A CONCEPTUAL FRAMEWORK FOR THE DEVELOPMENT OF APPLICATIONS CENTRED ON CONTEXT AND EVIDENCE-BASED PRACTICE

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Abstract: Conceptual *frameworks* are used to present a preferred approach to an idea or thought. Its use considerably facilitates the productivity of the data modelling phase and hence the development of applications, since it preserves portability and usability across domains. Evidence-Based Practice (EBP), usually employed in Medicine, represents a decision-making process centered on justifications of relevant information. EBP is used in several areas; however, we did not found conceptual models involving EBP that preserves portability and usability across domains. Besides, the decision-making context can have an impact on evidence-based decision-making, but the integration of evidence and context is still an open issue. This work presents a conceptual *framework* that integrates evidence with context applying it to the conceptual modelling phase for EBP domains. The use of context allows filtering out more useful information. The main contributions of this paper are: incorporation of contextual information into EBP procedures and presentation of the proposed conceptual *framework*. Also an implementation that uses the filtering of contextual information to support evidence-based decision making in the area of crime prevention is presented to validate the framework.

1 INTRODUCTION

The conceptual modelling phase within a methodology for systems development is of main importance. A conceptual *framework* is used to present a preferred approach to an idea or thought. It aims to provide a class diagram that can be used as basis for the modelling of the classes of several application domains. The product generated by a conceptual *framework* is not executable software, but a conceptual data scheme (Rocha et al., 2001). The use of a conceptual framework considerably facilitates the productivity of the data modelling phase in diverse domains, and hence the development of applications, since it preserves usability and portability across domains.

Evidence-Based Practice (EBP), usually employed in Medicine, are systematic procedures that take into account the problem of actors (e.g. diabetes in children), his/her needs and preferences for decision, leading to a search for evidence and an application based on the best research evidence found (Sacket et al., 2001). The procedures represent an evidence-based decision-making process, centered on justifications of relevant information (Dobrow et al., 2004).

The EBP paradigm is also used in other areas, such as Crime Prevention (Warren, 2007), Education (Thomas and Pring, 2004), Computer Science (Jorgensen et al., 2005), and Social Work (Satterfield et al., 2009). However, we did not found conceptual models involving EBP which preserves

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usability and portability across domains.

Context is a knowledge that supports the ability to define what is or is not relevant in a given situation (Vieira, 2008). The application of evidence to a particular patient, for example, detains important contextual information in the EBP procedures and includes comparative analysis between different contexts: that of the generation of evidence and that of the patient.

According to Dobrow et al. (2004, p. 208), "the two fundamental components of an evidence-based decision are evidence and context. The decision-making context can have an impact on evidence-based decision-making". But, the integration of evidence and context is still an open issue.

The aim of this paper is to present a conceptual *framework* that integrates evidence with context and preserves the characteristics of generality, flexibility and extensibility, applying it to the conceptual modelling phase for domains that use EBP.

Thus, the evidence retrieval with contextual information also can facilitate the reapplication of decision-making justifications, involving similar problems, and can avoid comparative analysis of different contexts in the future.

The use of context applies to filter out and share more useful information so that this information can meet the needs of the users. It becomes a significant tool to optimize performance and reduce search results. Filtering mechanisms avoid more explicit user interactions with the application (Bunningen, 2004).

Thus, another objective of this paper is to present an implementation that uses the filtering of contextual information to support evidence-based decision making.

In this way, our contribution serves to: (i) incorporate contextual information into EBP procedures; and (ii) present a conceptual *framework* centred in evidence and context, with portability and usability across domains.

The key concepts regarding context and evidence are described in Section 2. Section 3 presents the conceptual *framework* using UML. In Section 4, the framework is used in the conceptual modelling of data in the area of Crime Prevention. An implementation in this same area, presented in Section 5, serves to validate our work. Related Works are described in the next section. In the last section, we present our conclusions.

2 BACKGROUND

This section defines context and provides an overview of Evidence-Based Practice.

2.1 Context

There are several definitions of context. A classical definition (highly referred) is proposed by Dey and Abowd (2001, p. 11) where context is "any information that characterizes the situation of an entity, where this entity is a person, place or object considered relevant in the interaction between the user and an application. A context is typically the location, identity and status of people, groups and computational and physical objects".

Context can also be seen as a set of conditions and relevant influences that make a situation unique and understandable (Brézillon, 1999) or as a set of information items (e.g. concepts, rules and propositions) associated with an entity (Vieira, 2008).

An item is considered part of a context only if it is useful to support the resolution of a given problem. This item corresponds to a *contextual element* defined as "any data, information or knowledge that enables one to characterize an entity on a given domain" (Vieira, 2008, p. 45).

Contextual information regarding acquisitions is: (i) given by the user, whether from persistent data sources or from profiles; (ii) obtained from a knowledge base; (iii) obtained by means of deriving mechanisms; or (iv) perceived from the environment (Henricksen and Indulska, 2006). It is usually identified through of the dimensions *why*, *who*, *what*, *where*, *when* and *how* (Brézillon, 2007).

One step in the task execution or problem-solving process is known as *focus*. The contextual elements should have a relevant relationship to the focus of a human agent or software agent. In general, focus is what determines which contextual elements should be instantiated (Brézillon, 2007).

2.2 Evidence-based Practice

According to Thomas and Pring (2007), in general, information labeled as evidence is those whose collection had concerns about its validity, credibility and consistency with other facts or evidence. In relation to its credibility, the authors categorize evidence in three ways:

1. Based on professional practice, as a clinical examination;
2. Generated by a process involving scientific procedures with a proven history in producing valid and reliable results, for example a collect performed by biomedical;

3. Based from published research that corresponds to critical reviews of the area, such as randomized clinical trial.

"Evidence" in EBP, also called "research evidence", corresponds to the third category above and means a superior type of scientific research proof, such as generated through systematic review and meta-analysis in the highest level. These published researches are available in reliable data bases, usually found on sites over the Internet, carried out by independent research groups (Sackett et al., 2001). This is the concept of evidence applied in this paper.

To clarify further, a systematic review is a review that presents meticulous research and critical evaluations of primary studies (case study, cohort, case series, etc.), based on research evidence related to a specific *theme*. It contains analysis of *qualitative* results conducted in distinct locations and at different times. Meta-analysis is a systematic review of *qualitative and quantitative* characteristics (Friedland et al., 1998).

Evidence-Based Practice (EBP) involves complex decision-making, based on available research evidence and also on characteristics of the actor of the problem, his/her situations and preferences.

In the medical area, EBP primary focus is to provide effective counselling to help patients with terminal or chronic illness to make decision in order to cure the illness, extend or increase the quality of their life (Friedland et al., 1998). What is objectively searched is "the integration of best evidence from research, clinical skill and preferences of the patient, regarding their individual risks and the benefits of proposed interventions" (Sackett et al., 2001, p. 1).

In crime prevention, EBP involves the correlations practice that has been proven through scientific research, aimed at reducing the recidivism of offenders. EBP primarily considers the risk and need principle of the offender, besides the motivation, and treatment and responsibility principles (Warren, 2007).

The EBP focus for education area is improving the quality of research and evaluation on education programs and practices, and hence, the information diffusion in the *educational research* field to be used by professionals and policies creators. (Thomas and Pring, 2004).

We generalize the EBP steps in the following way:

1. Transforming the need for information into a question that can be answered;
2. Identifying the best evidence to answer the question;
3. Critically analyzing the evidence to answer:
   - Is it valid (proximity to the truth)?
   - Is it relevant (size of effect)?
   - Can it help (applicable in professional practice)?
4. Integrating critical analysis with professional skills and the values and cultural aspects of the actor of the problem answering:
   - How much the evidence can help the actor in particular?
   - Is it adaptable to actor's goal and preferences?
   - How much safety can be expected?
5. Evaluating the efficiency and effectiveness of the results of each step for future improvement.

Well-formulated questions usually have four components, called PICO: *Problem* (and/or actor), *Intervention*, *Comparison of interventions*, and *Outcome* (Sackett et al., 2001). The questions in steps 3 and 4 were adapted from Heneghan and Badenoch (2006, p. 7), and the answers of them represent contextual information that supports decision-making.

3 A CONCEPTUAL FRAMEWORK BASED ON EVIDENCE AND CONTEXT

The primary aim of this conceptual *framework* is to provide a class structure that represents information related to EBP procedures, while taking into consideration information about its decision-making context.

The domain analysis was done in juridical, medical and educational environments, and includes: bibliographical research, specific legislation research, analysis of real cases collected and interviews with decision-makers.

We utilize the extension construct *stereotype* of the UML to select enumerated values. To facilitate its presentation in a systematic way, it became convenient to group classes in two integrated packages: *Context* and *Evidence* (see Figure 1).

3.1 *Context* Package

The classes of the *context* package are based on Vieira (2008).

The *focus* is treated as an association of a *task* with an *agent*, which have a *role* in problem

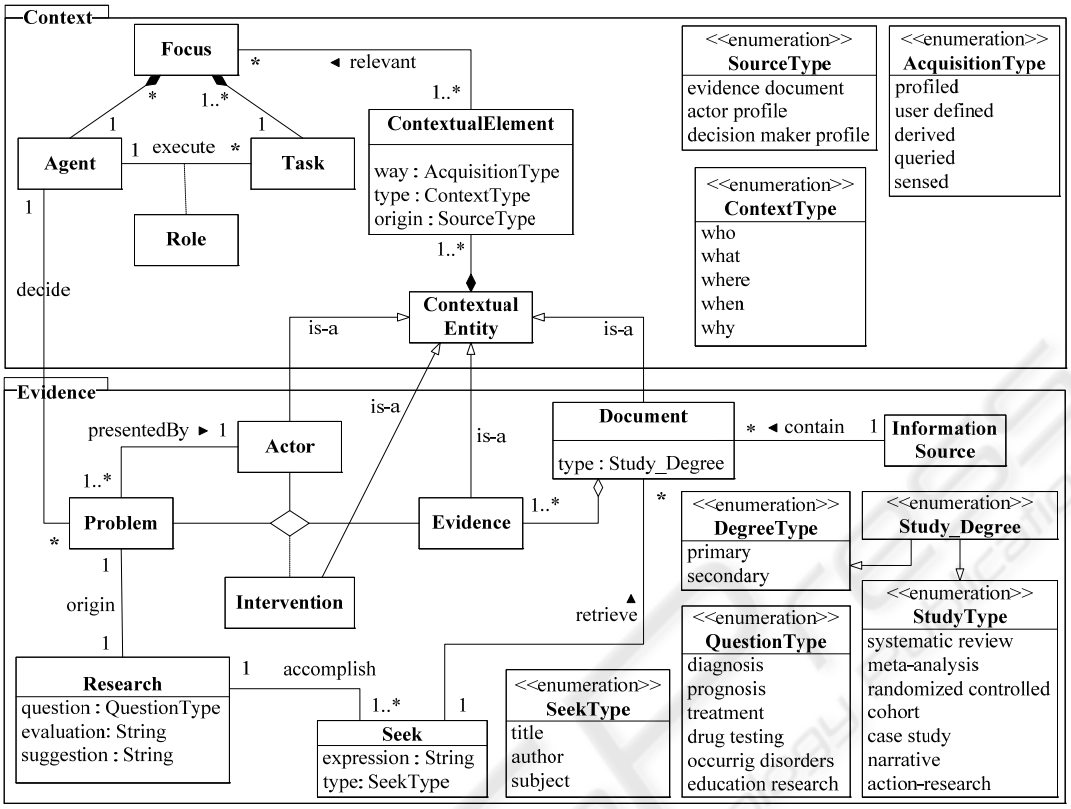

Figure 1: Conceptual framework integrating evidence with context.

resolution. A task "make a critical analysis of the best evidence found" for a “medical” agent in the role "evaluator", serve as example.

ContextualEntity represents the entities of the application conceptual model and is characterized by at least one contextual element. A contextual element is a property that can be identified by a set of attributes and relationships associated with *ContextualEntity* (Vieira, 2008, p.66). *Accessibility* is an example of a contextual element for the *Document* class. The association between *Focus* and *ContextualElement* determines what is relevant for a focus.

Characteristics attributed to the type of context (dimension) and the method of acquiring contextual elements are considered in the framework. Contextual sources may be internal or external to the decision-making environment (e.g., the patient’s medical records, a document with evidence obtained from websites).

3.2 *Evidence* Package

The starting point is the observation of a problem presented by an actor to be decided by agent.

Each problem is associated with an inquiry that is initiated by a formulated question (see step 1 of the EBP procedures), and completed with a self-evaluation of the research performance and suggestions for the future (see step 5 of the EBP procedures), whose information is instantiated in the *Research* class. Each domain in which EBP is applied has a list of different types of questions. For example: "diagnosis" and "prognosis" in the medical area, "drug testing" and "occurring disorders" in the area of crime prevention, and "educational research" in education.

During the evidence research, several searches can be performed to retrieve documents. For the *Seek* class, the expression and the type of search must be present. *InformationSource* represents the independent research groups that generate documents with evidence, such as Cochrane Collaboration (medical area) and Campbell Collaboration (areas of education and crime prevention). Springer Verlag is not generating evidence, but has held documents with evidence.

Each document presents a type of study that can be in all domains (e.g. systematic review, case study) or more present in the specific domain

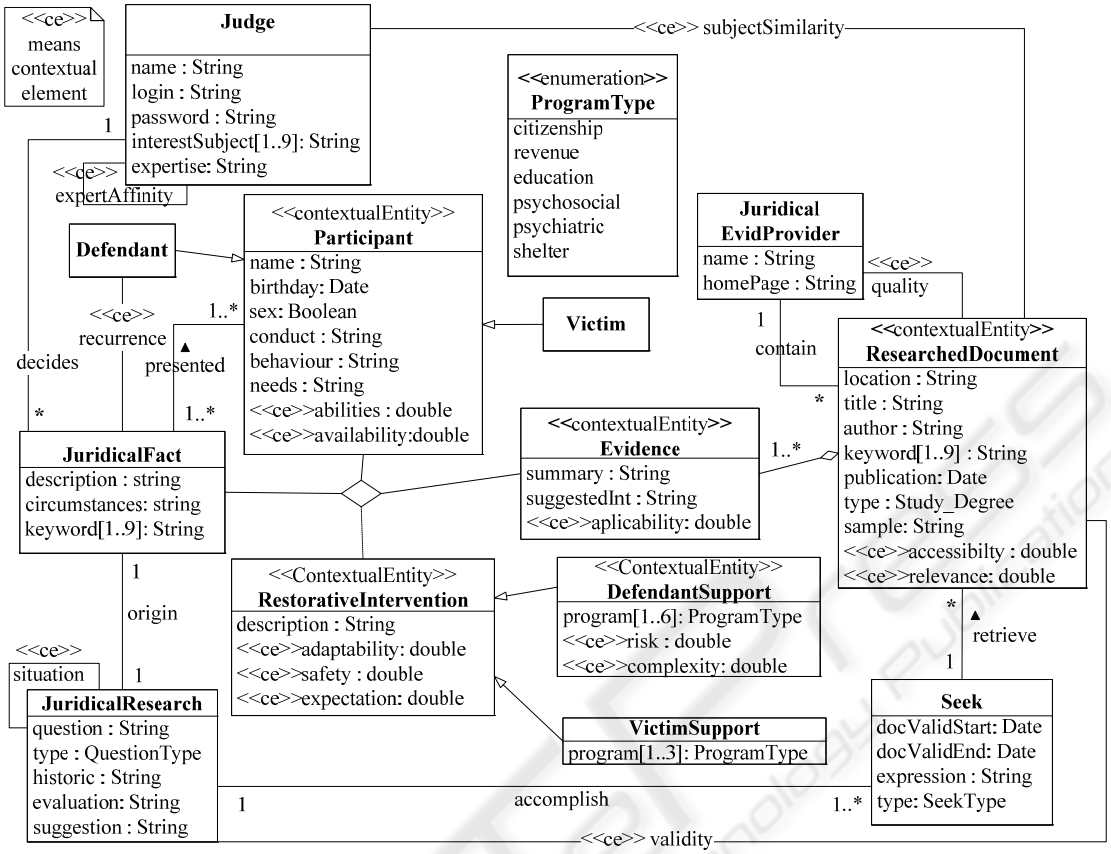

Figure 2: Framework applied to the area of crime prevention.

(cohort - in the medical area; narrative - in crime prevention; action-research - in education). Systematic review and meta-analysis are studies of second degree; the remains are of first degree (Friedland et al., 2001).

In the medical area, Evidence-Based Medicine Guidelines are clinical guidelines for primary care combined with the best available evidence. The framework is extendible from perspective of using guidelines adapted as a type of study.

After selecting the found evidence, the agent (decision maker) will choose the one that seems the most appropriate (step 2 of EBP), which is instantiated in the *Evidence* class.

The result of the critical analysis – or in other words the validity, relevance and applicability of the best evidence (step 3 of EBP) – corresponds to contextual information. Relevance is a contextual element in *Document*, while applicability (practical utility) is in *Evidence*. Thus, *Document* and *Evidence* are specializations of *ContextualEntity*.

The *Intervention* class is the result of an association among the *Problem*, *Actor* and *Evidence* classes. It contains a description of a decision made (intervening solution) where information about associated classes have been considered including preferences, values and cultural aspects (conduct, behaviour, for example) of the actor with the problem presented (step 4 of EBP). A preference is a contextual element and hence *Actor* is a specialization of *ContextualEntity*.

4 THE CONCEPTUAL FRAMEWORK IN THE AREA OF CRIME PREVENTION

The framework instantiated for the area of Crime Prevention is present in Figure 2 which was enriched with the stereotypes *<<ce>>* and *<<contextualEntity>>*, corresponding respectively to *ContextualElement* and *ContextualEntity*.

The Pernambuco state court (Brazil) was chosen because of its pioneering work on “restorative justice” and “therapeutic justice”, themes inherent in Evidence-Based Crime Prevention.

The main requirements are: to judge cases

through judicial sentences, and to make interventions based on support programs to the involved participants with the objective to avoid recidivism. The Figure 2 corresponds to the second requirement.

Each EBP procedure corresponds to a task. The following tasks were identified: (i) "make a question to find *evidence*"; (ii) "find the best juridical research *evidence*" based on the designation of sites with evidence juridical, types of study and search expressions associated with the given question; (iii) "make a critical analysis of the best *evidence* found"; (iv) "integrate the best *evidence* found with the values and preferences of the *participant* with presented *problem*"; and (v) "do a self evaluation of the *judge*'s performance" to measure all the tasks of EBP.

"Translator" and "designer" are the respective roles for tasks (i) and (ii); "intervenor" for the task (iv), while "evaluator" for the other tasks.

The association between *Judge* and *JuridicalFact* brings up the judges that decide juridical cases or make intervention of support programs.

The characterization of the problem is given through the constitution of the juridical fact and the circumstances that motivated the offender being represented in the *JuridicalFact* class. To facilitate information retrieval based on problems, key terms related to the juridical fact will be instantiated in the *JuridicalFact* class. The offender's personal data are represented in the *Defendant* subclass inherited from *Participant*. In several cases, the presence of victims occurs. Thus, *Defendant* and *Victim* are specializations of *Participant*.

The formulation of a question is based on data from the participant, possible interventions (programs like parent counselling, shelter, street lighting, etc.) and desired results. The question and its corresponding type are instantiated in the *JuridicalResearch* class. The *historic* attribute in this class should include general comments and the number of documents that were accepted and rejected.

Searches for evidence should mention the validity period of the documents requested for each reliable site (*start* and *end*).

For the *ResearchedDocument* class, the required attributes (besides the contextual elements) are: *location* (URI / URL), *title*, *author*, *keywords*, *publication* and *sample* of the study (participants, age interval, geographic and temporal aspects, etc.). Searches for secondary studies should be conducted on Campbell Collaboration's and Springer websites. Primary studies should be consulted on the websites of Courts (federal or state) and in respected electronic journals in the country (*JusNavigandi*, National Association of Therapeutic Justice, etc.). The *homePage* attribute value is the reference to the *JuridicalEvidProvider* class that hold judicial evidences.

Regarding the *Evidence* class, it should contain a summary of the found evidence and the suggested intervention contained in the document.

Information about priority solution that contains the proposals of evidence-based intervention must be present in the *RestorativeIntervention* class. The possible intervention programs are enumerated in Figure 2. For victim support we must consider psychosocial, psychiatric and shelter programs.

About Context, contextual entities and elements of the framework for the area of Crime Prevention were identified. We describe the contextual elements associated with the entities of the framework in two groups.

The first group concerns the elements inherent in the EBP procedures or elements that we have analyzed to be present in several domains:

1. *Accessibility* (*Document*) – mentions the degree of access to a document. Some sites display documents in their entirety (completed or in progress), while others allow you to view only the protocol of creation or just the abstract.
2. *Quality* (*Document*, *InformationSource*) - is derived from the association of the study type with the provider. Systematic review/meta-analysis and the databases of MEDLINE, Cochrane and Campbell Collaboration, when combined, represent the highest level of quality.
3. *Validity* (*Document*, *Research*) - indicates whether the document should be selected based on its quality and the methodological rigor associated with the question asked by the decision maker.
4. *Relevance* (*Document*) - indicates whether the set of results (outcomes) in the document, often presented in statistical form, is consistent and significant.
5. *Applicability* (*Evidence*) - indicates whether the evidence presented in the document is credible in the context of other knowledge, or whether it has practical utility in general.
6. *Adaptability* (*Intervention*) – indicates the degree of coherence in the application of evidence for

the conducted behavior, needs and preferences of the actor.

7. *Safety* (*Intervention*) - denotes the degree of safety that the decision maker have to apply the specific evidence to a particular actor.
8. *Expectation* (*Intervention*) - refers to the percentage of support expected from the use of evidence in relation to the actor.
9. *Abilities (Actor)* – represents the actor's skills (profile), and is used to find mutual affinities with intervention programs (e.g. revenue).
10. *Availability (Actor)* – registers the availability preferences, in days and shifts, of the actor. An actor with a good availability chart has more alternatives and higher chances of fulfilling the intervention on the schedule defined by the Judge.

For the second group, in addition to its relevance, the contextual elements identified are well suited to facilitate the filtering of large volumes of data, mainly for juridical domain:

1. *ExpertAffinity (Judge)* – identifies a relation of expertise from the Judge profile on a given subject matter (e.g. crimes against children). It helps to identify mutual affinities among judges and in the retrieval of evidence related to facts of the same nature (e.g. pedophilia).
2. *SubjectSimilarity* (*ResearchedDocument, Judge*) – is automatically derived and refers to percentage of similarity between keywords in a document and subjects of interest for the Judge.
3. *Recurrence (Defendant, JuridicalFact)* – indicates if the defendant is a primary defendant or not. This information (automatically derived) is crucial to sentencing new trials.
4. *Risk (DefendantSupport)* – it comes from juridical and psychosocial evaluations (profile). Behavior data, conduct, fact description and given sentences, especially for recurrent cases, are bases for measuring the degree of risk.
5. *Complexity (DefendantSupport)* – that comes from the juridical evaluation (defined by the user). It should represent the degree of difficulty that the judge had in solving the case and indicates the intervention program. *Recurrence* and *risk* increase this element.
6. *Situation (JuridicalResearch)* – is contextual information queried in the *JuridicalResearch* class to indicate whether the problem is ongoing or concluded.

To conclude this section, we show elements that characterize a framework through some examples. The *Agent* class corresponds, respectively, to the *Doctor*, *Judge* and *Professor* classes for the medical, juridical and educational areas. *Evidence* and *Seek*, for example, are general classes for any domains. Considering the medical domain, *Symptom* and *Signal* subclasses represent extensions of the *Problem* class. A point of flexibility can be presented in the *Intervention* class to represent different characteristics: *StudentSupport* in educational domain; *PatientSupport* and *FamilySupport* in medical domain; and *DefendantSupport* and *VictimSupport* in juridical domain.

5 IMPLEMENTATION

We present an example adapted from a real case involving an alternative penalty - a model for infractions that are of minor and moderately offensive potential (e.g., contravention, illegal weapon possession). It deals with a new modality, face-to-face restorative justice, in which a victim that suffered violence of an alcoholic offender receives support.
This case is justified because many of the present defendants suffered violence in the past and crime victims could be turn offenders in the future (Sherman et al, 2005).

A prototype was developed in *Java* language that interacts with a *PostgreSQL* Database. Figure 3 presents data for searching by evidence in the Court's Database.

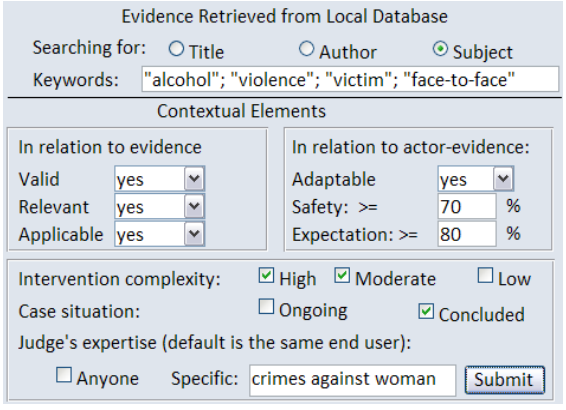

Figure 3: Data for searching evidence from local database.

	title character varying(200)	keywords character varying(200)	study character	source charact	sa nu	ex nu	expertise character varyir	con cha	situ- chai
1	Drunk and dangerous: a randomized controlled trial of alcohol	alcohol, brief interventions, violence, random	randomized	Spriger V	75	90	drug crimes	high	concl
2	Reducing violence through victim identification care and suppo	violence, crime victims rehabilitation, health p	narrative	World He	0.0	0.0	homicide		ongo
3	Assessing the effectiveness of interventions designed to supp	victims of crime, systematic review, violence,	systematic	Campbell	80	85	crimes against wom	mod	concl
4	Change in behaviour of alcohol consumption: what is the moti	alcoholism, motivation, gastroenterology, oul	case study	National	60	50	drug crimes	mod	concl
5	Effects of Drug Substitution Programs on Offending among Dr	drug substitution, drug-addicts, alcohol depe	systematic	Campbell	70	85	drug crimes	low	concl
6	Police crackdowns on illegal gun carrying: a systematic review	Campbell Collaboration, crackdowns, violence	systematic	Spriger V	80	85	homicide	high	concl
7	Cognitive-Behavioural Interventions for Children Who Have Be	child sexual abuse, victim, cognitive-behaviou	systematic	Campbell	85	80	crimes against child	mod	concl
8	School-Based Education Programmes for the Prevention of Ch	child sexual abuse, victim, school-based educ	systematic	Campbell	70	80	crimes against child	low	concl

	title character varying(200)	keywords character varying(200)	study character	source charact	sa nu	ex nu	expertise character varyir	con cha	situ- chai
1	Drunk and dangerous: a randomized controlled trial of alcohol	alcohol, brief interventions, violence, random	randomized	Spriger V	75	90	drug crimes	high	concl
2	Assessing the effectiveness of interventions designed to supp	victims of crime, systematic review, violence,	systematic	Campbell	80	85	crimes against wom	mod	concl

Figure 4: Retrieved documents with evidence: a) without using context (upper), (b) using contextual element (lower).

The High or Moderate Intervention Complexity is due to offender and victim need of treatment. The Judge's expertise in the new case is "drug crimes". We applied Salton's cosine formula used in Information Retrieval for keyword similarity search between query and document with evidence (Salton, 1968).

In the first retrieval, we do not use contextual elements and the results with several cases are present in Figure 4a.

Using contextual information parameters as filter fewer cases were selected (see Figure 4b).

To select a document, we use algorithms of similarity search between keywords (query and fact that motivated its intervention) (see Figure 5).

If the similarity value is highly meaningful, it represents great likeness between the new fact (query) and an old fact with applied evidence (retrieved locally). This can be sufficient to avoid search for evidences on the Internet, and hence, the comparative analysis of different contexts.

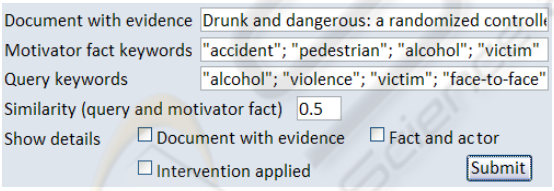

Figure 5: Similarity between query and old fact.

Otherwise, if the presented cases are not sufficient to give support to the solution, the judge should search for evidences on the Internet.

The research began with the question containing the problem and actor (woman with a psychological problem who was assaulted), intervention (face-to-face sessions), comparison of interventions (face-to-face sessions and conventional processes) and outcome (beneficial effects). The sources Campbell Collaboration and Springer Verlag were chosen and their respective home-pages were obtained. Figure 6 show data for second search regarding documents published between 2005 and now.

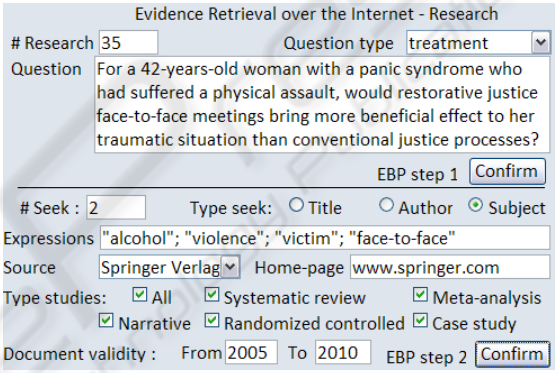

Figure 6: Data for searching evidence in Springer Verlag's database.

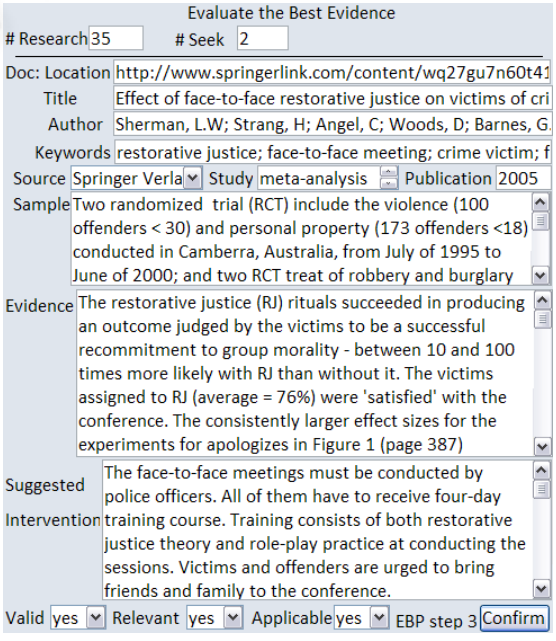

Figure 7: Evaluate the best evidence.

As shown in Figure 7, the document with the best evidence found was evaluated; its information was extracted and recorded in local database.

The decision making is presented in Figure 8. Data of the victim were informed and they are compatible with the best evidence founded. The victim agrees to participate in face-to-face meetings with the offender, provided that in previously established time and with the presence of authorities.

Victim support programs, with respect to psychosocial and psychiatric treatment, must be offered in this particular intervention.

The process concludes with documentation of the research performance made by judge.

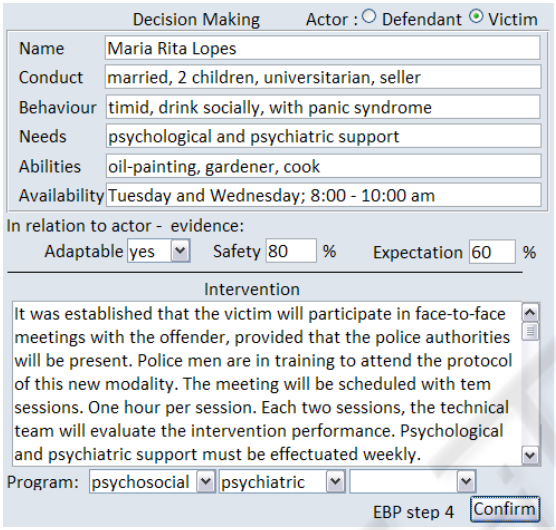

Figure 8: Decision-making.

6 RELATED WORKS

In this section we present some related work on the themes *evidence*, *context*, and *integration of evidence with context*.

In Stolba et al. (2009) is showed how Data Warehouse facilitating Evidence-Based Medicine can be applied for reliable and secure processing of huge amounts of medical data. The authors present a data model for building a federated Data Warehouse considering adopted international standards for the exchange of healthcare data.

Nakaya e Shimuzu (2006) present the Knowledge representation architecture based on Evidence based Logical Atomism (KELA) that consider the anatomic hierarchic structure from genome to human. Knowledge atoms of molecular and disease findings are modeled as entities and relationships - describes species, birthplace, and existing place as features in an entity.

Vieira et al. (2008) presents a domain-independent context metamodel, which guides context modelling in different applications. The metamodel offers integrated support for modeling structural and behavioral aspects involved in context management and usage. Contextual graph and UML were used.

Sheng and Benatallah (2005) introduce the ContextUML metamodel developed to support the modelling of context-aware Web Services. It separates context modeling (types, sources, etc.) from context-awareness modeling (objects and mechanisms) becoming restrict to the Web Services category of Context-Sensitive Systems.

Dobrow et al. (2004) emphasize the treatment of evidence with context. In a theoretical approach about Evidence-Based Decision-Making for health policy, the authors present a conceptual framework regarding the role of context in the evidence introduction, interpretation and application for decision-making support.

Kay et al. (2007) describe ONCOR, an ontology- and evidence-based approach applied to contexts. They provide an approach to build ontology of places, devices and sensors in ubiquitous computing in building environment. Locations, activities, services and devices are considered in ONCOR in order to treat context history to model indoor pervasive computing places.

The related works above regard individually evidence or context. The combination of evidence with context was developed for specific domains. But, none of them has the perspectives of integration and extension for several domains.

7 CONCLUSIONS AND FUTURE WORKS

This article proposes the integration of context with evidence represented in a conceptual framework to facilitate the development of applications centered in Evidence-Based Practice with the consideration of context for several domains.

The class structure of the framework was presented and used in the conceptual modelling phase for the area of crime prevention. Contextual information related to the EBP and specific of the criminal area were modeled and instantiated.

With a practical implementation for the Pernambuco state court, Brazil, we showed how contextual EBP can be used to support Judge's decision making. Besides, we verified that using

contextual information makes the retrieve and filtering mechanisms more effective.

Future researches encompass: (i) the incorporation of the classical case structure (problem, solution and result) into the conceptual framework and Case-Based Reasoning technique for decision making support; (ii) the creation of a semi-automatic Evidence-Oriented Information Extractor (EOIE); and (iii) the development of a computational tool for risk assessment.

REFERENCES

Brézillon, P. (1999). Context in Artificial Intelligence: I. A Survey of the Literature. *Computer and Artificial Intelligence*, v. 18, pp. 321-340.

Brézillon, P. (2007). Context modeling: Task model and practice model. *CONTEXT-07*, LNAI 4635**.** pp. 122-135, Roskilde, Denmark.

Bunningen, A, (2004). *Context Aware Querying - Challenges for data management in ambient intelligence*, Doctorate thesis, University of Twente.

Dey, A.K., Abowd, G. D. (2001). A Conceptual Framework and a Toolkit for Supporting the Rapid Prototyping of Context-Aware Applications. *Human-Computer Interaction (HCI) Journal*, v. 16, n. 2-4, pp. 97-166.

Dobrow, M. J., Goel, V., Upshur, R.E.G. (2004). Evidence-based health policy: context and utilization. *Social Science & Medicine*, Jan, 58(1), 207-17.

Friedland, D. J., Go, A. S., Davoren, J. B., Shlipak, M. G., Bent, S.W., Subak, L. L., Mendelson, T. (1998). *Evidence-Based Medicine: A Framework for Clinical Practice*. USA: McGraw-Hill.

Heneghan, C., Badenoch, D. (2006). *Evidence-Based Medicine Toolkit*. Oxford: Blackwell Publishing Ltd.

Henricksen, K., Indulska, J. (2006). Developing Context-Aware Pervasive Computing Applications: Models and Approach. *Pervasive and Mobile Computing Journal*, v. 2, n. 1, pp. 37-64.

Jorgensen, M., Dyba, T., Kitchenham, B. (2005). Teaching Evidence-Based Software Engineering to University Students. *Proceedings of the 11th IEEE International Software Metrics Symposium.* Washington, DC, pp. 24-31.

Kay, J., Niu, W. T., Carmichael, D. J. (2007). ONCOR: Ontology- and Evidence-based Context Reasoner. In *Intelligent User Interface - IUI'07*. ACM, pp. 290-293, Honolulu, Hawaii, USA.

Nakaya, J., Shimizu, T. (2006). Knowledge Architecture based on Evidence Based Logical Atomism for Translational Research. *International Journal of Computer Science and Network Security – IJCSNS*, February, v. 6, n. 2A, pp. 175-179.

Rocha, L. V., Edelweiss, N., Iochpe, C. (2001). *Geo-Frame-T: A temporal Conceptual Framework for Data Modeling.* ACM-GIS, 2001, 124-129.

Sackett, D.L., Straus, S.E., Richardson, W.S., Rosenberg, W., Haynes, R. B. (2001). *Evidence-based medicine: how to practice and teach EBM*. New York: Elsevier Health Sciences.

Salton, G. (1968). *Automatic Information Organization and Retrieval*. New York: McGraw-Hill.

Satterfield, J. M., Spring, B., Brownson, R. C., Mullen, E. J., Newhouse, R.P., Walker, B. B., Whitlock, E. P. (2009). Toward a transdisciplinary model of evidence-based practice. *The Milbank quarterly*. Blackwell Publishing, June, v. 87, n. 2, pp. 368-390.

Sheng, Q. Z., Benatallah, B. (2005). ContextUML: A UML-Based Modeling Language for Model-Driven Development of Context-Aware Web Services. In *Proc. of the International Conference on Mobile Business (ICMB05)*, pp. 206-212.

Sherman, L. W., Strang, H., Angel, C., Woods, D. J., Barnes, G. C., Inkpen, N., Bennett, S. B., Rossner, M. (2006). Effects of face-to-face restorative justice on victims of crime in four randomized, controlled trials. *Journal of Experimental Criminology*. Springer Netherlands, September, v. 2, n. 3, pp. 407-435.

Stolba, N., Nguyen, T. M., Tjoa, A. (2009). Data Warehouse Faciliting Evidence-Based Medicine. In Nguyen, T.M. (Ed.). *Complex Data Warehouse and Knowledge Discovery for Advanced Retrieval Development* (pp. 174-195). USA: Premier References Source.

Thomas, G., Pring, R. (2004). *Evidence-Based Practice in Education.* UK: Open University Press.

Vieira, V. (2008) *CEManTIKA: A Domain Independent Framework for Designing Context-Sensitive Systems*, Doctorate thesis, Federal University of Pernambuco, Brazil.

Warren, R. K. (2007). *Evidence-Based Practice to Reduce Recidivism: Implications for State Judiciaries.* Retrieved April 10, 2009, from http:// works.bepress.com/roger_warren/1