loop start
8: R[1]=GI[1] ; %
9: R[2]=GI[2] ; %
10: R[3]=GI[3] ; %
11: R[4]=GI[4] ; %Initialization of register variables
12: R[5]=GI[5] ; %
13: R[6]=GI[6] ; %
14: R[7]=GI[7] ; %
15: IF DI[2]=OFF,JMP LBL[1] ; %Starting safety condition
16: WAIT .50(sec) ; %Wait
17: LBL[4] ; %Fourth loop start
18: IF R[1]=1,JMP LBL[5] ; %
19: IF R[1]=2,JMP LBL[6] ; %
20: JMP LBL[7] ; %Jump to the seventh loop
21: LBL[5] ; %Fifth loop start
22:  PR[1,1]=PR[1,1]+R[8] ; %First variable increment
23:  JMP LBL[7] ; %Label 7 jump
24:  LBL[6] ; %Sixth loop start
25:  PR[1,1]=PR[1,1]-R[8]  ;
 %Variable no. 1 decrement about value of the eighth register
26:  LBL[7] ; %Seventh loop start
27:  IF R[2]=1,JMP LBL[8] ;
 %Check the direction opposite to the axis Y.
28:  IF R[2]=2,JMP LBL[9] ;   %Check the direction to Y axis.
29:  JMP LBL[10] ;    %Label 10 jump
30:  LBL[8] ; %Eighth loop start
31:  PR[1,2]=PR[1,2]+R[8]    ;    %Variable no. 2 increment
32:  JMP LBL[10] ;    %Label 10 jump
33:  LBL[9] ; %Ninth loop start
34:  PR[1,2]=PR[1,2]-R[8]    ;    %Variable no. 2 decrement
35:  LBL[10] ;    %Tenth loop start
36:  IF R[3]=1,JMP LBL[11] ;
 %Check the direction opposite to the axis Z.
37:  IF R[3]=2,JMP LBL[12] ; %Check the direction to Z axis.
38:  JMP LBL[13] ;    %Label 13 jump
39:  LBL[11] ;    %Eleventh loop start
40:  PR[1,3]=PR[1,3]+R[8]    ;    %Variable no. 3 increment
41:  JMP LBL[13] ;    %Label 13 jump
42:  LBL[12] ;    %Loop start
43:  PR[1,3]=PR[1,3]-R[8]    ;    %Variable no. 5 decrement
44:  LBL[13] ;    %Loop start
45:  IF R[4]=1,JMP LBL[14] ;
 %Check the direction opposite to the axis W.
46:  IF R[4]=2,JMP LBL[15] ; %Check the direction to W axis.
```

```
  47:  JMP LBL[16] ;    %Label 16 jump
  48:  LBL[14] ;    %Loop start
  49:  PR[1,4]=PR[1,4]+R[8]    ;    %Variable no. 4 increment
  50:  JMP LBL[16] ;    %Label 16 jump
  51:  LBL[15] ;    %Loop start
  52:  PR[1,4]=PR[1,4]-R[8]    ;    %Variable no. 4 decrement
  53:  LBL[16] ;    %Loop start
  54:  IF R[5]=1,JMP LBL[17] ;
   %Check the direction opposite to the axis P.
  55:  IF R[5]=2,JMP LBL[18] ;   %Check the direction to P axis.
  56:  JMP LBL[19] ;    %Label 19 jump
  57:  LBL[17] ;     %Loop start
  58:  PR[1,5]=PR[1,5]+R[8]    ;    %Variable no. 5 increment
  59:  JMP LBL[19] ;    %Label 19 jump
  60:  LBL[18] ;    %Loop start
  61:  PR[1,5]=PR[1,5]-R[8]    ;    %Variable no. 5 decrement
  62:  LBL[19] ;     %Loop start
  63:  IF R[6]=1,JMP LBL[20] ;
   %Check the direction opposite to R axis
  64:  IF R[6]=2,JMP LBL[21] ; %Check the direction to R axis
  65:  JMP LBL[22] ;    %Label 22 jump
  66:  LBL[20] ;     %Loop start
  67:  PR[1,6]=PR[1,6]+R[8]    ;    %Variable no. 6 increment
  68:  JMP LBL[22] ;    %Jump to label 22
  69:  LBL[21] ;     %Loop start
  70:  PR[1,6]=PR[1,6]-R[8]    ;    %Variable no. 6 decrement
  71:  LBL[22] ;    %Loop start
  72:J PR[1] R[7]% FINE    ;
   %Motion execution to a position PR[1] with a velocity R[7]
  73:  LBL[3] ;  %Third loop start
  74:  RO[1]=(DI[1]) ;
   %Milling cutter turning on or off depending on value of DI[1]
  75:  JMP LBL[1] ; %Label 1 jump
/POS    %End of the motion instruction
P[1]{   %Safety position coordinates information
GP1:    UF : 0, UT : 1, CONFIG : 'N U T, 0, 0, 0',
X =   890.000  mm,Y =     0.000  mm, z =   800.000  mm,
W =   180.000 deg,P =   -90.000 deg, R =     0.000 deg,
E1=     50.000  mm};
/END    %End of the program
```

(Example from Pioskowik D., (2013) The integration of communication protocols with the control system of an industrial robot FANUC ARC Mate 100iC. Master thesis promoted by Zolkiewski S. report. Silesian University of Technology, Gliwice)

Many scientific publications [19–24] propose detailed mathematical methods and algorithms based on vector analysis as well as methods of signal analysis which were used to obtain the results of the following integrated robot control systems.

3 Conclusions

Presented integrated system can be used both in educational and practical industry applications. The concept could also ensure ability to reach difficult places (e.g. concerning weld). In spite of the fact that human control the robot manually there is a possibility to ensure repeatability and floor space savings using the automatic control mode implemented in LabVIEW application. The proposed solution increases flexibility of the whole production system and makes it possible to program and control robot remotely in a new intuitive way. The presented system could be used in arc welding operations considering flexible work conditions, in assembling nontypical parts and mechanisms, in machining robots, in loading and unloading operations, in painting and dispensing robots ensuring a solution for atypical and not easily accessible surfaces paint, in industrial palletizing robots. The kinect motion sensor used in the industrial robot control system is an innovative approach in the field of robotics. In this paper, an example of a mechatronic control system based on a relatively new technology developed by the manufacturers of the kinetic motion sensor (Microsoft Kinect) was presented. The developed solution enriches functionality of industrial robot and makes it possible to program and operate the robot in a more intuitive way. Limitations of this research are connected with a lack of full access to all Fanuc libraries and a lack of access to necessary information such as methodology of Fanuc files compilation, that are closely guarded secrets of the company. Necessary in the project ASCII text data files (LS files) were compiled by means of an internal Roboguide compiler that limited the system performance. In future works some optimization in this process is going to be carried out. Using the Kinect for human gestures control does not require additional lightning but has some limitations connected with difficulty of usage in very well lit bays and rooms. Future research will also concern new industrial and medical applications of the developed human gestures control system and will develop authors' software for this purpose.

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Vision-Based Portuguese Sign Language Recognition System

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Abstract. Vision-based hand gesture recognition is an area of active current research in computer vision and machine learning. Being a natural way of human interaction, it is an area where many researchers are working on, with the goal of making human computer interaction (HCI) easier and natural, without the need for any extra devices. So, the primary goal of gesture recognition research is to create systems, which can identify specific human gestures and use them, for example, to convey information. For that, vision-based hand gesture interfaces require fast and extremely robust hand detection, and gesture recognition in real time. Hand gestures are a powerful human communication modality with lots of potential applications and in this context we have sign language recognition, the communication method of deaf people. Sign languages are not standard and universal and the grammars differ from country to country. In this paper, a real-time system able to interpret the Portuguese Sign Language is presented and described. Experiments showed that the system was able to reliably recognize the vowels in real-time, with an accuracy of 99.4% with one dataset of features and an accuracy of 99.6% with a second dataset of features. Although the implemented solution was only trained to recognize the vowels, it is easily extended to recognize the rest of the alphabet, being a solid foundation for the development of any vision-based sign language recognition user interface system.

Keywords: Sign Language Recognition, Hand Gestures, Hand Postures, Gesture Classification, Computer Vision, Machine Learning.

1 Introduction

Hand gesture recognition for human computer interaction is an area of active research in computer vision and machine learning. One of its primary goals is to create systems, which can identify specific gestures and use them to convey information or to control a device. Though, gestures need to be modelled in the spatial and temporal domains, where a hand posture is the static structure of the hand and a gesture is the

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dynamic movement of the hand. There are basically two types of approaches for hand gesture recognition: *vision-based approaches* and *data glove approaches*. This work main focus is on creating a vision-based system able to do real-time sign language recognition. The reason for choosing a system based on vision relates to the fact that it provides a simpler and more intuitive way of communication between a human and a computer. Being hand-pose one of the most important communication tools in human's daily life, and with the continuous advances of image and video processing techniques, research on human-machine interaction through gesture recognition led to the use of such technology in a very broad range of applications, like touch screens, video game consoles, virtual reality, medical applications, and sign language recognition. Although sign language is the most natural way of exchanging information among deaf people it has been observed that they are facing difficulties with normal people interaction. Sign language consists of vocabulary of signs in exactly the same way as spoken language consists of a vocabulary of words. Sign languages are not standard and universal and the grammars differ from country to country. The Portuguese Sign Language (PSL), for example, involves hand movements, body movements and facial expressions [1]. The purpose of Sign Language Recognition (SLR) systems is to provide an efficient and accurate way to convert sign language into text or voice has aids for the hearing impaired for example, or enabling very young children to interact with computers (recognizing sign language), among others. Since SLR implies conveying meaningful information through the use of hand gestures [2], careful feature selection and extraction are very important aspects to consider. Since visual features provide a description of the image content [3], their proper choice for image classification is vital for the future performance of the recognition system. Viewpoint invariance and user independence are two important requirements for this type of systems. In this paper, a vision-based system able to interpret static hand gestures from the Portuguese Sign Language alphabet is presented and described. The selected hand features were analysed with the help of Rapid Miner [4] in order to find the best learner for the problem under study. The rest of the paper is as follows. First we review related work in section 2. Section 3 presents the Sign Language Recognition prototype architecture and implementation. In section 3.2 the experimental methodology is describes and the obtained results are presented and discussed. Conclusions and future work are drawn in section 4.

2 Related Work

Hand gesture recognition, either static or dynamic, for human computer interaction in real time systems is a challenging task and an area of active research with many possible applications. There are many studies on gesture recognition and methodologies well presented in [5, 6]. As explained in the previous section, careful hand features selection and extraction are very important aspects to consider in computer vision applications for hand gesture recognition and classification for real-time human-computer interaction. This step is crucial to determine in the future whether given hands shape matches a given model, or which of the representative classes is the most similar. According to Wacs [7] proper feature selection, and their combination with sophisticated learning and recognition algorithms, can affect the success or failure of any existing and future work in the field of human computer interaction using hand gestures. Trigueiros, in is study [8], presented a comparative study of seven different algorithms for hand feature extraction with the goal of static hand gesture classification. The results showed that the radial signature and the centroid distance were the features that when used separately obtained better results, being at the same time simple in terms of computational complexity. He has also implemented a vision-based system [9], able to drive a wheelchair with a minimum number of finger commands. In the system, the user hand is detected and segmented, and fingertips are extracted and used as features to build user commands for wheelchair control. Wang [10] used the discrete Adaboost learning algorithm integrated with SIFT features for accomplishing in-plane rotation invariant, scale invariant and multi-view hand detection. Conceil [11] compared two different shape descriptors, Fourier descriptors and Hu moments, for the recognition of 11 hand postures in a vision based approach. They concluded that Fourier descriptors gives good recognition rates in comparison with Hu moments. Barczak [12] performed a performance comparison of Fourier descriptors and geometric moment invariants on an American Sign Language database. The results showed that both descriptors are unable to differentiate some classes in the database. Bourennane [13] presented a shape descriptor comparison for hand posture recognition from video, with the objective of finding a good compromise between accuracy of recognition and computational load for a real-time application. They run experiments on two families of contour-based Fourier descriptors and two sets of region based moments, all of them invariant to translation, rotation and scale-changes of hands. They performed systematic tests on the Triesch benchmark database [14] and on their own with more realistic conditions, as they claim. The overall result of the research showed that the common set Fourier descriptors when combined with the k-nearest neighbour classifier had the highest recognition rate, reaching 100% in the learning set and 88% in the test set. Huynh [15] presents an evaluation of the SIFT (scale invariant feature transform), Colour SIFT, and SURF (speeded up robust features) descriptors on very low resolution images. The performance of the three descriptors is compared against each other on the precision and recall measures using ground truth correct matching data. His experimental results showed that both SIFT and colour SIFT are more robust under changes of viewing angle and viewing distance but SURF is superior under changes of illumination and blurring. In terms of computation time, the SURF descriptors offer themselves as a good alternative to SIFT and CSIFT. Fang [16] to address the problem of large number of labelled samples, the usually costly time spent on training, conversion or normalization of features into a unified feature space, presented a hand posture recognition approach with what they called a co-training strategy [17]. The main idea is to train two different classifiers with each other and improve the performance of both classifiers with unlabelled samples. They claim that their method improves the recognition performance with less labelled data in a semi-supervised way. Rayi [18] used the centroid distance Fourier descriptors as hand shape descriptors in sign language recognition. Their test results showed that the Fourier descriptors and the Manhattan distance-based classifier achieved recognition rates of 95% with small computational latency. In terms of classification and learning, machine learning algorithms have been applied successfully to many fields of research like, face recognition and facial expressions [19, 20], automatic recognition of a musical gesture by a computer [21], classification of robotic soccer formations [22], classifying human physical activity from on-body accelerometers [23], automatic road-sign detection [24, 25], static hand gesture classification [26], serious games applied to rehabilitation [27-30] and intelligent wheelchairs [20, 31-34]. Trigueiros [26] have made a comparative study of four machine learning algorithms applied to two hand features datasets. In their study the datasets had a mixture of hand features. Ke [35] used a Support Vector Machine (SVM) in the implementation of a real-time hand gesture recognition system for human robot interaction. Masaki [36] used a SVM in conjunction with a SOM (Self-Organizing Map) for the automatic learning of a gesture recognition mode. He first applies the SOM to divide the sample into phases and construct a state machine, and then he applies the SVM to learn the transition conditions between nodes. Almeida [37] proposed a classification approach to identify the team's formation in the robotic soccer domain for the two dimensional (2D) simulation league employing Data Mining classification techniques. Hidden Markov Models (HMMs) have been widely used in a successfully way in other areas of application, and also applied quite successfully to gesture recognition. Oka [38] developed a gesture recognition system based on measured finger trajectories for an augmented desk interface system. They have used a Kalman filter for the prediction of multiple finger locations and an HMM for gesture recognition. Perrin [39] described a finger tracking gesture recognition system based on a laser tracking mechanism which can be used in hand-held devices. They have used HMM for their gesture recognition system with an accuracy of 95% for a set of 5 gestures. Nguyen [40] described a hand gesture recognition system using a real-time tracking method with pseudo two-dimensional Hidden Markov Models. Chen [41] used it in combination with Fourier descriptors for hand gesture recognition using a real-time tracking method. Kelly [42] implemented an extension to the standard HMM model to develop a gesture threshold HMM (GT-HMM) framework which is specifically designed to identify inter gesture transition. Zafrulla [43] have investigated the potential of the Kinect [44, 45] depth-mapping camera for sign language recognition and verification for educational games for deaf children. They used 4-state HMMs to train each of the 19 signs defined in their study. Cooper [46] implemented an isolated sign recognition system using a 1st order Markov chain. In their model, signs are broken down in visemes (equivalent to phonemes in speech) and a bank of Markov chains are used to recognize the visemes as they are produced. Trigueiros used HMMs in a vision-based system able to interpret gestures from a robotic soccer referee [47], and also in a generic solution, able to interpret user commands, composed of a set of dynamic and static gestures, and that can be used to build any human-computer interaction (HCI) system [48]. His solution has the advantage of being computationally simple, easy to train and use, and at the same time generic enough, allowing its application in any HCI interface.

3 Our Approach

The Sign Language Recognition Prototype is a real-time vision-based system whose purpose is to recognize the Portuguese Sign Language given in the alphabet of Fig. 1. The purpose of the prototype was to test the validity of a vision-based system for sign language recognition and at the same time, test and select hand features that could be used with machine learning algorithms allowing their application in any real-time sign language recognition systems. For that, the user must be positioned in front of the camera, doing the sign language gestures, that will be interpreted by the system and their classification will be displayed on the right side of the interface. The implemented solution uses only one camera, a Kinect camera [44], and is based on a set of assumptions, hereby defined:

1. The user must be within a defined perimeter area, in front of the camera.
2. The user must be within a defined distance range, due to camera limitations. The system defined values are 0.7m for the near plane and 3m for the far plane.
3. Hand pose is defined with a bare hand and not occluded by other objects.
4. The system must be used indoor, since the selected camera does not work well under sun light conditions.

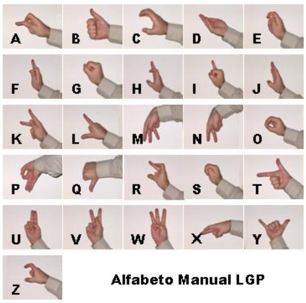

Fig. 1. Manual alphabet for the Portuguese Language

The diagram of Fig. 2 shows the proposed system architecture, which consists of two modules, namely:

- Data acquisition, pre-processing and feature extraction.
- Sign language gesture classification.

In the first module, the hand is detected, tracked and segmented from the video images. From the obtained segmented hand, features are extracted for gesture classification. In the gesture classification module, the obtained feature vector (instance vector) is normalized and classified with a previous trained Support Vector Machine (SVM), which is a pattern recognition technique in the area of supervised machine learning, which works very well with high-dimensional data.

3.1 Prototype Implementation

The human-computer interface (HCI) for the prototype was developed using the C++ language, and the openFrameworks toolkit [49] with the OpenCV [50] and the OpenNI [51] addons, ofxOpenCv and ofxOpenNI respectively. OpenCV was used for some of the vision-based operations like extracting the hand blob contour, and OpenNI was responsible for the RGB and depth image acquisition. For model training and gesture classification the open source Dlib library was used, a general-purpose cross-platform C++ library capable of SVM multiclass classification [52]. The SVM algorithm was selected for the final implementation, because in the experiments that were carried out with the selected features, it was able to achieve very high values of accuracy. Also, the resulting obtained model was compact and fast, able to be applied in applications with real-time classification demands. In the following two images it is possible to see the Sign Language Prototype with two vowels correctly classified and displayed on the right side of the user interface.

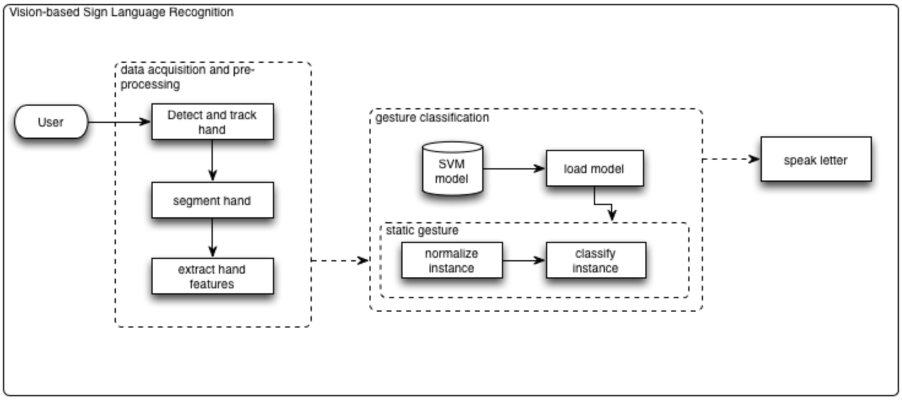

Fig. 2. Sign Language Recognition Prototype diagram

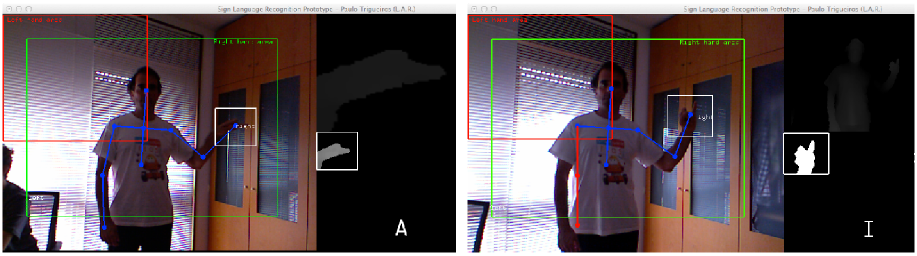

Fig. 3. Sign Language prototype interface wit two vowels correctly classified

3.2 Experimental Methodology

This experiment main goal was to test two different types of hand features in order to validate which one could achieve better results in terms of Portuguese Sign Language recognition. The first type of features, the centroid distance features, derived from the object boundary coordinates are also called a shape signature as shown in [53, 54]. According to Zhang [55] and Trigueiros [8], it gives very good results in shape retrieval and classification, being at the same time simple in terms of computational complexity. The centroid distance is expressed by the distance of the hand contour boundary points $(x_i, y_i) : i = 0 \ldots N-1$, from the centroid (x_c, y_c) of the hand and given by the following formula:

$$d(i) = \sqrt{(x_i - x_c)^2 + (y_i - y_c)^2} : \quad i = 0, \ldots, N \tag{1}$$

where $d(i)$ is the calculated distance. Due to the subtraction of centroid, which represents the hand position, from boundary coordinates, the centroid distance representation is invariant to translation. The second type of features is obtained from the hand depth image distance values. The distance values, which represent the distance from the object to the camera, can be seen in the image of Fig. 4 (right), with different distances represented by different grey values. The distance values could represent, in our opinion, good hand features giving a more possible hand representations with the same viewpoint. For the centroid distance, the number of features (N) was defined to be 16. For the distance values, the hand image was resized to be 16x16 pixels in size, giving a final vector with 256 features.

So, for this experiment, two types of images were used during the feature extraction phase and dataset construction:

- The binary hand blob for the centroid distance calculation (Fig. 4 – left and centre) and,
- The hand distance image for the distance feature vector (Fig. 4 - right).

For the centroid distance dataset (DataSet-1), a total of 2170 records with 16 features were used, and for the distance values dataset (DataSet-2), a total of 2488 records with 256 features were used.

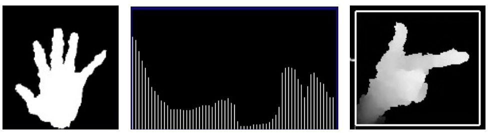

Fig. 4. Hand binary blob (left); Centroid distance signature (centre); Hand depth image (right)

All the built feature datasets were converted to Excel files, so that they can be imported into RapidMiner [4] for data analysis. The experiment was divided into two phases with the purpose of finding out for each dataset which parameters to use for classification. The first goal was to run a parameter optimization process, to find in terms of SVM classification, which kernels would achieve the bests results among the following four: linear, sigmoid, rbf (radial basis function) and polynomial. Although the rbf kernel is a reasonable first choice, there are some situations where this is not suitable. In particular, when the number of features is very large, one may just use the linear kernel. This was the reason that led us to perform this test. The second goal was to run for each dataset a parameter optimization test dependent on the chosen kernel type, in order to find the best parameters to be implemented in the final solution. Fig. 5 shows the RapidMiner process configuration for the kernel and the C (cost value) parameter optimization.

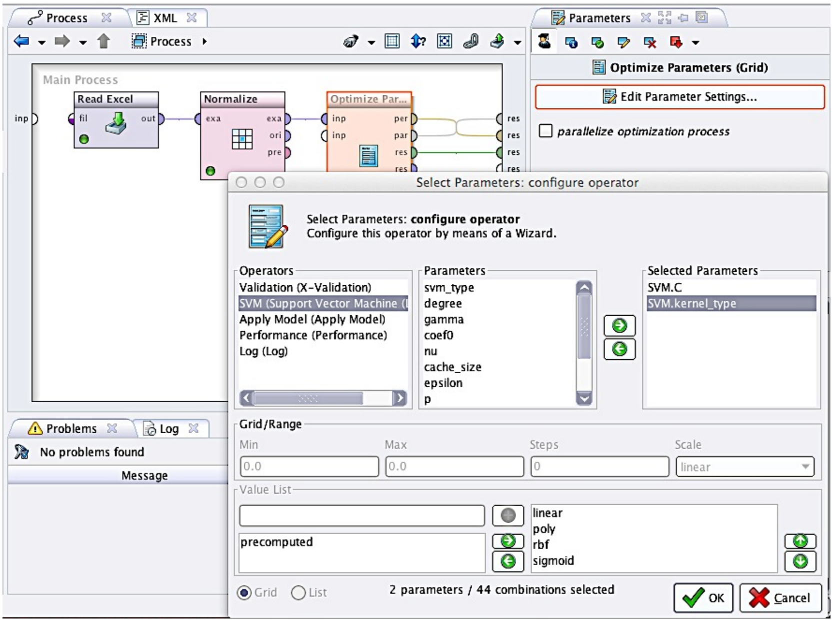

Fig. 5. RapidMiner process for parameter optimization

3.3 Results

The first phase of the experiment, as explained in the previous section, was to learn which kernels behaved better in terms of SVM classification for the two datasets under study. As can be seen on Table 1, for both datasets, the obtained best kernel type was the linear kernel, with a difference only on the obtained cost parameter C. For this reason the second part of the experiment was unnecessary, since the linear kernel does not need any further parameter optimization.

Table 1. Obtained parameters for the two datasets

Parameters	Dataset 1	Dataset 2
kernel type	linear	linear
C	1	2

The following table presents the obtained accuracy for each dataset with the corresponding kernel type and cost parameter.

Table 2. Obtained accuracy for each dataset

Parameters	Dataset 1	Dataset 2
Kernel type	Linear	linear
C	1	2
accuracy	99,4%	99,6%

In order to analyse how classification errors were distributed among classes, a confusion matrix was computed for each one of the datasets under study. The resulting confusion matrixes are represented in the following two tables.

Table 3. Centroid distance features confusion matrix

		Actual class				
		1	**2**	**3**	**4**	**5**
Predicted class	**1**	**455**	0	0	2	0
	2	0	**394**	1	1	0
	3	0	0	**401**	1	0
	4	4	2	0	**382**	0
	5	0	0	1	0	**439**

Table 4. Distance features confusion matrix

		Actual class				
		1	**2**	**3**	**4**	**5**
Predicted class	**1**	**622**	0	8	0	10
	2	0	**543**	1	0	1
	3	0	3	**451**	0	0
	4	0	0	0	**413**	0
	5	0	0	1	0	**434**

3.4 Discussion

The goal of this experiment was to carry a comparative study of two different types of hand features for the problem of sign language recognition using a Support Vector Machine (SVM). It was decided to choose this learning algorithm since it had already shown good results in previous experiments, in terms of classification, with the first type of hand features. From Table 2 one can easily see that the two different features gave similar results in terms of classification accuracy, with only a small difference of 0.2%. From the obtained results so far, one can conclude that the new features are not an asset, having the disadvantage of being heavier in terms of number of features and final sizes of the dataset and generated model. The corresponding confusion matrix also shows, that some major classification errors occurred between gesture one, the 'A' vowel, and gestures three and five, corresponding to the 'E' and 'U' vowels respectively. The centroid distance, on the other hand, being simple in terms of computational complexity gives rise to smaller datasets and a final small model file. Although the results were encouraging, further tests should be carried out, including not only more features from new users as well as the rest of the alphabet in the datasets in order to test the efficiency of the proposed system as well as the final classification model.

4 Conclusions and Future Work

Hand gestures are a powerful way for human communication, with lots of potential applications in the area of human computer interaction. Vision-based hand gesture recognition techniques have many proven advantages compared with traditional devices. However, hand gesture recognition is a difficult problem and the current work is only a small contribution towards achieving the results needed in the field of sign language recognition. This paper presented a vision-based system able to interpret static hand gestures from the Portuguese Sign Language. Experiments with two different datasets were carried out in order to find the best hand features, among two different types, in terms of Portuguese Sign Language gesture classification. The extracted features were tested with the help of the RapidMiner tool for machine learning and data mining. That way, it was possible to identify the best SVM parameters for learning and classification. The obtained parameters were able to achieve very good results in terms of real-time gesture classification with a minimal difference (0,2%) between the two hand features. The proposed solution was tested in real time situations, were it was possible to prove that the obtained classification models were able to recognize all the trained gestures being at the same time user independent, important requirements for this type of systems. The selected hand features, in conjunction with machine learning algorithms, proved to be very efficient, allowing their application in any real-time sign language recognition systems. As future work it is intended to keep improving the system and make experiments with complete language datasets. It is also intended to test systems able to interpret dynamic sign language gestures where there is a need for reliable solutions for the problem of start and end gesture identification. As a final conclusion one can say that although there is still much to do in the area, the proposed solution is a solid foundation for the development of any vision-based sign language recognition user interface system. The sign language grammar can be easily changed and the system configured to train the new language gestures.

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