The Slow Wheels of Requirements Engineering Research: Responding to the Challenge of Societal Change

Return to Published Papers

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Abstract

Despite the significant Requirements Engineering (RE) research efforts over the past decade the research--industry gap still remains persistent. Recent attempts by the RE research community to address this issue include cumulative knowledge studies to describe the current state of RE research and the establishment of a new conference dedicated to the comparative evaluation of RE.

This paper reports the state of RE research from 2001 to 2005. A taxonomy of RE literature is presented and a conceptual framework for understanding the current state of RE is also described. The ensuing analysis shows that during the period 2001-2005 there was only an incremental development of RE research without any radical theoretical contributions to its body of knowledge. The paper also poses a challenge for the RE research community to respond to the dramatic changes in the social and business world.

1. RE as a Discipline

Over ten years ago, Jawed Siddiqi (1994, page 18) predicted "*Requirements engineering is likely to be a major issue in this decade*". Indeed, over the last decade, Requirements Engineering (RE) research has evolved and played a critical part in systems development through exploring, studying and addressing issues of concern to both developer and business communities. Over time, various understandings and definitions had to be formulated to support RE research and to distinguish it from its reference disciplines - such as software or system engineering (Loucopoulos and Karakostas, 1995; Zave, 1997; Kotonya and Sommerville, 1998); complex and multi-dimensional RE process were developed (Pohl, 1994); and socio-ethical aspects of RE were explored (Goguen, 1997). In the process, many useful definitions of RE have been proposed by numerous authors (Finkelstein, 1994; Nuseibeh and Easterbrook, 2000), one of the most popular can be attributed to Pamela Zave (1997):

> "*Requirements engineering is the branch of systems engineering concerned with the real-world goals for, services provided by, and constraints on a large and complex software-intensive system. It is also concerned with the relationship of these factors to precise specifications of system behaviour, and to their evolution over time and across system families.*" (Zave, 1997)

While recognising the complexity and diversity of perspectives in the discipline, Zave clearly classifies RE as a *branch of* systems *engineering*. Furthermore, as evidenced from the cumulative reviews of the progress in RE research, this view is not only shared by much of the RE community but it has also strongly influenced the evolution of RE research, its principal issues and agendas.

Anthony Finkelstein (1994) conducted one of the earliest examinations of such RE research issues and agendas. In the process, he identified seven key research areas that can be used to categorise and compare RE research exploits; they include:

- Context of a project;
- Groundwork necessary for RE activities;
- Acquisition of the "raw" requirements;
- Analysis of the requirements;
- Modelling and specification of requirements;
- Measurement approaches to controlling both the requirements and the RE process;
- Communication and documentation.

These key research areas evolved and became complementary to Zave's (1997) classification scheme, which identifies common RE problems and their typical solutions. Zave's dimensions include (1997):

- RE tasks such as requirements elicitation, validation, and specification
- Problems in carrying out the tasks such as barriers to communication, incompleteness, and inconsistency
- Solutions, i.e. RE methods and techniques, including formal languages, analysis algorithms, prototyping, metrics and traceability
- Types of system under study: embedded systems, safety-critical systems, distributed systems
- Research methods to contribute to knowledge: descriptions of current practice, case studies, controlled experiments

The reviews by Finkelstein and Zave (1994; 1997) indicated that early research efforts in RE placed considerable focus on the understanding of requirements and RE processes, as well as, the development of solution to RE problems in terms of methods, techniques and tools.

Having identified and assessed the then RE research effort in these key areas, Finkelstein (1994) pointed out: "*We lack an adequate understanding of the requirements engineering process as a whole*". In response to Finkelstein's (1994) call for the increase in RE process comprehension, very significant attempts were made to understand, describe, improve and control the RE process (Pohl, 1994; Loucopoulos and Karakostas, 1995; Kotonya and Sommerville, 1998).

More recently, Nuseibeh and Easterbrook (2000) offered a much more comprehensive roadmap to RE. Having recognised the multidisciplinary characteristic of RE, the authors discussed a number of theoretical foundations from related disciplines including sociology, anthropology, cognitive psychology, and linguistic and their relations to RE research. RE activities, as reported in the previous studies, were re-examined and consolidated into five core activities of Eliciting, Modelling and Analyzing, Communicating, Agreeing (on), and Evolving requirements. New research ideas emerged recognising the importance of context and a wider environment of RE projects. Interestingly, based on common limitations of the past research effort, Nuseibeh and Easterbrook (2000) suggested future

challenges to RE. These include the need for modelling and analyzing the environment, the increasing gap between requirement elicitation and formal specification, the demand for richer models of non-functional requirements (NFR), the impact of software architecture, and a need for the multidisciplinary education for requirements practitioners.

Recently, Gervasi et al. (2004) and Opdahl et al. (2004) conducted a review of research papers published at a series of ten consecutive annual workshops Requirements Engineering – Foundation of Software Quality – one of the mainstream forums in RE research. Both the statistical lexical analysis (Gervasi *et al.*, 2004) and the qualitative analysis (Opdahl *et al.*, 2004) described a chronological account of evolution of RE and its research focus between 1994 and 2004. While importance of research on requirements, processes, and relations of RE with other System Development Life Cycle (SDLC) phases was shown to be increasing, other research interests were also disclosed and included the issues of quality, RE activities, business procurement, hypertext and hypermedia. Opdahl et al. (2004) revealed also a growing preoccupation of RE researchers with COTS and market-driven development, the emergence of frameworks to study non-functional requirements – those areas previously identified as challenges in Nuseibeh and Easterbrook's work (Nuseibeh and Easterbrook, 2000).

The above mentioned reviews have often been referred to as the "state of the art" or in other words the current state of RE research at different points of time over the last decade. Worryingly, at the recent conference REFSQ 2006, delegates viewed the landscape of the current RE research with degree of scepticism and soberly acknowledged today's problems and the barriers to the future of RE research:

'The last decade has seen improvements in our understanding of RE with better practices supported by better techniques, methods and tools. Despite these successes, many quality-related problems remain, while new challenges for RE constantly emerge'.[1]

In view of these challenges, this paper describes yet another attempt at gaining the cumulative understanding of recent RE research for the period of

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[1] http://discuss.it.uts.edu.au/pipermail/re-online/2006-March/000338.html

2001 to 2005, and reports on efforts in detection of trends emerging in the current RE research.

The first contribution of this study is a considerable extension to the accumulated knowledge about RE research. As Bob Galliers (1991) points out, researchers fail to develop historical repositories of relevant domain knowledge, which is necessary to ensure that subsequent work builds on past endeavours.

The second contribution is the proposal of a taxonomy of RE research that provides a framework for describing and analyzing the current and future states of RE research. The taxonomy differentiates itself from the previously identified studies in this area in that it takes into account both the RE as subject under study "*what is being studied*" and the research approach "*how RE research is being conducted*".

This subsequent discussion is organized as follows. Section Two describes the conceptual framework developed based on a synthesis of previous reviews and debates about the state of the art in RE research. The framework was adopted as a taxonomy for the review of the RE publications from 2001 to 2005 inclusively. Section Three outlines the research approach employed for this study. Section Four presents and discusses the results and provides a summary of the key findings. Section Five summarises and reflects on the conducted work. Finally section Six concludes the paper by discussing implications, contributions and limitations of this research and outlines future research and recommendations.
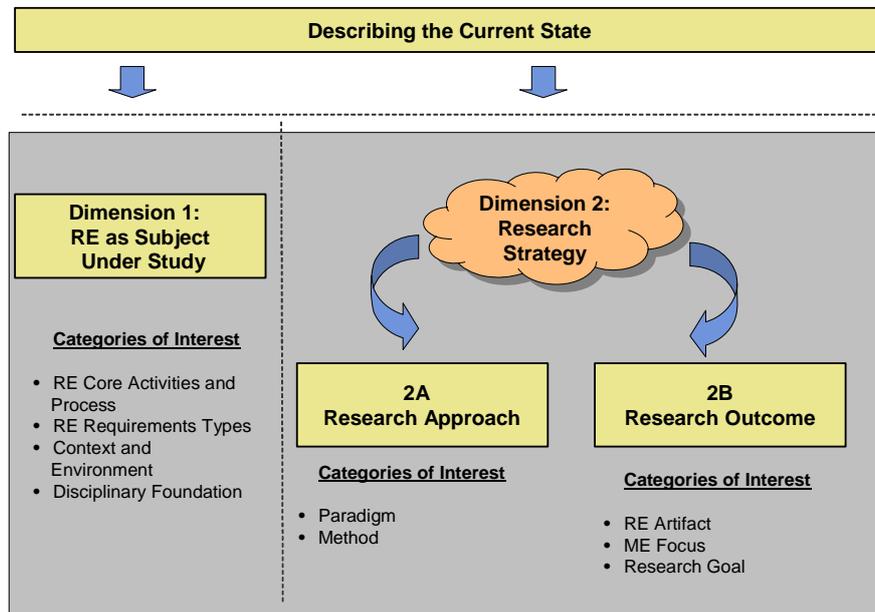
2. A conceptual framework for the review

Figure 1: Conceptual Framework for Review of RE Research 2001 to 2005

The conceptual framework for this study, presented in Figure 1, is based on four seminal RE papers by Hsia et al. (1993), Finkelstein (1994), Jarke and Pohl (1994), and Nuseibeh and Easterbrook (2000). Each of these papers describes a snapshot of RE research up to year 2000 and contributes distinct aspects of RE knowledge, which spans two research dimensions, i.e. the subject under study that is related to some aspect of RE knowledge and the research strategy employed to conduct the reported study. Each dimension is described in the following sections.

2.1 First Dimension: RE as Subject under Study

The purpose of this first dimension is to situate the RE research within the RE domain and to describe the researcher's area of interest. Within the dimension, four major categories of interest have been identified and their description derived from the work of the following researchers: Hsia et al. (1993), Finkelstein (1994), Jarke and Pohl (1994), Nuseibeh and Easterbrook (2000), Loucopoulos and Karakostas (1995), Sommerville and Sawyer (1997), Kotonya and Sommerville (1998) and Zave (1997).

2.1.1 RE Core Activities and Process

This category of interest allows identifying subtasks or activities within the RE process under investigation. Nuseibeh and Easterbrook (2000) identified five such core activities, which in our study are used as sub-categories, these include: Eliciting Requirements, Modelling and Analysing Requirements, Communicating Requirements, Agreeing (on) Requirements and Evolving Requirements. These core activities represent both the technical and social dimension of RE and are often referenced in the RE literature (see for example Loucopoulos and Karakostas, 1995; Christel and Kang, 1992; Sommerville and Sawyer, 1997; Kotonya and Sommerville, 1998).

2.1.2 RE Requirements Types

RE by nature is about its core activities, such as eliciting, specifying and representing requirements. Requirements and their types are seldom even mentioned in an open and explicit fashion.

The purpose of this category is therefore to identify research efforts dedicated to requirements in their own right and not as an output or input into a core activity such as elicitation and modelling and analysis, and not as part of the secondary research goal.   For example, requirements are broadly

classified into either functional or non-functional and within non-functional there are particular kinds such as safety, security, reliability and usability (Gervasi *et al.*, 2004; Nuseibeh and Easterbrook, 2000; Opdahl *et al.*, 2004).

2.1.3 Context and Environment

Context can be defined as a set of facts or circumstances that surround a situation or event. In Computer Science, *environment* often refers to the entire set of conditions under which one operates a computer, which relates to hardware, operating platform or operating system.

Jarke and his colleagues (Jarke *et al.*, 1993) take a different approach to contextualising requirements by identifying distinct 'worlds' of requirements issues, which includes a development world, subject domain world, machine world, usage world, etc. Based on this understanding, in our study, environment describes the circumstances that set the scene for a RE research project and range from the immediate context of Project Management and SDLC, business domains, organizational and business context, to a broader social environment.

2.1.4 Disciplinary Foundations

Disciplinary foundations identify reference disciplines used in a paper as a *source* of theory or context. It was earlier acknowledged that RE commonly defines its root position as a branch of systems engineering, it is therefore heavily informed by software engineering (SE), computer science (CS) and information systems (IS). It is not uncommon, however, for RE publications to discuss social and ethical issues (for example see Goguen, 1997; Jirotka and Goguen, 1994) or be concerned with cognitive and linguistic phenomena (Nuseibeh and Easterbrook 2000).

2.2 Second Dimension: RE Research Strategy

The inclusion of research strategy reflects an emerging interest in research approaches and methods utilized within the fields of IS and SE. This is particularly well evidenced by conferences such as PACIS 2003, CAIS 2004, ACIS 2004 and CERE 2004 calling for papers into understanding and comparing of research methods, as well as, research validation in RE.

As a result, a number of authors have investigated research methodology trends in IS and SE (Palvia *et al.*, 2004; Davis and Hickey, 2004; Sutcliffe, 2004; Glass *et al.*, 2004; Liang, 2003; Mingers, 2001; Alter, 2005; Becker *et al.*, 2004).

Additionally there has been much exploration and debate surrounding the need to embrace pluralist research perspectives, adopt multi-paradigmatic approaches and the need for theory development, especially in IS (Gregor, 2002; Orlikowski, 1991; Mingers, 2001).

Given that RE defines its root position in systems engineering, it is of interest to determine whether RE research is encumbered by research approaches and methods applied in the broader domain of SE, e.g. as investigated by Glass *et al* (2004).

2.2.1. Research Approaches

Research approaches reported in RE publications are often given in terms of their paradigm and their methods, both of which are often sourced from the work by Galliers (1991) and Neuman (2000).

Paradigm reflects the basic beliefs and assumptions which guide the research design and the two most widely cited include positivist and interpretivist (Orlikowski, 1991).

2.2.2 Research Outcomes

The type of theoretical contribution made by a particular study is commonly the most distinguishing feature of any scientific writing.

The research theoretical contribution can be effectively classified using Neuman's (2000) taxonomy of research goals such as descriptive, explanatory, exploratory and evaluative and Zave's (1997) types of artefact produced such as method, tool or framework.

Method and tool artefacts are further classified in terms of their alignment with the Truex and Avison (2003) framework of method engineering (ME) which is firmly based in the information systems theory. Our interest in Truex and Avison (2003) method engineering stems from Siddiqi's (1996) observation that RE method and tool development is closely following trends in information systems development.

2.3 Conceptual Framework Summary

The conceptual framework described above forms an initial taxonomy for the review of 241 publications from 2001-2005.

The dimensions outlined offer two conceptual lenses to understand a specific RE study. The categories of interest and their underlying concepts, which reflect cumulative RE research state reviews and some widely cited notions and their associated research strategies. Although this framework represents predominantly a priori concepts, it remains

flexible enough to allow capturing the emerging concepts during the data collection and analysis phase of the study.

In comparison to the past studies undertaken by Hsia et al. (1993), Finkelstein (1994), Jarke and Pohl (1994) Nuseibeh and Easterbrook (2000) this framework extends the understanding of the current state to include the Research Strategy. These past studies have focused predominantly on Dimension One, i.e. RE as Subject under Study.

3. Research Approach

3.1. Research Method Used in this Study

The primary objective of this study is to obtain a description of RE research evolution from 2001 to 2005. A survey of publications during this period was conducted in 2006. Content analysis (Krippendorff, 2003) was used for the purpose of identifying the existence and frequency of concepts associated with the RE Subject Under Study and RE Research Process. This allowed an inductive interpretation of the text contained within RE research papers during the meaning extraction and interpretation phase of the research process.

Similar research methods have been reported as useful in recent analytic literature surveys within IS, SE and CS (Glass *et al.*, 2004; Liang, 2003; Mingers, 2001; Becker *et al.*, 2004; Palvia *et al.*, 2004).

3.2. Data Collection

The population of interest includes RE research papers that have been published in mainstream conferences and journals between 2001 and 2005.

These papers were collected using a keyword search on "Requirements Engineering" across on-line databases associated with the disciplines of SE, IS and CS and were collected manually from RE publication venues such AWRE and RESFQ. These searches yielded an initial sampling frame of 1108 RE research papers representing 171 unique publication sources.

The 171 unique publication sources were classified into the following source categories: primary conference, primary journal, secondary conference and secondary journal. A primary conference or journal can be defined as a conference or journal dedicated specifically to promoting the RE discipline. A secondary conference or journal is defined as a conference or journal in a wider context of SE, IS and CS.

Finally the 1108 papers were stratified by year by source category and the final sample size of 241

being 21.75% was randomly selected within each stratum of year by source category. This ensured a diverse and unbiased sample for content analysis.

Publication sources contributing to the final sample papers are identified in Table 1.

Source Classification	Publication Source
Primary Conferences	• Australian Workshop on Requirements Engineering • IEEE RE • International Workshop on Requirements Engineering: Foundations for Software Quality
Primary Journals	• Requirements Engineering Journal
Secondary Conferences	• Americas Conference on Information Systems • International Conference on Software Engineering
Secondary Journals	• Software IEEE

Table 1: Publication Sources represented in the final sample

3.3. Data Analysis

The analytical construct for this study has been developed using the content analysis guidelines prescribed by Krippendorff (2003). It takes into consideration important decisions concerning concept identification and translation rules to ensure consistent coding.

The conceptual framework described in section two forms the initial taxonomy built on predetermined concepts derived from the RE domain. During the coding process this taxonomy evolved to capture emerging concepts. This resulted in a combination of pre-determined and interactive coding.

Translation rules have been addressed through the development of operational definitions for the a priori concepts to increase the reliability and repeatability of the coding process. Rules were also established to identify mutually exclusive concepts and to guide the capture of single or multiple occurrences with each category of interest.

The results, though derived from qualitative data are represented quantitatively using techniques associated with nominal data. Nominal level data can be analyzed using methods such as frequency counts and distribution, proportions and percentages and pictorial representations such as bar charts and pie charts (Blaikie, 2003). Therefore the final analysis can be supported with quantitative representations

4. Findings

Findings are presented by Dimension and Category of interest as described in Figure 1. Where findings have been represented using graphs it is important to note that in some cases the total frequency counts will not match the final sample size of 241. This is due to the one to many relationships that exist in the coding scheme for some concepts e.g. a single paper can be coded for multiple RE core activities.

Overall, no new major categories have emerged. However, there have been emerging trends at a lower level of the conceptual framework.

4.1 First Dimension – RE as Subject under Study

4.1.1. RE Core Activities and Process

RE research spanning the years 2001 to 2005 seems to primarily favour the technical RE dimensions to the detriment of the social dimensions (see Graph 1).

RE core activities associated with the technical dimension of RE include Modelling and Analysing Requirements, Eliciting Requirements and the RE process per se and these represented 73% of the observations recorded for RE Core Activities. The social aspect of RE accounted for 27%. There has been a steady interest in Agreeing Requirements during this period and a decline in Communicating Requirements.

Studies of the RE Process appear to have shifted away from the generic 'one size fits all' RE process models to a broad understanding of the applicability and utility of RE process models across specific systems (Bleistein *et al.*, 2004; Gibson, 2004; Tagg, 2004). Work on RE process quality and improvement still remains popular.
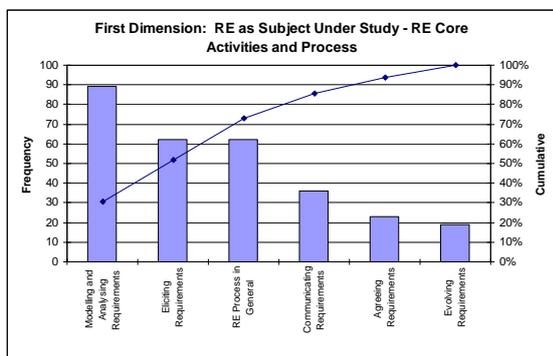
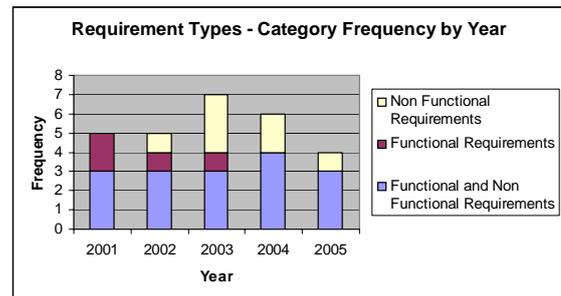**Graph 1**: RE Research 2001 to 2005: Number of Papers coded for the presence of RE Core Activities and Process

As demonstrated nearly 10 years ago by Zave (1997), RE research themes associated with RE core activities and process continue to demonstrate high levels of heterogeneity.

Current research activity shows both an absence and presence of addressing past research recommendations made prior to 2001 however no significant trends are discernible within this sample.

4.1.2. RE Requirements Types

The sample indicates minimal research activity dedicated to defining and describing requirement types per se (see Graph 2). Only 27 papers out of 241 or 11% dedicated themselves to the subject of RE Requirements Types. The graph below shows the distribution of these papers by year by requirements type category.

A trend was noted in the increasing frequency of work associated with functional and non-functional privacy and security requirements. Of the 27 papers in this space 11 of these (40%) were associated with privacy and security requirements. This indicates a response to the growing concerns security and privacy issues on the Internet and terrorism threats.

Graph 2: RE Research 2001 to 2005: Number of Papers coded for the presence of Requirement Types

4.1.3. Context and Environment

The top three Context and Environment factors used to situate research or bound scope are System Type, Industry Specific Case Studies and Software Development Methodologies (see Graph 3).
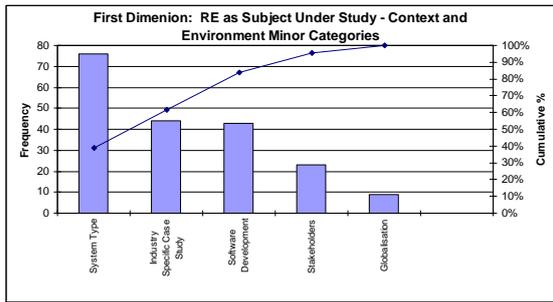
Graph 3: RE Research Papers 2001 to 2005: Number of Papers coded for the presence of Context and Environment factors

Over the last five years 80% of research activity associated with system types has been around COTS, e-business or e-commerce. This is consistent with the findings of Opdahl et al (2004). In the remaining 20% there is high diversity of system types being referenced with no apparent trends or patterns.

Industry specific case studies represented are very broad and very diverse over the entire five year period of the study.

A similar phenomenon is also noted in the category of software development where 80% of this context-related research activity exhibits very high diversity. The most referenced Software Development Methods used to establish context or environment are market driven product development, goal oriented RE and viewpoint RE.

Education for Requirements Engineers and/or Developers and Stakeholder analysis appear to be popular research themes associated with stakeholders.

There was weak evidence suggesting that RE research is driven by global or external environmental factors, such as globalisation, government regulation or deregulation, global economy (2001; 2003), or development from other branches of sciences, to situate its trends or to turn to these factors as a catalyst to proactively identify future research directions.

4.1.4 Disciplinary Foundation

There is significant diversity in the disciplines being referenced outside of SE (see Table 2). The a-priori framework commenced with the disciplines discussed by Nuseibeh and Easterbrook (2000) and increased during the coding process.

The most frequently occurring theories are being drawn from Business Management Science and Management Information Systems. Within Business Management Science, Organizational Theory is most frequently referenced and within Management

Information Systems the themes of security and risk management are prevalent.

Although there has been an increase in multi-disciplinary referencing over the past five years i.e. the use of two or more disciplines, this only accounts for 30% of the sample for this period. The inclination towards self-referencing remains prevalent and reflects practice within the broader SE domain as observed by Glass *et al* (2004).

	Proportion of Papers with more than two references	**Number of Papers with two or more references**	**Total Papers for Year**
2001	**22.92%**	11	48
2002	**24.00%**	12	50
2003	**34.04%**	16	47
2004	**32.69%**	17	52
2005	**38.64%**	17	44
Total	**30.29%**	**73**	**241**

Table 2: RE Research 2001 to 2005: Proportion of Research Papers drawing on more than two disciplinary foundations

4.2 Research Strategy

4.2.1 Research Approaches

RE research exhibits significant variation in the amount of disclosure or explicitness about the chosen research strategy and design (see Graph 4).

In those studies, which explicitly state their research approach, the positivist research paradigm seems to dominate at 63% of the sample with interpretivist at 20% and Design research at 17%.

The most popular research methods reported in the past five years have been Argumentative or Conceptual Development and Case Studies. At the same time, there is a noticeable trend in the decline of Argumentative or Conceptual Development in favour of case studies from 2001-2005. These methods are commonly being applied to study the most favoured core activities of Modelling and Analysis, Elicitation and RE Process.
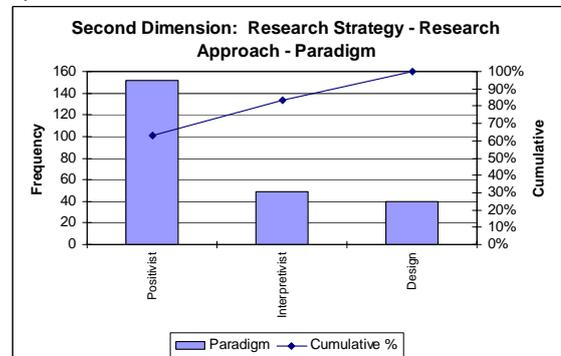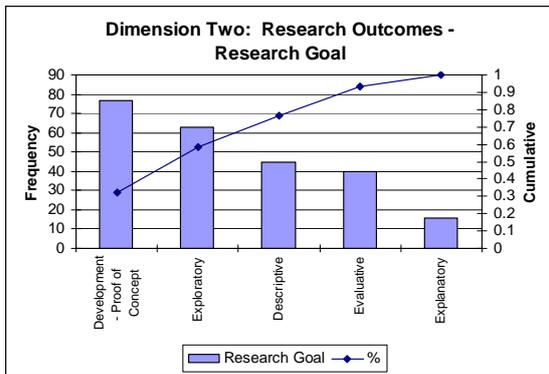
Graph 4: RE Research 2001 to 2005: Frequency of Papers based on Research Paradigm

We found no evidence of multi method use (i.e. pluralism). These findings appear to be consistent with Mingers (2001) and Glass *et al* (2004) who indicate that IS research uses a narrow range of research methods with little multi method use. This could be due to the publication format and review practice?

4.2.2 Research Outcomes

The most popular research goal for the five-year period (see Graph 5) was Development whether Proof of Concept or Exploratory in nature. However, between 2002 and 2003 Evaluative research goals increased substantially over those based on Development however from 2003 the inverse has occurred.

Graph 5: RE Research 2001 to 2005: Frequency of Papers by Research Goal

The two artefacts that dominate RE research (see Graph 6) are 1) RE Methods and Tools and 2) New Theories.

While there is sustained research activity associated with the development of RE Methods and Tools 80% of the resultant artefacts are aligned at the lower levels of method engineering evolution that are synonymous with development and improvement. This is consistent with the focus prior to 2001.
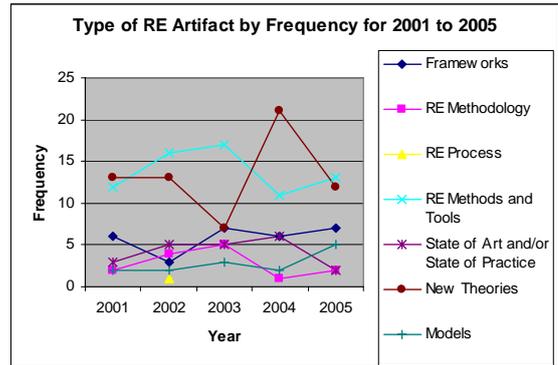
**Graph 6**: Types of Research Artifacts produced by RE Research 2001 to 2005

5 Discussion

5.1 Subject under Study

Current research tends to favour the technical dimension of RE as opposed to its social dimension. The three core activities being most vigorously investigated are Modelling and Analysis, Elicitation and RE Process. At this high level of focus, findings are consistent with the research focus prior to 2001.

Research associated with the RE Process appears to have shifted away from the generic 'one size fits all' process models to a more realistic one aiming at understanding the applicability and utility of the RE process across a diverse range of system types. Research interest still exists in the RE process quality and improvement.

Overall, the RE methods and tools research continues to follow the trends in method engineering (ME) (Truex and Avison, 2003). It seems, however, that RE slightly lags behind ME in its maturity. RE research can be best positioned at Level 1 and 2 of ME classification (see Chart 7), which is synonymous with standardization and merely filling in the gaps. Since 2003, there has been an increase in focus towards inter-connecting methods which is considered ME level 3. As a result there is still significant volume of research dedicated to the development of methods and tools as opposed to their rigorous evaluation. This is similar to the research landscape before 2001.
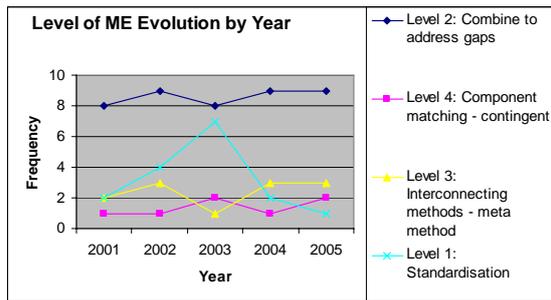
Graph 7: Level of ME Evolution by Year

Research themes and focus for RE Subject under Study continue to exhibit high heterogeneity as found in categories such as System Types, Software Development Methodologies, Disciplinary Foundations and Industry Domains used for case studies. This implies considerable complexity and fragmentation.

There are still no significant trends or patterns; no major categories have been noticed to emerge. Some recent trends, such as education of Requirements Engineers, focus on privacy and security requirements, e-business, e-commerce, business alignment exist but not in sufficient quantity to be considered a major trend or pattern. Other recent trends, such as agile RE, service-oriented, creativity, expected to appear as a result of special themes in conferences and workshops; again, however, their number was not significant.

Some evidence exists that the past research recommendations, such as those made pre 2001, are slowly being addressed; nevertheless, almost equally strong evidence suggests that some of these recommendations - for example, the need for multi-disciplinary training, contextual approaches to RE, or environment analysis - have not been addressed at any level of significance.

Overall, the findings suggest that current research focus appears to be an uninspiring continuation of research pre 2001, though it is suspected that some shifts and trends are happening at a considerably lower level of detail. This indicates a period of incremental evolution in RE research, a period of stability during 'normal science' (Kuhn, 1970).

5.2 Research Process

RE Research Strategies and Outcomes represent a microcosm of the SE and IS domains. The disciplinary similarities are concentrated around the development of methods and tools - the findings in agreement with those of Glass (2004). Findings are also consistent with Mingers' (2001) who claims that

RE exhibits tendency to rely on multi paradigm research; at the same time, there is only a narrow range of research methods being adopted in RE and there is weak evidence of multi method use.

Concerns exist that RE focus is still around early evolutionary stages of ME. There is little advancement on higher levels of RE conceptualisation, still the RE domain is displaying a limited degree of conceptual development and new framework formulation.

Palvia et al. (2004) claim a reduction in theories and frameworks of RE, which could be interpreted as increasing the level of maturity within a domain. Since our findings indicate that there exist a noticeable proliferation of continually emerging frameworks and theories, this means that the RE domain is still developing and its maturing is far from over. Again, this indicates that during 2001-2005 RE was in a period of 'normal science' stability and it did not undergo any significant 'paradigm shifts' (Kuhn, 1970). It is not clear, however, whether the RE domain is currently in a state of flux or stagnation, or whether a natural cycle of reinvigoration is occurring after the RE domain reached a certain level of maturity.

6. Conclusion and Future Work

At a high conceptual level, RE research is continuing along the same path as it was before 2001. It continues to exhibit an incremental evolution with high diversity and lacking the apparent trends or patterns of any significant nature. At a lower level of analysis there have been minor shifts in focus. In one way, in the absence of a complete and universally accepted classification framework and the short period selected for the study, it is difficult to identify any significant change that could be considered as the 'paradigm shift'.

The relative stability in RE research is not necessarily detrimental to the overall RE development, nevertheless, it a rather surprising trend. Our world is currently undergoing very rapid changes (see Figure 2), e.g. in the IT we experience the second wave of e-commerce take up, in Politics the threats of terrorism dominate the news, in Business we can see the emergence of new forms of business dependent on global interactions, in the Environment we all suffer from the climate change and green house effects, in Sociology we cannot estimate the impact of the rapidly aging population (for example Turban *et al.*, 2001; Avison and Fitzgerald, 2003), etc. While all these external factors

and uncertainties have the potential to shape and influence the future direction of RE research and practice, the RE seems rather passive, slow and unresponsive to the world dynamics and changes. Possibly, the RE as a research domain has traditionally been looking inwards and relied on the 'internal' motivators driving the RE research directions. We believe, however, that the RE community needs to face up to the challenge of exploring new research opportunities using the 'external' motivators and be stimulated by changes in business and the society.
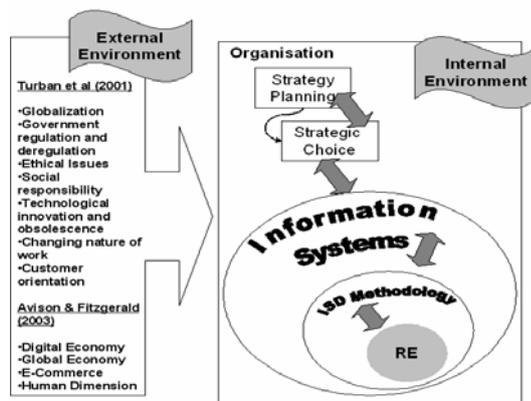

Figure 2: RE as situated within the internal and external environment

In conclusion, this paper explored two problems in the RE research. The first is related to the research --industry gap that has persisted for years, and considering RE's slow development, it is likely to persist well into the future. The second relates to the predominantly internal motivation of RE research, which results in its slow response to external change. However, being an interface between organisations and technology and providing the human element to any IT or IS development, RE should become more responsive to the dramatic changes in the social and business world and should proactively act as an enabler to business innovation and social changes using the emerging technologies.

In view of the suggested new role for RE, we suggest possible extensions for this study through applying various future studies research methods to identify possible lead visions and opportunities for RE research which is influenced by and, through innovative applications of ITC, influences the rapidly changing business and social world.

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