



Technical Report N° 2006/13

Protocol for a Systematic Literature Review of Motivation in Software Engineering

***Sarah Beecham
Nathan Baddoo
Tracy Hall
Hugh Robinson
Helen Sharp***

5th October 2006

***Department of Computing
Faculty of Mathematics and Computing
The Open University
Walton Hall,
Milton Keynes
MK7 6AA
United Kingdom***

<http://computing.open.ac.uk>

MoMSE

Modelling Motivation in Software Engineering

Systematic Review – Cover Sheet

Review Title: Protocol for a Systematic Literature Review of Software Engineer Characteristics and Motivation

Reviewer Name: Sarah Beecham

Researchers involved in piloting the Systematic Review:

Nathan Baddoo, Tracy Hall, Dorota Jagielska, Hugh Robinson, Helen Sharp

Contact Information:

Sarah Beecham

University of Hertfordshire, Hatfield, Herts AL10 9AB

s.beecham@herts.ac.uk

Protocol for a Systematic Literature Review of Motivation in Software Engineering

Preamble

Motivation is a crucial factor in software productivity and software failure (MoMSE 2005). The proposed study brings together published work in the field of software engineer motivation by following systematic literature review guidelines (Kitchenham 2004) for the first time. The literature review aims to summarise research studies related to our research questions in a way that is fair, rigorous and auditable.

As recommended by ¹Kitchenham (2004) we consider the wider implications of our research. This study has a broad justification because it could help software engineers to understand factors affecting software quality and productivity. For example, understanding and applying motivation approaches that tap into the true needs of software engineers could lead to less absenteeism and improved levels of staff retention. We note however, that factors affecting software quality are very varied and multidimensional and that motivation may only play a small part in influencing the quality of the software product. Noting this limitation, a synthesis of the literature on software engineer characteristics and motivation may reveal discrepancies between beliefs, anecdotes and the current state of practice.

1. Background

The proposed systematic literature review is concerned with a crucial but neglected area of software engineering – *the motivation of software engineers*. While there is increasing recognition that motivation in software engineering may be problematic, no studies have been undertaken to bring together the studies of motivation in a software engineering setting (MoMSE 2005).

Motivation is increasingly cited as a particularly pernicious people problem in software engineering. In DeMarco and Lister's 1999 survey, motivation was found to be one of the most frequently cited causes of software development project failure (DeMarco and Lister 1999). The Standish report (1995) amplifies this finding by reporting that having access to competent, hard working and focused staff is one of ten success criteria for software projects.

The studies in this area suggest that conventional approaches to motivation within the industry might be outdated. They have concentrated on rewards and recognition, e.g. (ProjectLink 2006), whereas some experts have identified software engineers as having a distinctive personality profile (Capretz 2003) that are instead motivated by the nature of the job, e.g. technical success and challenging technical problems (Couger and Zawacki 1980).

The literature is presenting mixed messages relating to software engineer motivation. For example, a body of work found that programmers and analysts have lower

¹ The idea and structure of this protocol stems from Kitchenham's (2004) guidelines for systematic reviews

measured needs for social interaction and higher growth needs than the general population, e.g., (Couger and Zawacki 1980; Couger and Adelsberger 1988; Khalil et al. 1997). The literature often characterises IT employees as a homogeneous group of high achievers (Couger and Zawacki 1980; Capretz 2003). These studies suggest that IT employees are somehow different to non-IT employees, a view reinforced by Wynekoop and Walz (1998) who found “important differences in personalities exist between IS employees and the general population”.

On the other hand, Ferratt and Short (1986) question the existence of differences between IT and non-IT employees. They found that IT employees within the technical-professional and managerial sub-occupations of IT employees were not more motivated by achievement needs than corresponding subgroups of non-IT employees. Although they did find that meaningful work was the highest motivator for these IT subgroups.

To summarise, the prevalent view in the IT literature suggests that IT employees are homogeneous in their needs and that IT employees are motivated by the same employment arrangement, e.g., see (Wynekoop and Walz 1998). Yet according to a recent human resources study (Enns et al. 2006) “managers should look beyond the stereotypes and strive for a richer understanding of their IT professionals”. We therefore construct several research questions to gain a broad view of the research on software engineer characteristics and software engineer motivation.

2. Research Questions

We considered whether our general research question “Does Software Engineer motivation affect software productivity?” is suitable for investigation by systematic review. *Prima facia* this question does not closely match the type suggested by Kitchenham (2004) where the emphasis is on assessing how technology is adopted in/affects software engineering. Our work perhaps relates more closely to the root of the guidelines provided by the medical literature. We can adapt a medical theme, “Assessing the economic value of an intervention or procedure”, to “Assessing the economic value of applying motivation approaches in software engineering”.

Initial research shows very little work in the area of the economics of motivation in software engineering. However, before answering our research question “Does Software Engineer motivation affect software productivity?” we need to know the characteristics of a Software Engineer. This is because we need to understand where Software Engineers are placed in terms of the generic models of motivation found in the psychology, sociology and organisational behaviour texts. When we have a grasp of these characteristics we can ask: what motivates software engineers; how existing motivation theories are adopted in practice; and how motivation impacts productivity. To ensure that we do not exclude relevant work in this area, we also look at software engineer de-motivators.

2.1 Five research questions

To assess the economic value of applying motivation approaches in software engineering, we ask five questions:

- RQ1: What are the characteristics of Software Engineers?*
RQ2: What (de)motivates Software Engineers to be more (less) productive?
RQ3: What are the external signs or outcomes of (de)motivated Software Engineers?
RQ4: What aspects of Software Engineering (de)motivate Software Engineers?
RQ5: What models of motivation exist in Software Engineering?

2.2 Constructing Search terms

The following details of the population, intervention, outcomes, and experimental designs of interest to the review will form the basis for the construction of suitable search terms later in the protocol (Section 3.2). We note however, that not all research questions require intervention.

Population: Software Engineers

Intervention: motivation approaches, productivity measures

Outcomes of relevance: Software Engineer characteristics; motivational factors; results of applying motivational methods, change in productivity (to include quality and timescales), models of motivation.

Experimental design: Empirical studies, theoretical studies, expert observation, experience reports.

An example a research question that includes these details is:

RQ2:

[What (de)motivates]

[Software Engineers]

to be

[more(less) productive]

INTERVENTION

POPULATION

OUTCOMES OF RELEVANCE

The **experimental design** is not included in the research question. We are ‘open’ to the types of study we include as there don’t appear to be ‘standard’ study approaches in the area of SE motivation. This is possibly due to the multi-disciplinary nature of the research questions. Motivational issues are addressed both empirically and theoretically. Empirical studies include ethnographic observational studies, action research, questionnaires, individual interviews and focus groups. Theoretical studies are those not based on an experiment or direct observation, for example when an expert makes observations and draws on some of the motivational literature more associated with psychology and sociology and organisational behaviour. Until the literature review is complete, it is not possible to predict whether there is a general approach to recognising SE motivation issues. Appendix A: section 3.2 (inclusion criteria) relates to experimental design and our quality assessment covers experimental design in more detail (section 4.1.3). All papers in our review will categorise the experimental design as reported in our Endnote fields under ‘Type of Study’, see section 4.1.2. On completion of the systematic literature review, this categorisation will allow us to identify whether there is a standard study approach, and will also allow us to conduct sensitivity analyses based on experimental design.

3. Search Strategy

3.1. Identifying search terms for automated searches

The strategy used to construct search terms is as follows:

- a. derive major terms from the questions by identifying the population, intervention and outcome;
- b. identify alternative spellings and synonyms for major terms;
- c. check the keywords in any relevant papers we already have;
- d. when database allows, use the Boolean OR to incorporate alternative spellings and synonyms;
- e. when database allows, use the Boolean AND to link the major terms from population, intervention and outcome.

Results for a)

For clarity, terms for each research question are given separately.

RQ1: Software engineer, characteristics (*no intervention – based on observations*)

RQ2: Software engineer, (de)motivation, productivity measures

RQ3: *(de)motivation, impact, software engineering (*search terms used in this question were based on RQ “What is the impact of de motivation on Software Engineering” designed to uncover external signs of de-motivated engineers)

RQ4: aspects, software engineering, (de)motivate, software engineer

RQ5: model, motivation, software engineering.

Results for b)

* = truncation

Software engineer: (software OR information technology OR information system* OR comput* OR IT OR IS) AND (engineer* OR developer* OR professional* OR programmer* OR personnel OR people OR analyst* OR team leader* OR project manager* OR practitioner* OR maintainer* OR designer* OR coder* OR tester*)

Characteristics: characteristic* OR types OR personality OR human factors OR different OR difference* OR psychology OR psychological factors OR motivator* OR prefer* OR behavio*r*

Motivation: motivat* OR demotiv* OR de-motiv* OR satisf* OR inspir* OR prompt* OR morale OR encourage* OR manage OR induc* OR provoke* OR trigger off OR caus* OR incentive* OR drive* OR morale OR enthusias* OR impetus OR stimul* OR spur OR driving force* OR impuls*

Productivity measures: productiv* OR factor* OR output OR efficien* OR interact OR yield OR production OR creat* OR prolific OR industrious OR fruitful OR dynamic OR hinder OR resist* OR increase* OR decrease*

Software engineering: {Software Engineering} OR {Software Development} OR {Information Technology} OR IT OR {Agile Development} OR {Open Source Development} OR {Open Source Systems} OR OSS OR {Information Systems} OR

IS OR {Extreme Programming} OR XP OR {Agile Programming} OR {Systems Engineering} OR {Systems Development OR Computing}

Results for c)

Titles and keywords of important publications were updated as a result of validating our search terms. Early versions of searches failed to capture relevant known works such as the studies of Couger, Baddoo and Capretz.. Adding the following ensured these works (and others not yet known), were retrieved:

Words: Software Practitioner, Software Professional, Personality

Acronym: IS

Different spelling: de-motivator

Results for d) and e)

Search Terms (as trialled in Compendex - notation will be changed to suit each database). Appendix C provides a lookup table that maps databases to their search strings. As some databases have different syntax and search rules, the example below will often be modified and sometimes simplified (see section 3.2 for list of Databases)

RQ1

(((((software OR {information technology} OR {information system*} OR system* OR comput* OR IT OR IS)wn TI AND (engineer* OR developer* OR professional* OR programmer* OR personnel OR people OR analyst* OR {team leader}* OR {project manager}* OR practitioner* OR maintainer* OR designer* OR coder* OR tester*) wn TI) AND (((characteristic* OR types OR personality OR {human factors} OR different OR difference* OR psychology OR {psychological factors} OR motivator* OR prefer* OR behavio*r*)wn TI)))

RQ2

(((((software OR {information technology} OR {information system*} OR system* OR comput* OR IT OR IS)wn TI AND (engineer* OR developer* OR professional* OR programmer* OR personnel OR people OR analyst* OR {team leader}* OR {project manager}* OR practitioner* OR maintainer* OR designer* OR coder* OR tester*) wn TI) AND ((motivat* OR demotiv* OR de-motiv* OR satisf* OR inspir* OR prompt* OR morale OR encourage* OR manage OR induc* OR provoke* OR {trigger off} OR caus* OR incentive* OR drive* OR morale OR enthusias* OR impetus OR stimul* OR spur OR {driving force}* OR impuls*)wn AB AND (productiv* OR factor* OR output OR efficien* OR interact OR yield OR production OR creat* OR prolific OR industrious OR fruitful OR dynamic OR hinder OR resist* OR increase OR decrease)wn AB))

RQ3

((motivat* OR demotiv* OR de-motiv* OR satisf* OR inspir* OR prompt* OR morale OR encourage* OR manage OR induc* OR provoke* OR {trigger off} OR caus* OR incentive* OR drive* OR morale OR enthusias* OR impetus OR stimul* OR spur OR {driving force}* OR impuls*)wn TI AND (impact OR influence* OR impression* OR effect* OR bearing*)wn TI AND ({Software Engineering} OR {Software Development} OR {Information Technology} OR IT OR {information systems} OR IS OR {Agile Development} OR {Open Source Development} OR {Open Source Systems} OR OSS OR {Extreme Programming} OR XP OR {Agile

Programming} OR {Systems Engineering} OR {Systems Development} OR computing)wn TI)

RQ4

((aspect* OR feature* OR characteristic OR part OR side OR view)wn ALL AND ({Software Engineering} OR {Software Development} OR {Information Technology} OR IT OR {Agile Development} OR {Open Source Development} OR {Open Source Systems} OR OSS OR {information systems} OR IS OR {Extreme Programming} OR XP OR {Agile Programming} OR {Systems Engineering} OR {Systems Development})wn AB AND (motivat* OR demotiv* OR de-motiv* OR satisf* OR inspir* OR prompt* OR morale OR encourage* OR manage OR induc* OR provoke* OR {trigger off} OR caus* OR incentive* OR drive* OR morale OR enthusias* OR impetus OR stimul* OR spur OR {driving force}* OR impuls*) wn AB AND ({Software Engineer}* OR {Software Developer} OR {IT professional}* OR {Information Technology programmer}* OR {Systems Developer}* OR {software practitioner} OR {Information Systems Developer}* OR {IS professional}* {Information Systems Professional}* OR programmer* OR {Software Engineer}* OR {Systems engineer}* OR {Systems Analyst}* {software tester}* OR {software team leader}* OR {software project manager}*)wn AB)

RQ5

((model* OR replica* OR represent* OR version OR copy OR framework OR paradigm OR example OR pattern OR standard OR prototype OR exemplar OR archetype OR structure OR frame OR skeleton OR outline OR context)wn TI AND (motivat* OR demotiv* OR de-motiv* OR satisf* OR inspir* OR prompt* OR morale OR encourage* OR manage OR induc* OR provoke* OR {trigger off} OR caus* OR incentive* OR drive* OR morale OR enthusias* OR impetus OR stimul* OR spur } OR {Open Source Development} OR {Open Source Systems} OR OSS OR {information systems} OR IS OR {Extreme Programming} OR XP OR {Agile Programming} OR {Systems Engineering} OR {Systems Development} OR computing OR {Software Engineer}* OR {Software Developer} OR {IT professional}* OR {Information Technology programmer}* OR {Systems Developer}* OR {software practitioner} OR {Information Systems Developer}* OR {IS professional}* OR {Information Systems Professional}* OR programmer* OR {Software Engineer}* OR {Systems engineer}* OR {Systems Analyst}* OR {software tester}* OR {software team leader}* OR {software project manager}*)OR {driving force}* OR impuls*) wn AB AND ({Software Engineering} OR {Software Development} OR {Information Technology} OR IT OR {Agile Development})wn TI)

3.2 Resources to be searched:

Databases

IEEE Explore

ACM Digital library:

Google scholar (scholar.google.com)

UH University's electronic library (voyager.herts.ac.uk)

Inspec (www.iee.org/Publish/INSPEC/)

ScienceDirect (www.sciencedirect.com)

EI Compendex (www.engineeringvillage2.org/Controller/Servlet/AthensService)

ISI Web of Science

<http://portal.isiknowledge.com/portal.cgi?DestApp=WOS&Func=Frame>)

Other sources:

Proceedings for the special interest group for computer personnel research (<http://www.sigmis.org/>)

International Journal of Information Management

Computer Personnel Journal

International Conference on System Sciences (IEEE)

Work by Authors: Agarwal, Couger, Enns, Frangos, Goldstein, Prasad, Ferratt

Contact directly: Jayesh Prasad (prasad@udayton.edu); Couger, Goldstein,

Frangos; Da Cunha, D (Newcastle Univ):

<http://www.dirc.org.uk/research/DIRC-Results/>

Added: S. Ang; F. Niederman; S. Slaughter; M. Sumner; M. Trauth. R. Turley.

(This list is continually updated through applying our search strategy for accepted papers. When completing details about accepted papers, the researcher is prompted to consider secondary searches that are independent of the database search)

Scope: To avoid bias we have selected a broad range of databases, will include Technical reports, Conference Proceedings and Journal papers. We will also contact key authors directly to check for any new work that has been accepted for publication, but is not yet in print. Finally we will follow up secondary studies identified in our primary searches. However, it is beyond the scope of this systematic review to search for and review work in the form of PhD Theses. We therefore exclude PhD theses from our review of the literature on Software Engineer Motivation. We also exclude books from our review of the literature.

4 Search Process Documentation

The search process involves two stages. Stage one: A primary search on the ‘databases’ and ‘other sources’ listed in 3.2. Stage two: Secondary searches made as a result of identifying work in our primary search.

4.1 Primary search documentation

We document our primary search as follows.

4.1.1 Document: Search terms (tailored for each Database, Journal, Proceeding)

The example below contains Compendex Search terms for RQ1. Searches are grouped by years and research question. Although Compendex allowed us to combine all search terms together into one nested set, the search engine could not process the high numbers of references this produced.

Table 1 gives an example of a nested Search String as used in the Compendex database. The table shows that this search string was used three times, where each search is given a unique ‘Search Identifier’. For example, the search terms used for

RQ1 and years 2000-2005 are given the search identifier 'COMP 1.3'. When a reference is downloaded to Endnote from this particular search, 'COMP 1.3' is placed in the field 'Search Terms'. The Look-up table can be used to check the precise terms used and years included for each recorded paper. We store as much information as possible about each paper in Endnote.

Table 1: Search Identifier

COMPENDEX SEARCH TERMS LOOKUP TABLE – 21st March 2006

Researcher Name:

Date	Search string	Search Identifier	Comments
	wn TI = within Title wn AB= within Abstract wn ALL = within ALL * = truncation. { } encapsulates terms.		
22 March 2006	((((software OR {information technology} OR {information system*} OR system* OR comput* OR IT OR IS)wn TI AND (engineer* OR developer* OR professional* OR programmer* OR personnel OR people OR analyst* OR {team leader}* OR {project manager}* OR practitioner* OR maintainer* OR designer* OR coder* OR tester*) wn TI)) AND (((characteristic* OR types OR personality OR {human factors} OR different OR difference* OR psychology OR {psychological factors} OR motivator* OR prefer* OR behavio*r*)wn TI)))		RQ1 - Expert Search
		3 separate searches for RQ1	
		COMP 1.1	1980-1989
		COMP 1.2	1990-1999
		COMP 1.3	2000-2006

Researchers use lookup table 1 to

- A CUT AND PASTE **SEARCH STRING** INTO DATABASE SEARCH WINDOW and
- B PLACE **SEARCH IDENTIFIER** INTO ENDNOTE 'SEARCH TERMS' FIELD.

When we develop our search strings for each separate database on our list (in section 3.2), we place them in Appendix C and give them a unique reference. This is necessary as databases tend to have proprietary search methods (e.g. different syntax, nesting allowances, etc). All search strings will be tested to ensure that key texts (known to be in the particular database) are extracted in the search.

4.1.2 Document: Default Endnote fields are expanded to include the following:

- Author
- Year
- Title
- Paper ID: (AAYYYT)
- Journal/Conference/Report
- Publisher
- Volume
- Issue
- Pages
- Date (of conference)
- Researcher Name
- Date of Search
- Search String: Lookup Table Ref #
- Exclusion Criteria (a) Is study based on cognitive behaviour?
- Exclusion Criteria (b): Is study external to software engineering?

Exclusion Criteria (c): Is study personal opinion piece or viewpoint?
+Inclusion Criteria (a): Research Question Answered?
+Inclusion Criteria (b): Acceptable source?
++Quality Criteria (score)
++Type of Study: (empirical/theoretical/both/secondary data/Literature Review)
***Type of Empirical Study: Questionnaire/survey(self completed) ; Face to face interviews ; Observation; Focus Groups; Other (state)**
Decision Based on: (Keywords/Abstract/Introduction/Conclusion/ Methodology/Results/Whole Paper/Peer Review/Arbitration)
+++repeated study
***population**
***geographical area**
Decision Status: (Include/Reject/Waiting for Full paper/Don't Know)
***Keywords**
***Abstract**
***Notes**
URL
~*Review Guidelines (pdf file linked to Endnote for easy reference)
>>+Quality Assessment and Results form (Embedded 'Quality Assessment and Accepted papers and Follow-up form')
***Name of Reference Database**

KEY:
 * = optional fields (dependent on type of study and available data);
 ~ = you need to make link from your stored file;
 + = only if paper passes exclusion criteria test;
 ++ = only if paper passes exclusion AND inclusion tests
 +++ = only if paper passes exclusion AND inclusion tests AND quality criteria assessment made.
 >> = embedded file

 All other fields are compulsory

4.1.3 Document: Quality Assessment Form

This form, as shown in Table 2, is embedded in the Quality Assessment and Results form field in Endnote. The form is completed for ALL papers that have passed the exclusion and inclusion assessments. The quality assessment form lists and aggregates quality criteria. The objective is to provide a rough guide to the quality of the paper before completing the accepted papers form. This assessment does not act as an exclusion criterion but guides interpretation. The score alone has little meaning; to understand the quality we need to look at the criteria and context of the assessment and cannot compare quality of different papers as based on the score alone.

Endnote has only one field that allows a file attachment. We will use this field for both this quality form AND the accepted papers form (explained in next section 4.1.4).

Table 2: QUALITY ASSESSMENT

Item	Assessment criteria	Score between 0 – 1	Response options for Score
1	Does study report clear, unambiguous findings based on evidence & argument?		Yes = 1 /No = 0

For empirical studies:		
2	Is sample unbiased?	Random Sample = 1 Non-random sample representative of sub-group = .5 Not representative = 0
3	Could you replicate study?	Yes = 1/ No = 0
4	Number of participants?	See coding and scores in Table 2.1 Give sample size here
5	For a questionnaire, what is the response rate?	No response rate given = 0 Over 80% = 1 Under 20% = 0 Between = .5
For theoretical studies:		
6	Is the paper well/appropriately referenced?	Yes = 1 Moderately = .5 No = 0
Total Quality Score	%	<i>Enter the % score in Endnote Quality assessment field</i>

- Fill in Endnote Field ‘Quality Assessment (score)’ with Total Quality % Score,
 - If study is empirical, fill in Endnote Field “Type of Empirical Study” with type of study code given in Table 2.1
- Fill in results form (on next page of this form).

Table 2.1: Coding and Scoring Data collections		
Data collection Method	**Code	Score (Sample No)
Questionnaire/Survey (self completed)	1	Unit = 1 person <=5 = 0; >5<50 =.5; >50 = 1
Face to face interviews	2	Unit = 1 person Depends on depth of interview. Heuristic <3 = 0; ≥3 ≤5 = .5; >5 = 1
Observation	3	Unit = 1 person Depends on depth and time spent. Heuristic <3 = 0; ≥3 ≤5 = .5; >5 = 1
Focus Groups	4	Unit = Group Depends on depth and time spent. Heuristic <3 = 0; ≥3 ≤5 = .5; >5 = 1
Theoretical Study (no data collection)	5	n/a
Secondary Data used (e.g. systematic literature review)	6	n/a
<i>For empirical studies, enter code number into Endnote “Type of Empirical Study” field</i>		
<i>If method not included in this table, Add new row and number here and update protocol accordingly – creating a new version number.</i>		

4.1.4 Document: Accepted papers/Follow-up Form

This form, shown in Table 3, will be embedded in the ‘Quality Assessment and Results form’ field in Endnote (along with the Quality Assessment). This ensures that all documentation relating to each paper is stored in one place.

If a paper passes through our exclusion criteria, meets our inclusion requirements and has been given a quality score, results are abstracted and recorded against the relevant research question(s). This is not a description of the paper, but a list of results. For full description of our exclusion, inclusion criteria and quality assessment, see Appendix A (section 3).

The accepted papers/follow-up form includes prompts for secondary source follow-up. This form can be used for secondary sources even if the primary paper isn't accepted.

Table 3: GENERIC FORM FOR RESULTS OF ACCEPTED PAPERS:

Reviewer Name	
Title of Paper	
Paper ID	
THE FOLLOWING REFER TO OUR RQs:	RECORDED IN PAPER
1. Software engineer characteristics (RQ1)	
2. Software Engineer motivators (RQ2)	
3. Software Engineer 'de-motivators' (RQ2)	
4. External signs or outcomes of motivated software engineers (RQ3)	
5. External signs or outcomes of de-motivated software engineers (RQ3)	
6. SW Engineering as a motivator (e.g. what is motivating about the type of development used; task of coding, testing etc) (RQ4)	
7. Frameworks /models that reflect how software engineers are motivated (RQ5)	
8. Other observations	
Secondary Sources/Follow up Work	
9. References found in paper (to follow up)	
10. Secondary studies in paper (where authors have used enough detail that we can extract the work directly) Note number(s) 1 – 8 from table above, to indicate which RQ is being addressed	
11. Secondary studies embedded in paper that require analysis of original work before using in review	Give Reference and area of work interested in following up.
12. Author direct contact	If study is important, incomplete or suggests author is continue to research in this area, note contact details here and what question we want to ask them.
13. Does the author have other related work?	If this is likely, run secondary search on Author name.
14. Does the source (e.g. journal or conference proceeding) contain other related work?	If this is likely, run secondary search on the source.

Instructions:

If you fill in any of the fields 1 – 8,

- a. Save hard copy of the Quality Assessment and Results form in Accepted papers folder – along with the full version of the paper.

- b. Embed electronic copy of this form into Endnote Quality and Results Form field.

If you fill in secondary sources fields (9 - 14), make a copy of the file and save in Secondary Sources folder, for later follow up work. Always fill in the paper ID reference at top of form for traceability.

This form will be attached to form 4.1.3 – the quality assessment.

4.1.5 Document: Secondary Search

This is similar to primary search documentation, other than no search string/lookup table will be used. Endnote is used in the same way to record the references as for primary studies. The one exception is that for secondary sources, the ‘search string’ field in Endnote is filled in with the details of the primary source that led to this paper being identified along with words “secondary search”. We also add the search term, if this is used, e.g. author “Couger”. The Field “Name of reference database” is filled in to give information on where search took place, e.g. IEEE Xplore or ACM.

4.1.6 Document: Procedure for conducting the search

To ensure that the procedure is reliable and replicable, four researchers used the prescriptive process in three separate pilot studies. The outcome of successive trials resulted in the following procedural document which we will use for all our primary searches.

Data

Each researcher performing the systematic review will be given the same Data:

Search Data:

URL links to all **databases** on our list (specific guidelines.doc)

List of **Search terms** tailored to source (“Search_Terms_Database_Name.doc”)

Reference Data:

Our Research Questions (specific guidelines.doc)

Exclusion Criteria (specific guidelines.doc)

Inclusion Criteria (specific guidelines.doc)

Quality Criteria (specific guidelines.doc)

The Systematic Procedure (detailed in this section “Checklist of activities”)

Output Data:

Quality Assessment and Results Form.doc

For practical purposes, the two output forms (‘Quality Assessment’ and ‘Results’ are combined into one document.

Checklist of activities – The Procedure:

INITIAL SET UP

1. Create an electronic ‘MoMSE Systematic Review’ folder, within this folder:
 - 1.1 Create a ‘MoMSE_Generic_documents’ folder, in this folder:

- 1.1.1 save 'Search_Terms_Database_Name.doc'
 - 1.1.2 save 'Quality Assessment and Results Form.doc' '
 - 1.2 create a 'MoMSE Endnote Library' folder
 - 1.3 create a 'MoMSE Papers' folder
 - 1.4 create a 'MoMSE Secondary Sources' folder
 - 1.5 create a 'MoMSE quality assessments and accepted paper forms' folder
2. Get 5 box files (or your preferred method of storing hard copies of papers) & label
 - 2.1 "First Pass Papers";
 - 2.2 "Papers Pending Decision";
 - 2.3 "Arbitration Papers";
 - 2.4 "Accepted Papers".
 3. Open Electronic Reference Manager "Endnote 9".
 4. In Endnote, create four Libraries; save them in 'MoMSE Endnote Library' folder:
 - 4.1 All References.enl – a permanent store of ALL downloaded papers;
 - 4.2 WIP Papers.enl – a temporary store for Work in Progress papers;
 - 4.3 Accepted Papers.enl – a subset of 'All References.enl' library papers.
 - 4.4 Multiple Publications.enl – a subset of 'Accepted Papers.enl' library papers

REPEAT FOR EACH INDEX DATABASE/JOURNAL/PROCEEDINGS IN LIST

5. Go to specified source in lookup table, e.g. 'Compendex', ACM, IEEE Xplore, etc.

REPEAT FOR EACH RESEARCH QUESTION (RQ) IN LIST

6. Select one RQ Search String from "Search_Terms.doc"
7. Copy and Paste string into the search box of the indexing database.
8. Download papers based on "Face Value" evaluation into Endnote 'All References.enl' library

REPEAT FOR EACH PAPER IN LIST

9. Open paper in your Endnote 'All References.enl' library and manually fill in all compulsory fields **not** automatically completed in the download, e.g. PaperID, name of researcher, research string reference, etc.
10. Check paper and type in answers to each exclusion criterion (given in separate fields) – there are three possible outcomes:
 - 10.1 If all exclusion **criteria are NOT met** – paper is progressed to inclusion criteria check (11),
 - In "All References.enl" go to Decision field and type "paper not excluded".
 - Proceed to inclusion criteria check (no.11)
 - Else –
 - 10.2 If exclusion criteria **undecided**,
 - go to Endnote Decision field

- list why paper cannot proceed to inclusion criteria check
- give date and name of reviewer responsible
- **copy** reference to Endnote Library “WIP Papers” (where paper remains until decision is made: see arbitration 4.1.7.2)
 - If decision is to reject – Delete paper from WIP library and follow instructions for 10.3.
 - If decision is to include, Delete paper from WIP library **and** open paper reference in “All References.enl” **and** follow instructions given in 10.1.

Else –

10.3 If **exclusion criteria are met – paper is rejected**

- Go to Decision field and put “reject”, date, reviewer responsible, and reason for fail.
- Go to next paper (work from step 9), If at end of list of papers
 - Go to next Research Question (step 6 onwards), if all research questions have been dealt with
 - Go to next index source (step 5 onwards), if all sources have been searched
 - END input

11. Open reference in Endnote ‘All References.enl’. Check and type answers to each **inclusion criterion** (given in separate fields) – there are three possible outcomes:

11.1 If all inclusion **criteria met**,

- In “All References.enl” go to Decision field and type “inclusion criteria met”
- **copy** reference to Endnote Library ‘Inclusion Criteria Met’
- download full electronic paper and save in “MoMSE Paper” folder
- print out full paper for quality and results check
- store hardcopy in the “accepted papers” box file

Else –

11.2 If inclusion **criteria undecided**,

- go to Endnote Decision field
 - list why paper cannot proceed to quality check
 - give date and name of reviewer responsible
- **copy** reference to Endnote Library “WIP Papers” (where paper remains until decision is made: see arbitration 4.1.7.2)
 - If decision is to reject – Delete paper from WIP Endnote library and follow instructions for 11.3.
 - If decision is to include, Delete paper from WIP Endnote library **and** open paper reference in “All References.enl” **and** follow instructions given in 11.1.

Else –

11.3 If **inclusion criteria fails**

- Go to Decision field and put “Inclusion criteria failed”, date, reviewer responsible, and reason for fail.
- Go to next paper (work from step 9), If at end of list of papers
 - Go to next Research Question (step 6 onwards) if all research questions have been dealt with
 - Go to next index source, if all sources have been searched,
 - END input

12. Open reference in Accepted Papers.enl Library, go to Quality Assessment form (MS Word Document) embedded in Quality Assessment and Results field.

- Fill in all Quality Assessment fields.

12.1 If quality criteria form can be completed,

- Go to Endnote Quality Criteria field and enter “score”.
- Complete the Results section of Quality Assessment and Results.doc”
 - If there are any secondary sources referenced in this form, save copy in Secondary Source folder
- save form as “[PaperID]Quality Assessment and Results.doc
- print hard copy of form (to store with full paper in accepted papers box file)
- insert completed electronic form as an embedded ‘object’ into Endnote ‘Quality assessment and results form’ field.
- Go to Endnote Decision field and report “paper accepted”
- File hard copy of paper in “Accepted Papers” Box file together with print out of quality assessment and results.doc form

Else –

12.2 If quality criteria is undecided

- Go to Endnote Quality Criteria (score) field and enter “undecided”
- Go to Endnote “Decision field” and list why paper cannot proceed to the next stage
- Place hard copy of paper in “Papers Pending Decision” box file. Write on paper why paper quality is undecided.

Alternatively,

- If paper needs to go to arbitration - move hard copy of paper into “Arbitration Papers” box file. Write on paper why it needs to go to arbitration. (Paper remains here until decision is made: see arbitration section 4.1.7.2)

GO TO NEXT PAPER IN LIST – (go back to 9)

End when all Papers in list have been processed

GO TO NEXT RESEARCH QUESTION – (go back to 6)

End when all Research Questions have been processed

GO TO NEXT INDEX SOURCE – (go back to 5)

End primary search when all agreed Index sources have been searched

Secondary Searches

GO to Secondary Source folder. Do individual searches on new references, authors, journals etc.

Follow Procedure for stages 6 – 12.

When all primary AND secondary searches have been completed, run search for multiple studies (see section 4.1.7.3). If multiple studies are found select only one study for the review (the most recent/most detailed).

After searches for multiple studies have been performed and key paper is identified and selected the data extraction procedure ends.

4.1.7 Document: Specific Guidelines

The generic procedure outlined above, requires “Specific Guidelines” in order to implement the process. Appendix A gives an example of a specific guideline used in our pilot study, it includes rules on how to fill in Endnote fields and forms, our exclusion, inclusion and quality criteria. The inclusion, exclusion and quality criteria given in this document will be used in the final review.

4.1.7.1 Completion of Systematic Review

At the end of the procedure (primary and secondary study data extraction and reporting), we examine the following:

Box Files: Papers Pending Decision & Papers for Arbitration (to try to progress)
Papers Accepted and Papers Rejected (for notes in case of disagreement)

Endnote libraries: WIP papers(pilot).enl and Accepted Papers(enl).enl.

WIP papers are categorised into the reasons they have not been progressed. A common reason is that a full paper is not readily accessible. Where possible, a decision is made whether to reject or accept. If a decision cannot be reached by the researcher alone, the paper goes to arbitration.

Accepted papers. The review will be conducted by one researcher (Sarah). A second researcher (Dorota) will act as a checker by looking at all the accepted papers. Where researchers agree, the paper will be included in the review. Where researchers disagree, the paper goes to external arbitration.

4.1.7.2 Arbitration

Papers that may go to arbitration fall into the following categories:

(a) Papers that are in Pending Decision and Arbitration Box files

- (b) Papers that are in the electronic WIP library (stored there prior to saving a hard copy or rejecting paper – reason for not proceeding is recorded in Endnote ‘Decision’ field)
- (c) Papers that have been not been accepted by all researchers (identified through comparison of ‘Accepted Papers.enl’ Endnote libraries).

Stage 1: Internal Arbitration: Researchers involved in the data extraction will try to reach an agreement on all papers (whether to include or exclude).

If there is still no agreement, the papers go to stage 2, external arbitration.

Stage 2: External Arbitration: If the first internal arbitration fails to reach an agreement PDF(s) of arbitration paper(s) are sent to external research experts (Tracy, Nathan, Helen and Hugh) who, based on knowledge of our exclusion criteria, inclusion criteria and quality criteria, will make a final decision – whether to accept or reject the paper.

4.1.7.3 Multiple Publications

Considering all papers in the ‘Accepted Papers.enl’, searches are made for articles that report the same study. This is done by grouping papers by author (and co-authors). Duplicate work may not be referenced by the author directly therefore papers grouped by author need to be carefully read to uncover possible duplication. Where duplication is found we include only one paper in our review (that we consider to be the best quality – e.g. the most thorough and ideally most up-to-date). Duplicate papers are removed from ‘Accepted Papers.enl’ and placed the duplicate papers repository in Endnote Library “Multiple Publications.enl”. In this way we avoid giving one finding too much prominence. The one remaining paper in ‘Accepted Papers.enl’ has its ‘repeated study’ field filled in with “YES”; # of duplicate papers; “stored in “Multiple Publications.enl””.

4.1.8 Document: Data Synthesis

Data synthesis forms will bring together all the findings reported in our Accepted papers/Follow-up forms (Document 4.1.4 in this protocol). The synthesis comprises qualitative lists of findings that will provide broad answers to our research questions. In order to perform sensitivity analysis we categorise the quality, population, location, year and type of study.

There are three forms:

- Data Synthesis Form 1: lists findings of each paper according the research question.
- Data Synthesis Form 2: categorises the findings and notes how many papers agree with each finding.
- Data Synthesis Form 3: Is a sensitivity analysis and separates the findings identified in Data Synthesis Form 2 to see whether there are any differences in the identified groups.

Data Synthesis Form 1: Research Question 1

of papers accepted that relate to this question (completed at end):

<i>RQ1: What are the characteristics of Software Engineers?</i>						
Paper ID	Quality (score)	Population (e.g. age group, experience level)	Geographical location	year of study	Type of Study	SW Engineer Characteristics (list)
Paper ID	Quality score	Population (e.g. age group, experience level)	Geographical location	year of study	Type of Study	SW Engineer Characteristics (list)
etc						

Data Synthesis Form 1: Research Question 2

of papers accepted that relate to this question (completed at end):

<i>RQ2: What (de)motivates Software Engineers to be more (less) productive?</i>						
						MOTIVATORS
Paper ID	Quality	Population	Geographical location	year of study	Type of Study	SW Engineer motivators (list)
Paper ID	Quality	Population	Geographical location	year of study	Type of Study	SW Engineer motivators (list)
						DE-MOTIVATORS
Paper ID	Quality	Population	Geographical location	year of study	Type of Study	SW Engineer de-motivators (list)
Paper ID	Quality	Population	Geographical location	year of study	Type of Study	SW Engineer de-motivators (list)
etc						

Data Synthesis Form 1: Research Question 3

of papers accepted that relate to this question (completed at end):

<i>RQ3: What are the external signs or outcomes of (de)motivated Software Engineers?</i>						
						MOTIVATED
Paper ID	Quality	Population	Geographical location	year of study	Type of Study	External Signs of Motivated Engineers (list)
Paper ID	Quality	Population	Geographical location	year of study	Type of Study	External Signs of Motivated Engineers (list)
Etc.						
						DE-MOTIVATED
Paper ID	Quality	Population	Geographical location	year of study	Type of Study	External Signs of De-Motivated Engineers (list)

Paper ID	Quality	Population	Geographical location	year of study	Type of Study	External Signs of De-Motivated Engineers (list)
etc						

Data Synthesis Form 1: Research Question 4

of papers accepted that relate to this question (completed at end):

<i>RQ4: What aspects of Software Engineering (de)motivate Software Engineers?</i>						
						MOTIVATE
Paper ID	Quality	Population	Geographical location	year of study	Type of Study	Software engineering is .. (list)
Paper ID	Quality	Population	Geographical location	year of study	Type of Study	Software engineering is .. (list)
etc						
						DE-MOTIVATE
Paper ID	Quality	Population	Geographical location	year of study	Type of Study	Software engineering is .. (list)
Paper ID	Quality	Population	Geographical location	year of study	Type of Study	Software engineering is .. (list)
etc						

Data Synthesis Form 1: Research Question 5

of papers accepted that relate to this question (completed at end):

<i>RQ5: What models of motivation exist in Software Engineering?</i>						
Paper ID	Quality	Population	Geographical location	year of study	Type of Study	Frameworks /models that reflect how software engineers are motivated
Paper ID	Quality	Population	Geographical location	year of study	Type of Study	Frameworks /models that reflect how software engineers are motivated
etc	Quality	Population				Frameworks /models that reflect how software engineers are motivated

When findings have been recorded in these summary forms, a finer-grained classification of themes is conducted. We now class synthesis the findings as shown in this example:

Data Synthesis Form 2: Counts of Identified factors

<i>RQ1: What are the characteristics of Software Engineers?</i>		
SW Engineer Characteristic A (identified in Form 1)	# of papers	
SW Engineer Characteristic B (identified in Form 1)	# of papers	
etc		

A data synthesis for all RQs will be performed based counts of identified factors reported in Form 1.

When we have identified all the factors we run a sensitivity analysis as shown in example Data Synthesis Form 3:

Data Synthesis Form 3: Sensitivity Analysis based on population for RQ1

<i>RQ1: What are the characteristics of Software Engineers?</i>			
Population	# of papers	Differences (list)	Similarities (list)
e.g. Students			
e.g. Computer Operators			
e.g. Novices			
e.g. Experienced Practitioners			

Sensitivity analyses (highlighting similarities and differences between groups) will be performed for ALL RQs based on: Population; Geographical Area; Chronology; Study Type (e.g. empirical versus theoretical studies), Data collection method (e.g. questionnaire versus participant observation). When populating the results forms for each individual paper we may find further categories to investigate.

5. Validation of review process

This section explains how we validate our systematic review process - this is in four parts.

The Pilot – Testing the Process

- a.. Three independent researchers use a subset of resources to test the process. Problems in replicating the process are identified, process is refined accordingly (This stage is completed)
- b. Gaps in our searches are identified and search terms and resources are changed to include missing papers.

- c. Data Extraction. We test the reliability of how we extract details from accepted papers. An independent researcher, not involved in the pilot, is given a set of accepted papers and asked to fill in the final report. (Nathan will be given five ‘accepted’ papers and will fill in five results forms ‘results_form.doc’).
-

The review – Testing reliability of selection

- d. As only one researcher will conduct the final review, we will test the reliability of the researcher’s selection by conducting an inter-rater reliability test. (Dorota to do a stratified sample test based on a representative sample of papers from each library that contains all the papers selected by Sarah).

Each of these four validation schemes are explained below in full.

5.1 Validation – the Process

Potential conflict of interest: Co-investigators, Dr Nathan Baddoo and Dr Tracy Hall have authored/co-authored papers on Software Engineer motivation that may be included in the review. These researchers will not be involved in evaluating or arbitrating any of their own papers. The key researcher, Dr Sarah Beecham, has not published papers in this area. Should the search reveal any papers that are authored or co-authored by any of the researchers involved in this review; the author(s) will not be involved in the selection process. All quality and acceptance decision made by the key researcher will be checked by a second researcher.

We test that our process is fair and unbiased, replicable and open to external review. Pre-pilot: Three reviewers (Dr Tracy Hall, Dorota Jagielska, and Dr Sarah Beecham) are given a procedure to follow that is a step-by-step guide to extracting papers from reference databases. These guidelines include research terms, inclusion and quality criteria. (See Appendix A for the formal procedure followed). The process was trialled three times, each time the process was refined. On the third trial a new researcher (Dr Helen Sharp) along with Dr Sarah Beecham and Dorota Jagielska, tried the guidelines. The results given in Table 4 below, confirmed the process to be replicable, where number of references downloaded by each researcher received close to 100% agreement. As we were trialling the process, the actual number of accepted papers from each researcher (all of whom downloaded approximately 1445 papers) is not considered critical to this part of the study. Time didn’t allow for final reports to be made on all papers. The trial served to test that our inclusion criteria was understandable and our forms were workable.

Table 4. Extraction Summary – of Endnote Library Entries using Compendex Database and 5 sets of research terms.

Researcher →	# of papers found in database			# of papers extracted All references			# of papers in WIP			# of papers included		
	A	B	C	A	B	C	A	B	C	A	B	C
Search Identifier ↓												
COMP 1.1	269	269	269	58	24	25	18	5		10	7	5
COMP 1.2	317	317	317	41	8	28	19	0		2	2	1
COMP 1.3	260	260	260	37	8	13	7	3		4	1	3
COMP 2.1	66	66	66	3	3	3	2	1		0	0	0
COMP 2.2	130	130	130	8	7	8	2	2		0	0	0
COMP 2.3	100	100	100	6	9	6	5	0		0	2	0
COMP 3	71	71	71	15	6	8	8	0		2	2	2
COMP 4.1	20	20	20	1	1	0	1	1		0		0
COMP 4.2	42	42	42	1	2	3	1	2		0		0
COMP 4.3	42	42	42	6	4	2	1	1		2		1
COMP 5.1	13	13	13	6	0	0	4	0		0		0
COMP 5.2	40	40	40	13	0	0	5	0		0		0
COMP 5.3	80	76	81	23	9	1	5	2		3		0
Total # of papers (primary)	1450	1446	1451	218	81	97	78	17	n/a	23	14	12
% of whole – for a stratified sample	100			15%			5.5%			2%		

The purpose of this study is to check consistency of papers included not for completeness. Consistency results are given in Table 5.

Table 5. Consistency of results	
Library	Result
<p>Papers found in database search: 5 sets of research terms are used in Compendex.</p>	<p>It is important that this category is the same for all researchers. There is a close to 100% agreement on the papers downloaded from the database using the given search terms. As the database is updated regularly the slight discrepancy might be due to different time of retrieval.</p>
<p>All_references Library Papers downloaded from database for further consideration (based only on face value). This is an intermediary library, inclusion in this library is no guarantee of inclusion in the review although exclusion from this library means the paper will not be included in final review.</p>	<p>There is a discrepancy in numbers of papers downloaded into this library. Discussing reason with other researchers revealed a difference in the amount of processing/sifting done within the database prior to retrieval. We therefore do not consider the number of references held in this library to have any significance in revealing any bias or inconsistency in papers chosen for eventual inclusion in review. The final outcome is not affected by these differences. Differences in included papers will be picked up in the final 'papers_accepted' library when conducting the full review.</p>
<p>Work in Progress (WIP) library This library is a temporary store for papers that need more information (e.g. full papers) before a decision can be made. It also holds papers that require arbitration.</p>	<p>There is a large difference in how this library has been used. One researcher, who was not going to continue further with the study, did not use it at all other than to log a secondary study that was not connected directly to any of the searches. Another researcher used it extensively, as they were going to do the final review and wanted to come back to any ambiguous work – and they recorded a great many rather than risk excluding a relevant paper. The third researcher used it moderately, but in the way intended. WIP is a temporary store, and is not relevant to the validation of the process. When papers are further assessed they will be deleted from this library. Until all the papers in this section have been assessed, we cannot derive a final figure of accepted papers.</p>
<p>Papers that meet the inclusion criteria Papers that meet inclusion criteria (answers a RQ, reliable source, not a personal viewpoint).</p>	<p>All three researchers placed papers in this section. The Venn diagram shows where agreements and disagreements occur.</p>

The intersections in the Venn diagram (in figure 1) show that there are 15 papers that have been selected by more than one researcher. The likelihood of the same 15 papers being selected by three researchers from 1446 by chance is extremely low², we therefore feel that this exercise shows the process to be reliable and repeatable. It also confirms that researchers are interpreting the inclusion criteria correctly.

The 17 (9 + 8) papers selected by only one researcher are re-circulated amongst the researchers (A, B C) for further assessment. They are used to familiarise and consolidate the researchers' understanding of the inclusion criteria prior to conducting

² Likelihood of A & B having five papers in common is 1.8×10^{-6} , A & C having 12 papers in common is 2.6×10^{-22} , and B & C having 2 papers in common is 5.8×10^{-3}

the full study. They serve to uncover possible misunderstandings or ambiguities in the process. Where the three researchers cannot agree, these papers will go to external arbitration, with Dr Tracy Hall, Dr Nathan Baddoo or Dr Hugh Robinson.

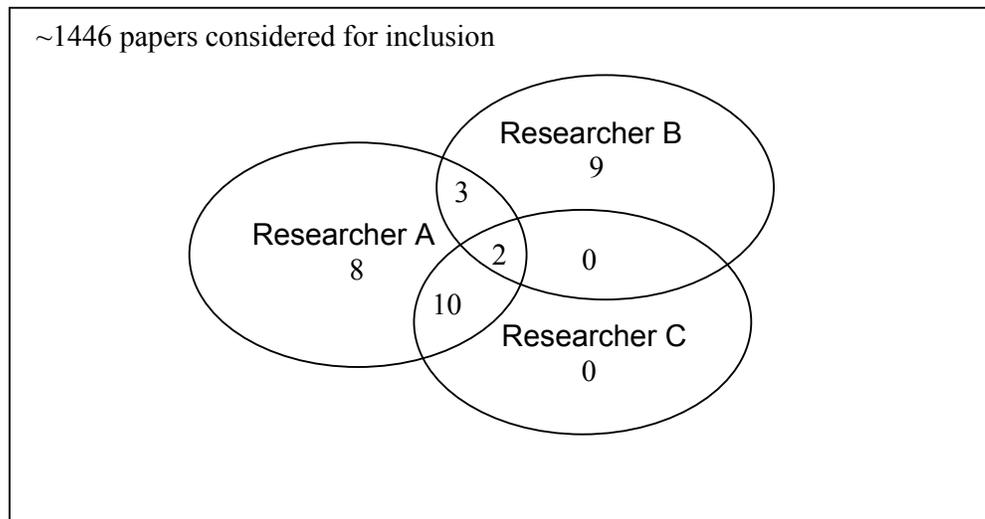


Figure 1: Venn Diagram showing agreements and disagreements of three researchers' choice of paper inclusion

The study also revealed different use of the WIP library. For example WIP was not used by researcher number B, as this researcher was only involved in the pilot study and was not going to continue further with the study.

We have not included the accepted papers library numbers since very few papers reached this stage due to lack of time. This library and the accompanying generic accepted papers form will be fully tested by Nathan in a separate study. Nathan will be given 5 accepted papers and asked to fill in the form. Sarah will also fill in the forms and a comparison of substantive results will be made.

5.2 Validation – Coverage

Second, we check that our search terms retrieve the whole population of publications relevant to our research questions (or at least as many as are available) by identifying gaps in retrieval.

5.2.1 Key texts validation: Publications known to be relevant are used to evaluate the thoroughness of the search terms and resources. Table 6 gives examples of missing texts identified in our pilot study and how we addressed these gaps through amending our search terms.

Table 6: A comparison of Compendex references and key Texts

Key Texts (from MoMSE proposal case for support)	Results from search (using 5 separate sets of key terms)
Adams JS (1965) Inequity in social	Not found in search.

exchange. in L.Berkowitz (ed) <i>Advances in Experimental Social Psychology</i> , 2, New York: Academic Press	OUTSIDE OUR SEARCH DATES (and DB dates)
Aldeferer CP (1972) <i>Existence, relatedness and growth: human needs in organisational settings</i> . New York:Free press	Not found in search BOOK therefore outside scope of study
Baddoo N & Hall T (2002) <i>Motivators of Software Process Improvement: An Analysis Of Practitioners' Views</i> . <i>Journal Of Systems & Software</i> 62(2):85-96	MISSING(AVAIL in Compendex) - AMEND SEARCH TERMS TO INCLUDE DE-MOTIVATORS (different spelling) and {Software Practitioner*}
Campion M A & Mc Clelland CL (1993) Follow up and extension of the interdisciplinary costs and benefits of enlarged jobs, <i>Journal of Applied Psychology</i> 78, 339-351	MISSING (NOT AVAIL in Compendex). Outside the scope of this study. Work is unconnected to software engineering.
Capretz, L (2003) <i>Personality Types in Software Engineering</i> , <i>International Journal of Human-Computer Studies</i> , 58(2) 207-214.	MISSING(AVAIL in Compendex) - AMEND SEARCH TERMS TO INCLUDE in abstract the words 'PERSONALITY' and 'TYPES' and 'SOFTWARE PROFESSIONALS'
Couger JD and Zawacki RA (1980) <i>Motivating And Managing Computer Personnel</i> . John Wiley and Sons.	BOOK (outside scope)
Couger JD and Adelsberger H (1988) <i>Comparing Motivation Of Programmers And Analysts In Different Socio/Political Environments: Austria Compared To The United States</i> . <i>Computer Personnel</i> 11(4):13-16.	Not in Compendex – NEED TO DO SEPARATE SEARCH in COMPUTER PERSONNEL journal
Couger, J. D., H. Adelsberger, et al. (1990). "Commonalities in motivating environments for programmer/analysts in Austria Israel, Singapore and USA." <i>Information & Management</i> 18(1): 41-46.	Identified in Search
Couger, J. D. and M. A. Colter (1984). "EFFECTS OF MAINTENANCE ASSIGNMENTS ON GOAL CONGRUENCE FOR PROGRAMMERS AND ANALYSTS." <i>Conference Paper Proceedings of the International Conference on Information Systems</i> : 83-100.	Identified in Search
DeMarco T and Lister T (1999) <i>Peopleware - Productive Projects And Teams</i> . Dorset House.	BOOK, but search did bring up: DeMarco, T. and T. Lister (1985). "PROGRAMMER PERFORMANCE AND THE EFFECTS OF THE WORKPLACE." 268-272.
Griffin RW & McMahan GC (1994) <i>Motivation through job design</i> In J Greenberg (Ed) <i>Organisational Behaviour: the state of science</i> , Hillsdale NJ Lawrence Erlbaum Associates, pp23-44.	BOOK CHAPTER
Hackman JR, Oldman GR (1976) <i>Motivation through the design of work: test of a theory</i> . Academic Press, NY.	Book

Porter LW & Lawler E E (1968) <i>Managerial Attitudes and Performance</i> , Homewood Illinois: Irwin	
Khalil M, Zawacki E, Zawacki A, Selim A (1997) What Motivates Egyptian IS Managers and Personnel: Some Preliminary Results, <i>SIGCPR97</i>	MISSING(AVAIL in Compendex) - AMEND SEARCH TERMS TO INCLUDE the acronym 'IS'.
McClelland DC (1978) Managing motivation to expand human freedom, <i>American Psychologist</i> , March, 201-210	MISSING(NOT AVAIL in Compendex) Outside the scope of this literatures (dealing with motivation, unconnected to software engineering)
*Vroom VH (1964) <i>Work And Motivation</i> . New York: John Wiley.	BOOKS
Work of Fitz-enz (recommended by N.B)	BOOKS. Not in Compendex. Work appears to be sourced in text books

We amended the search terms and tested the new terms. An example of how we now capture the Capretz study is given below.

Validation:

Search Results

1 record in Compendex for 1969-2006 [Save Search](#) - [Create Alert](#) -

[RSS](#) ?

[+\(\(\(\(software OR {information technology} OR {information system*} OR system* OR comput* OR IT OR IS \)wn TI AND \(engineer* OR developer* OR professional* OR programmer* OR personnel OR people OR analyst* OR {team leader}* OR {project manager}* OR practitioner OR maintainer* OR designer* OR coder* OR tester*\) wn TI\) \) AND \(\(\(characteristic* OR types OR personality OR {human factors} OR different OR difference* OR psychology OR {psychological factors} OR motivator* OR behaviour*\)wn TI AND \(capretz\)wn AU\)\)\)](#)

Sort by: ▼ Relevance [Date](#) [Author](#) [Source](#) [Publisher](#)

1. **Personality types in software engineering**

[Capretz, Luiz Fernando](#) (Dept. of Electrical and Comp. Eng., University of Western Ontario) **Source:** *International Journal of Human Computer Studies*, v 58, n 2, February, 2003, p 207-214

Database: Compendex

[Abstract](#) - [Detailed](#) - [Full-text](#)

The inclusion of search terms such as IS, de-motivations, software professionals and software practitioners is also likely to increase the number of publications relevant to our study, not necessarily known about prior to the study.

To summarise, validating the gaps in our the pilot study revealed that we need to include more terms, and also conduct independent secondary searches on key authors, key conferences and key journals.

5.3 Testing Boundaries/scope:

The scope of this study is sometimes dictated by limitations of databases (which is beyond our control), or by retaining the focus of our research questions. We found

following the guidelines of inclusion/exclusion criteria and quality criteria clear. However, there are a few exceptions that we note below which explain why certain texts are not (and will not be) included in our review.

5.3.1 Books. Some key texts are in book form. However we eliminate the many books that have been written on motivation from our search, and focus only on resources available through indexing databases. We make this decision not only for pragmatic reasons, but also because we want to sample work that has been peer reviewed, is reliable, and reflects the thinking at time of publication. However, we do note here that books do include relevant information, e.g., business models, process models and motivation models, of the type we are searching for in our review of the literature. An example of seminal work relating to software engineering motivation that is only available in a text book is Couger JD and Zawacki's (1980) model in *Motivating And Managing Computer Personnel*, John Wiley and Sons. We will be recording secondary sources (to include books) in our accepted primary study paper results form. Where work is referenced in books we will endeavour to source and reference the findings in these books also. This will be a secondary phase that takes place after the systematic review of the literature available in databases.

5.3.2 Years: 1980 - Date

We decided to include all literature from 1980 onwards. Although we are more interested in current thinking, we need to know whether software engineer characteristics and motivation have changed over the years. A lot of work on motivation was published in the 1980's. There is little published in this field before this date. The exceptional key studies that pre-date the 1980s, can be found referenced or even reproduced in more recent work. To ensure this work, and other related work, is included in our review we have included a field in our final report form. This field prompts the researcher to record important references and secondary sources for further investigation.

5.3.3 Negative results:

Our set of inclusion criteria endeavours to ensure that we will include negative results, where we interpret 'negative' as being work that suggests that there is no need for a separate model of software engineer motivation; or that software engineers are no different to any other group of workers. As researchers looking for differences, we might be inclined to only include work on how software practitioners' needs and characteristics are different to the rest of the working population; how current models don't fit, etc. However, as with much published work, it is debatable if papers that show no difference ever get published or whether organisations want to publish negative results. We realise therefore that we are creating a literature review of work that may not reflect the true state of practice.

5.3.4 Scope: Cognitive behaviour studies

Our pilot studies revealed a large body of work that looks at the cognitive behaviour of Software Engineers. While we are interested in how groups of engineers behave and process information, we decided that this work is outside the scope of our systematic literature review of software engineer motivation. When

developing our model of Software Engineer motivation (that this literature review will feed into), we will seek expert advice on the cognitive behaviour of software engineers. We will include studies that reveal some general software engineer characteristics; we cannot include work on how software engineers improve productivity based on a new tool or promotion.

5.3.5 Scope: Motivation in software engineering

We do not include any studies on motivation unless it is connected to software engineering / software engineers. Assessing generic studies and generic models of motivation is beyond the scope of this study.

We exclude work on:

- company structures and hierarchies unless expressly linked to the individual engineer's motivation.
- motivating students to learn – even if they are IT students.

We include studies

- using students to study motivation to develop software.

5.3.6 Scope: Motivation of individual software practitioners

We exclude any studies on motivation that relate to:

- users/end users (unless they producing the software –directly)
- software managers (e.g. Chief Information Officers, project managers) who are not directly producing the software.
- the body of work on IT group/team motivation and dynamics.
- Studies on gender differences (too low level)

5.4 Replicable process – data extraction evaluation

In order to test the reliability of the papers included in our review we will perform an inter-rater reliability test. When searching the databases we retrieve thousands of potentially relevant papers. From this list we need to extract those that meet our inclusion and quality criteria. The inter-rater reliability test is performed as follows.

One researcher makes a search of an indexing database using search terms that cover all our research questions. A process of selection is performed, whereby papers are checked against several criteria: Check 1. Face Value selection; Check 2. Inclusion Criteria Met; Check 3. Quality Criteria met. Only papers that go through these three checks will be included in the review. Table 7: “Pilot study results” outlines the process showing how an initial list of 1445 papers undergoes several checks and is whittled down to include only ³30 papers. To check the reliability of researcher 1's selection decisions, a second researcher looks at a representative sample from each of the 5 categories of paper (as shown in column 1 below). Researcher two is not told how any of these papers were categorised by researcher 1. Using our pilot study figures as an example, a total of 140 papers (approximately 10%) are given to researcher two.

³ The actual number of accepted paper is likely to be higher as there are several papers in our work in progress (WIP) temporary paper store. These WIP papers require more information before we can make a decision.

5.4.1 Validation of reliability of selected papers (stage 1 validation)

Category of paper	Definition	Distribution % of pilot study papers	Allocation of papers based on sample
Reject outright	Paper listed in database is not selected for further consideration. (Search terms bring up some papers that do not relate to our study)	Researcher 1 rejects 84% of papers by reading title, possibly key words and abstract, while still in indexing database.	R1 rejects 1220 out of 1445 papers (84%) 110 rejected papers given to R2 ($140 \times 84\% = \sim 118$)
Check 1: Include at face value	From reading reference (title, author, and keywords and abstract where possible) in the database list, we include all papers that appear relevant to our research questions.	16% are downloaded from database for consideration based on title, keywords, abstract or author.	R1 selects 225 out of 1445 papers (16%) 20 included face value papers are given to R2 ($140 \times 16\% = \sim 22$) papers given to R2 in this category will NOT go on to next phase.
Check 2: Exclusion/ Inclusion criteria	The paper passes our exclusion/inclusion criteria check	Approx 2% of papers are included based on reading a full version of the paper – although a good abstract may include enough detail for inclusion criteria to be met	R1 includes 30 papers out of 1445 in this category (2%). 2 papers from this category are given to R2 as examples of papers that are included in our accepted papers folder.
Not sure or waiting for full paper	Papers that are difficult to access or require further consideration before being included. This is a temporary store – once full paper is found, the paper will either be rejected or accepted.	5.5% of papers enter this category as we err on the side of caution rather than reject a potentially relevant paper. Where it is impossible to get a full version of paper, the paper remains here.	R1 includes 80 papers out of 1445 in this category (5.5%). R2 is given a representative 8 papers from this category ($138 \times 5.5\% = \sim 8$)

The second researcher is given a stratified sample of papers (numbers shown in bold in table, column “allocated sample..”) to reflect those in our 4 paper categories. Researcher two is given definitions of our 4 categories to include detailed notes on our research questions, exclusion criteria, and inclusion criteria. The second researcher is then asked to place each of these 140 papers into one of the five paper categories. The results are then compared using Cohen Kappa’s inter-rater reliability test. [We will report the *k* statistic ... (if good, will go ahead, if bad will reflect on how we need to change our categories before going ahead with reporting the review).

5.4.2 Validating our qualitative data abstraction (stage 2 validation)

A separate validation is made on a group of accepted papers. Given the qualitative nature of most of the work in this field, we need a reliable way to report main findings from these papers. An independent researcher (researcher D) is presented with five accepted papers. Researcher D distils the substantive details (being careful not to ‘interpret’) and matches the paper’s results with one or more of five research questions. An example of a completed form used for this purpose is given in Appendix B. The details we place in the form do not present

a summary or abstract of the paper, but provide precise concrete details of how the paper answers our research question(s). It also details any secondary searches that are required.

5.5 Validation of the Protocol

This first draft is circulated to Helen, Hugh and Nathan for comment. Amendments have been made accordingly. These can be traced on the MoMSE web-based repository (http://mcs-notes2.open.ac.uk/QuickPlace/mmse/Main.nsf/h_Toc/4df38292d748069d0525670800167212/?OpenDocument). An external review of this protocol has been conducted by Professor Barbara Kitchenham (see Appendix D: Evidence Based Software Engineering Checklist for peer-review of a protocol).

Major amendments to the protocol have now been made in accordance with all feedback and reviews. This version (4) will be used to perform the review. Should any further changes be required we will update this protocol and change the version number accordingly. The most up-to-date version of the review will be posted on the MoMSE collaborative website (Lotus Quickplace) so that all researchers involved in the review have access to the current version.

6. Schedule of Activities

MoMSE Systematic Review - Schedule of Activities

Activity	Date	People involved	Completion Date	comments
Planning and Preparation				
Pre-pilot (1)	21.2.2006	Tracy, Sarah, Dorota	21.2.2006	Completed
Pre-pilot (2)	7.3.2006	Tracy, Sarah Dorota	8.3.2006	Completed
Pilot	16.3.2006	Helen, Sarah Dorota	16.3.2006	Completed
Protocol is developed v1	20.2.2006	Sarah	29.3.2006	Completed
Protocol v1 circulated for comment	29.2.2006	Nathan, Helen and Hugh	31.3.2006 pm (or Sat)	Please let Sarah know if you can't get comments back by this time
Revised accepted papers form	29.2.2006	Nathan, Helen	a.s.a.p	Helen will test the new form on one paper. Nathan will test the form and process on 5 papers (selected by Sarah)
Amend protocol and forms	1.4.2006	Sarah		Based on feedback
Protocol v2 circulated for comment	4.4.2006	Tracy, Nathan, Helen, Hugh	6.4.2006	Please let Sarah know if you can't get comments back by this time
Protocol v3 (final draft) sent to Barbara for independent review	7.4.2006	Sarah	a.s.a.p.	Need to check with Barbara when this can be completed

Address Barbara's comments	21.4.2006	Sarah	9.5.2006	Protocol returned on 20.4.2006
Give Feedback on changes	9.5.2006	Helen, Hugh, Nathan, Tracy	asap	Discuss at group meeting held on 9.5.2006. Changes e-mailed to group & posted on mmse site
Produce v4 of protocol incorporating agreed changes	10.5.2006	Sarah	10.5.2006	Version used in actual Review

Conduct Review				
Stage 1 Download face value papers	11.5.2006	Sarah (519 references found - placed in Endnote)	17.5.2006	Create search strings for each DB & RQ Download references into Endnote from from ALL databases
Stage 2 Check Exclusion/inclusion criteria – from abstract	18.5.2006 (Thurs)	Sarah 159 papers rejected after looking at abstract	22.5.2006 (Mon)	Copy and paste accepted papers into 'inclusion criteria met' Endnote library
Stage 2.1 Check Exclusion/inclusion criteria – from full paper	23.5.2006	Sarah 367 references – working on 144 full papers (incl some secondary papers)	On-going	223 missing papers – 120 missing papers allocated to Tracy, Helen, Nathan. 103 papers to find. DJ downloaded 70. 33 ordered from BL
Stage 3 Complete quality assessment and results forms	6.6.2006	Sarah (247) Tracy (50) Helen (50) Nathan (20)	On-going	Download full versions of accepted papers
MEETING (with lunch)	12.6.2006	Helen, Tracy, Nathan, Hugh Dorota, Sarah	-	Helen, Tracy and Nathan meeting at 11.30. Sarah, Hugh and Dorota joining meeting at 12.30
LEAVE	23.6.2006	Sarah	3.7.2006	Spain
Stage 4 Check results forms for secondary studies	3.7.2006	Sarah	10.7.2006 (Mon)	Perform Secondary Study searches and repeat stages 2-4 for all papers
Validate review process	11.7.2006	Sarah/Dorota	Final results	Sarah to select a random stratified sample of papers from each Endnote library
Perform Inter-rater reliability test	13.7.2006	Sarah/Dorota	13.7.2006	Sarah & Dorota discuss differences to see whether we can agree
Arbitration (2)	28.7.2006	Hugh	4 papers went to arbitration 28.7.2006	Papers where Sarah and Dorota can't agree are given to Hugh for arbitration
Validate Results Of accepted papers (Inter-rater check of quality assessment and completed paper forms)	12.7.2006	Nathan/Sarah	Batches 1, 2, 3 & 4 completed 12.7.2006	Nathan to look at all accepted papers to check findings. Where there is a disagreement they will try to come to an agreement –
Arbitration (3)	13.7.2006	Hugh	13.7.2006	Papers that Sarah and Nathan can't agree on

Arbitration (1) (Helen, Tracy, Hugh)
Papers will be given to team when Sarah is uncertain about including them – cancelled

				are given to Hugh for arbitration. (Tracy & Helen not available)
Synthesise Data	August	Sarah	August	synthesise data
LEAVE	17.7.2006	Sarah	26.7.2006	Tresco
Publish Results				
Report the review	September 06	Sarah et al		Produce TR published in both UH and OU
Report findings	Oct 06	Sarah et al		IST & Computing Personnel specialist group conference

7. Reporting the review

We plan to publish the process and results of performing the systematic literature review on software engineer motivation in the journal IST which has explicitly requested systematic reviews and/or as a conference paper (e.g. specialist group for computing personnel research). This will be supported by a detailed technical report that provides all the necessary transparency into the process and final reports.

8. Making changes to the Protocol

It is likely that changes to the protocol will be made when applying the procedures in new situations. Some changes will be made out of necessity, whereas other changes may be made to improve the current process. Every change to the protocol will be recorded and the protocol updated accordingly.

The end of the Protocol

Acknowledgements

The Modelling Motivation in Software Engineering (MoMSE) project is funded by the UK's Engineering and Physical Science Research Council, under grant number EPSRC EP/D057272/1. WebSite: gow.epsrc.ac.uk/viewgrant.aspx?Grant=EP/D057272/1&bannerlink=Programme%20support

We extend special thanks to Professor Barbara Kitchenham for her guidance in helping us to prepare this protocol and for formally reviewing the protocol. Thanks also to the following authors for supplying their papers and reports (sometimes in draft form) – they all helped to guide the development of this protocol:

M. Staples and Mahmood Niazi (2006). Experiences Using Systematic Review Guidelines. Accepted for International Conference on Evaluation and

Assessment in Software Engineering (EASE 2006), University of Keele, Keele, UK.

Mark Turner and Stuart Charters (EBSE Systematic Review: Protocol for a Systematic Literature Review of the Technology Acceptance Model and its Predictive Capabilities) Draft protocol

Barbara Kitchenham, Emilia Mendes, Guilherme Travassos (Protocol for Systematic Review of Within- and Cross-Company Estimation Models). Draft protocol

References

- Capretz, L. (2003). "Personality Types in Software Engineering", International Journal of Human-Computer Studies 58 (2): 207-214.
- Couger, J. D. and H. Adelsberger (1988). "Comparing Motivation Of Programmers And Analysts In Different Socio/Political Environments: Austria Compared To The United States", Computer Personnel 11(4) 11 (4): 13-16.
- Couger, J. D. and R. A. Zawacki (1980). "Motivating And Managing Computer Personnel", John Wiley and Sons.
- DeMarco, T. and T. Lister (1999). "Peopleware - Productive Projects And Teams", Dorset House.
- Enns, H. G., T. W. Ferratt, et al. (2006). "Beyond Stereotypes of IT Professionals: Implications for IT HR practices", COMMUNICATIONS OF THE ACM 49 (4): 105-109. ACM.
- Ferratt, T. W. and L. E. Short (1986). "Are Information Systems People Different: An Investigation of Motivational Differences", MIS Quarterly 10 (4): pp. 377-387.
- Khalil, O. E. M., R. A. Zawacki, et al. (1997). "What motivates Egyptian IS managers and personnel: Some preliminary results": 187-192. ACM, New York, NY, USA.
- Kitchenham, B. (2004). Procedures for Performing Systematic Reviews, Keele University and National ICT Australia Ltd.: 1 - 28.
- MoMSE (2005). "Modelling motivation in software engineering ", Case for Support. (EPSRC Proposal, EPSRC Reference: EP/D057272/1).
- ProjectLink. (2006). "Motivation House." <http://www.projectlink.co.uk/whoweworkfor.htm>, accessed 12.5.2006.
- Standish Report. (1995). "Standish Group Chaos Report." from URL <http://www.scs.carleton.ca/~beau/PM/Standish-Report.html>.
- Wynekoop, J. L. and D. B. Walz (1998). "Revisiting the Perennial Question: Are IS People Different?" The DATA BASE for Advances in Information Systems 29 (2) The University of Texas, San Antonio.

Appendix A: Example of Specific Guidelines for implementing the Review Process using Compendex indexing database

Our search involves all five Research Questions:

- *RQ1: What are the characteristics of Software Engineers?*
- *RQ2: What (de)motivates Software Engineers to be more (less) productive?*
- *RQ3: What are the external signs or outcomes of (de)motivated Software Engineers?*
- *RQ4: What aspects of Software Engineering (de)motivate Software Engineers?*
- *RQ5: What models of motivation exist in Software Engineering?*

One Indexing service

EI Compendex (www.engineeringvillage2.org/Controller/Servlet/AthensService)

EI Compendex - Although this service allows us to run Boolean and nested searches we cannot include all research terms in one search as the output is so large (over 150,000 papers), that the system crashes. We will therefore run 5 separate searches (one for each research question) and limit the time intervals. Specific step by step instructions are given below.

NB. It is important to note that although we are separating the search terms into sets relating to individual research questions, IF you find a paper in ANY search that relates to another research question do not ignore it. The 'Results' form for accepted papers will prompt you and allow you to fill in answers to any of the five RQs. Because the research questions have overlapping themes, it is likely that you will get some overlapping papers in each search. If you get the same paper coming up in subsequent searches you should ignore it. Each paper should have only one results form – so please fill in all categories in the results form when you first look at the paper (an example of the results form is given at the end of this document in section 3.5).

Implementing search dates and terms

1. Go to Search Engine

EI Compendex (www.engineeringvillage2.org/Controller/Servlet/AthensService)

This can be accessed from StudyNet homepage –

- on the left menu bar choose 'Journals & Databases'
- select 'Software'
- select 'Info DBs' A-Z list
- select 'E'
- scroll down and select 'Ei Engineering Village' and click on http link.

1.1 Once in EI Engineering Village (aka Compendex) go to **expert search**,

- **Search From:** select dates from pull down menu in both **from** and **to** fields.
- In “**Enter Search terms below**” window - copy & paste complete set of **search terms** given in your accompanying document “Search_Terms_pilot_16.03.2006.doc”. For completeness, these terms are also given below.

- The “Search_Terms_pilot_16.03.2006.doc is a table with reference numbers you will need to complete your search string ref # Endnote field. The table also contains cells for your search results (you will need to complete these immediately after you perform each search).

Search RQ1

Basic search terms: *Software Engineer* **AND** *Characteristics*

Search Terms for RQ1 (copy and paste)

((((software OR {information technology} OR {information system*} OR system* OR comput* OR IT OR IS)wn TI AND (engineer* OR developer* OR professional* OR programmer* OR personnel OR people OR analyst* OR {team leader}* OR {project manager}* OR practitioner* OR maintainer* OR designer* OR coder* OR tester*) wn TI) AND (((characteristic* OR types OR personality OR {human factors} OR different OR difference* OR psychology OR {psychological factors} OR motivator* OR prefer* OR behavio*r*)wn TI)))

Search Dates (1980 – Date)

Perform 3 searches for RQ1 on following dates:

From 1980 To 1989
 From 1990 To 1999
 From 2000 To Date (2006)

Look at a maximum of 100 papers in each of the three searches (in order given by search)

Search RQ2

Basic search terms: *Software Engineer* **AND** *motivation* **AND** *productivity*

Search Terms for RQ2 (copy and paste)

((((software OR {information technology} OR {information system*} OR system* OR comput* OR IT OR IS)wn TI AND (engineer* OR developer* OR professional* OR programmer* OR personnel OR people OR analyst* OR {team leader}* OR {project manager}* OR practitioner* OR maintainer* OR designer* OR coder* OR tester*) wn TI) AND ((motivat* OR demotiv* OR de-motiv* OR satisf* OR inspir* OR prompt* OR morale OR encourage* OR manage OR induc* OR provoke* OR {trigger off} OR caus* OR incentive* OR drive* OR morale OR enthusias* OR impetus OR stimul* OR spur OR {driving force}* OR impuls*)wn AB AND (productiv* OR factor* OR output OR efficien* OR interact OR yield OR production OR creat* OR prolific OR industrious OR fruitful OR dynamic OR hinder OR resist* OR increase OR decrease)wn AB))

Search Dates

Perform 3 searches for RQ2 on following dates:

From 1980 To 1989
 From 1990 To 1999
 From 2000 To Date (2006)

Be aware that some papers may be repeated from earlier search using different a search string. Ignore repeated papers included in earlier searches. When all papers have been downloaded for

each research question, we need to check and delete duplicated references before completing any other details. Use Endnote's duplicate function (Endnote 9 → References → Find Duplicates).

Search RQ3

Basic search terms: *Motivation AND impact AND Software Engineering*

Search Terms RQ3 (copy and paste)

((motivat* OR demotiv* OR de-motiv* OR satisf* OR inspir* OR prompt* OR morale OR encourage* OR manage OR induc* OR provoke* OR {trigger off} OR caus* OR incentive* OR drive* OR morale OR enthusias* OR impetus OR stimul* OR spur OR {driving force}* OR impuls*)wn TI AND (impact OR influence* OR impression* OR effect* OR bearing*)wn TI AND ({Software Engineering} OR {Software Development} OR {Information Technology} OR IT OR {information systems} OR IS OR {Agile Development} OR {Open Source Development} OR {Open Source Systems} OR OSS OR {Extreme Programming} OR XP OR {Agile Programming} OR {Systems Engineering} OR {Systems Development} OR computing)wn TI)

Search Dates: perform one search 1980 – 2006

Search RQ4

Basic Terms: *Aspects AND software engineering AND Motivation AND software engineers*

Search Terms RQ4 (copy and paste)

((aspect* OR feature* OR characteristic OR part OR side OR view)wn ALL AND ({Software Engineering} OR {Software Development} OR {Information Technology} OR IT OR {Agile Development} OR {Open Source Development} OR {Open Source Systems} OR OSS OR {information systems} OR IS OR {Extreme Programming} OR XP OR {Agile Programming} OR {Systems Engineering} OR {Systems Development})wn AB AND (motivat* OR demotiv* OR de-motiv* OR satisf* OR inspir* OR prompt* OR morale OR encourage* OR manage OR induc* OR provoke* OR {trigger off} OR caus* OR incentive* OR drive* OR morale OR enthusias* OR impetus OR stimul* OR spur OR {driving force}* OR impuls*) wn AB AND ({Software Engineer}* OR {Software Developer} OR {IT professional}* OR {Information Technology programmer}* OR {Systems Developer}* OR {software practitioner} OR {Information Systems Developer}* OR {IS professional}* {Information Systems Professional}* OR programmer* OR {Software Engineer}* OR {Systems engineer}* OR {Systems Analyst}* {software tester}* OR {software team leader}* OR {software project manager}*)wn AB)

Perform 3 searches for RQ4 on following dates:

From 1980 To 1989
From 1990 To 1999
From 2000 To Date (2006)

Search RQ5

Basic Terms: *Model AND motivation AND software engineering*

Search Terms for RQ5 (copy and paste)

((model* OR replica* OR represent* OR version OR copy OR framework OR paradigm OR example OR pattern OR standard OR prototype OR exemplar OR archetype OR structure OR frame OR skeleton OR outline OR context)wn TI AND (motivat* OR demotiv* OR de-motiv* OR satisf* OR inspir* OR prompt* OR morale OR encourage* OR manage OR induc* OR provoke* OR {trigger off} OR caus* OR incentive* OR drive* OR morale OR enthusias* OR impetus OR stimul* OR spur OR {driving force}* OR impuls*) wn AB AND ({Software Engineering} OR {Software Development} OR {Information Technology} OR IT OR {Agile Development} OR {Open Source Development} OR {Open Source Systems} OR OSS OR {information systems} OR IS OR {Extreme Programming} OR XP OR {Agile Programming} OR {Systems Engineering} OR {Systems Development} OR computing OR {Software Engineer}* OR {Software Developer} OR {IT professional}* OR {Information Technology programmer}* OR {Systems Developer}* OR {software practitioner} OR {Information Systems Developer}* OR {IS professional}* {Information Systems Professional}* OR programmer* OR {Software Engineer}* OR {Systems engineer}* OR {Systems Analyst}* {software tester}* OR {software team leader}* OR {software project manager}*)wn TI)

Perform 3 searches for RQ5 on following dates:

From 1980 To 1989
From 1990 To 1999
From 2000 To Date (2006)

PLEASE USE LOOKUP TABLE (Search_Terms_Pilot_16_03_2006.doc) FOR copying and pasting SEARCH STRING and SEARCH STRING Endnote REFERENCE.

2. Endnote Fields:

We have used one Reference type for all sources (Journals/Conferences/Reports/Web material)

The Endnote Library has been modified to include the following fields (example responses are given):

Endnote Reference Example:

Reference Type: Journal/Conference/Report/etc

Record Number: 5

Author: Almstrum, V. L.

Year: 2003

Title: What is the attraction to computing?

Paper ID: (AAYYYT TTT): AL2003WHA

Journal/Conference/Report: Communications of the ACM

Publisher: ACM, USA.

Volume: 46

Issue: 9

Pages: 51-5

Researcher: Sarah
Date of Search: 21 5 2006
Search String Lookup Table Ref: INSPEC 1
Exclusion Criteria (a): Is study based on cognitive behaviour? No
Exclusion Criteria (b) Is study external to software engineering? No
Exclusion Criteria (c): Is study personal opinion piece or viewpoint? No
+Inclusion Criteria (a): Research Question answered? RQ4 (RQ 5* *rejected at synthesis stage: AL2003WHA is not a model of motivation because it's a table of factors).
+Inclusion Criteria (b): Acceptable source? yes
++Quality Criteria(Score) - (Appendix A 3.3)see quality assessment form
 40% (short paper doesn't give response rate)
+Type of Study (empirical/theoretical/both/based on secondary data, Literature review); Empirical
***Type of Empirical study: Questionnaire/survey(self completed); Face to face interviews; Observation ; Focus Groups; Other (state)**
 Questionnaire
Decision Based on: (Keywords/Abstract/Introduction/Conclusion/ Methodology/Results/Whole Paper/Peer Review/Arbitration
 Whole Paper
+++repeated study (check for each accepted study) no
***population** computing professionals 78% women
***geographical area** 89% US 11% outside US
Decision Status: Proceed to next stage/Reject/Waiting for full paper/Don't Know/Include in Systematic Review
 Include in Systematic Review (Have full paper)
***Keywords**
***Abstract:** The strongest motivators in studying computing include a sense of accomplishment from solving problems and programming; the weakest include being captivated by the Web and a passion for playing computer games. Etc.
***Notes:** (Endnote places missing field here when uploading citations from databases)
***URL :** <http://doi.acm.org/10.1145/903893.903920>
 ~***Review Guidelines**
>>++Quality Assessment & Results form
***Access Date**
***Last Modified Date**
***Name of Reference Database:** ACM

<p> KEY: * = optional fields; ~ = you need to make link from your stored file; + = only if paper passes exclusion criteria test; ++ = only if paper passes exclusion AND inclusion tests +++ = only if paper passes exclusion AND inclusion tests AND quality criteria assessment made. >> = embedded file All other fields are compulsory </p>

3. Guidelines for filling in Endnote Fields and embedded forms

These guidelines explain how to fill in Endnote fields, “Exclusion Criteria”, “Inclusion Criteria”, “Quality Criteria”, “Decision based on reading”, “Decision Status” and finally “Results Form”.

3.1 ‘Exclusion criteria’ Fields (a – c)

a) Is study based on cognitive behaviour?

Response format: Yes / No / Not Sure

Guideline: The many detailed studies on cognitive behaviour of software engineers are outside the scope of this study. Although we are interested in general software engineer characteristics, the cognitive behaviour studies tend to be specific to certain environments and testing new methods and tools. Analysing and synthesising results from this type of work requires a separate study. Experts in this area – external to this review - will provide us with an overview of software cognitive behaviour which may prove important.

Cognitive behaviour papers along with all other ‘rejected’ papers are not deleted from the ‘All papers.enl’ library. They remain here (with reason for rejection entered into Endnote Decision Field) as they may prove a valuable resource for other systematic reviews.

Endnote Entry responses for Exclusion Criterion (a) are:
No - Accept paper/ Yes - Reject Paper/ Waiting for full paper/Not sure

b) Is study external to Software Engineering?

Response format: Yes / No / Not Sure

Endnote Entry responses for Exclusion Criterion (b) are:
No - Accept paper/ Yes - Reject Paper/Waiting for Full Paper/Not sure

Guideline: We discount studies on motivation that are not connected to software engineering.

c) Personal opinion / viewpoint

[Does this paper present a personal opinion, viewpoint or is it purely anecdotal?]

Response format: yes / no

Endnote Entry responses for Exclusion Criterion (c) are:
No - Accept paper/ Yes - Reject Paper/Waiting for Full Paper/Not sure

Guidance – If paper presents a personal opinion, viewpoint we do not include it in the final literature review. (Experience reports, referenced work and theoretical studies are not considered personal opinion and will not be excluded on this basis – the source will be judged in next stage)

If the paper does NOT fulfil any of the above criteria, i.e.

- Is NOT a cognitive behavioural study

AND

- Is NOT external to software engineering

AND

- Is NOT a personal opinion/viewpoint

[answers are: “no, no, no”]

– we can say that the exclusion criteria are ‘NOT MET’ and we CAN proceed to assessing the INCLUSION criteria in the next stage.

3.2 ‘Inclusion criteria’ Fields (a – b)

a) Research question answered

[Which research question does this paper address?]

Response format: in the form: Q1, Q2, Q3 etc.

Endnote Entry responses for Inclusion Criterion (a) are:
Q1/Q2/Q3/Q4/Q5 (one or more) = Accept paper
None answered = reject paper
Waiting for Full Paper = Paper is in WIP
Not sure = Paper is in WIP

Guidance – refer to the five research questions and exclude work on:

- a. Company size/hierarchy/structure
- b. Gender Differences/representation (too low level)
- c. Education (e.g. motivating IT students to learn)
- d. Group/team motivation and dynamics
- e. IT management (e.g. CIOs, project managers, project managers)

b) Acceptable source

[Is the source acceptable?]

Response format: yes / no

Endnote Entry responses for Inclusion Criterion (b) are:
Yes/ No/Waiting for Full Paper/Not sure

Guidance –Acceptable sources are: papers (in peer reviewed journals and conferences), technical reports, web site material. Not included are slides and books/book chapters.

If the paper fulfils all of the above criteria, i.e.

- answers at least one research question,
- source is acceptable and

[for example, answers are: “Q1, yes,”]
– we can say that the inclusion criteria are ‘MET’ and we can proceed to checking the QUALITY criteria.

3.3 ‘Quality criteria(score)’ Field

This quality check is used to guide interpretation and prepares information for future sensitivity analyses – if a paper has reached this stage, it will have gone through our exclusion and inclusion checks in 3.1 and 3.2. We do not exclude a paper on the basis of quality unless it is of such poor quality that we cannot interpret it. However, we will by the end of this section have an idea of the quality and whether we can generalise from the results. The Endnote Field requires you to fill in a quality score. To get a score you need to go to the Quality Assessment and Results Form, embedded in the Endnote Field of the same name. By completing the form you will get separate score and by aggregating the results you have a ‘quality score’ (given as a percentage). It is a very rough measure and can only be used in the context of the type of study being performed. For example of the form see section 4.1.3 in the body of the report.

Endnote Entry responses for Quality Criteria are:
Score (range 0 - 5)/Waiting for Full Paper/WIP/In arbitration

When you have completed the quality assessment form, convert score to a percentage and fill in Endnote “Decision status” field with score. Paper is not rejected because of poor quality. We do not expect all fields in the quality section to score highly or be positive. The score represents an aggregated quality assessment. See aggregated quality assessment form in section: 4.1.3

3.4 ‘Decision based on Reading’ Field

Endnote Entry responses for Decision based on reading are:

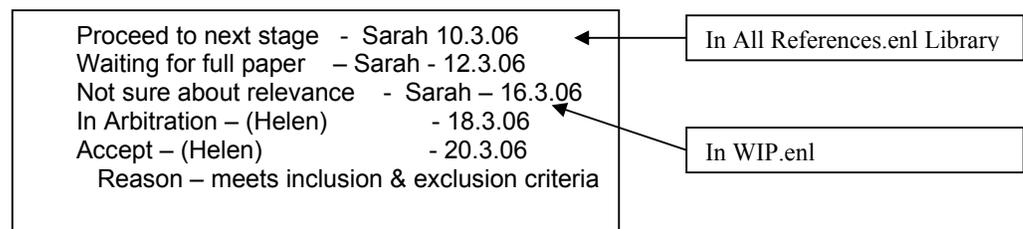
T – Title	I – introduction	D - discussion
K – keywords	M – methodology	C - Conclusion
A – abstract	R – results	WP – whole paper

3.5 Decision status Field (most important field)

Endnote Entry responses for Decision Status are:

- a) Proceed to next stage/Reject/Waiting for Full Paper/Not sure/In Arbitration/Accept in Systematic Review/Secondary study included/Related paper
- b) Name of person making decision (e.g. Nathan, Helen)
- c) date of entry

Guidance: In this field list the changing status of paper – until a decision is reached. In the case of arbitration, give details of person who is arbitrating; in all other situations give name of researcher responsible for decision. Record all changes to status here with dates (i.e. do not delete any entries). So the field might be filled with:



Secondary study included = refers to work embedded in primary paper that is recorded when primary paper is not included. We retain details within primary paper for consistency and traceability.

Related study = refers to work that DOES NOT relate directly to our research questions, but that has a wider application and might be of interest/relevance to the project as a whole. These papers will NOT be included in the systematic review, but are stored in Related study folder.

If paper is rejected state “reject” and fill in field with reason, e.g. ‘Reason: failed to meet inclusion criteria’. No more details are required.
 If paper status is “accept” – go to “Results Form” field

3.6 ‘Quality Assessment and Results Form’ Field

This form is only used if a paper is accepted (meets all exclusion and inclusion criteria). This form is part of a separate Word Document ready to embed in the “Quality Assessment and Results Form” field in Endnote. (Right click on the field and click on “Insert Object” from the drop down menu).

The results form follows on from our quality assessment (is physically on the same form) and is embedded into the Quality Assessment and Results field in Endnote.

The “Results Form” looks like this:

Paper study results/findings Form (Used only for ACCEPTED papers OR Follow-Up)

Reviewer Name	
Title of Paper	
Paper ID	
Paper Quality	EXCELLENT / VERY GOOD / GOOD / NEUTRAL / POOR / VERY POOR
THE FOLLOWING REFER TO OUR RQs:	RECORDED IN PAPER
1. Software engineer characteristics (RQ1)	
2. Software Engineer motivators (RQ2)	
3. External signs or outcomes of motivated engineers (RQ3)	
4. Software Engineer ‘de-motivators’ (RQ2 – indirect)	
5. External signs or outcomes of de-motivated software engineers (RQ2 – indirect)	
6. SW Engineering as a motivator (e.g. what is motivating about the type of development used; task of coding, testing etc) (RQ4)	
7. Frameworks /models that reflect how software engineers are motivated (RQ5)	
8. Other observations	

If you fill in any of the fields 1 – 8:
 a) Link file to ‘results form’ field in Endnote, and
 b) Save file in accepted papers electronic folder.

Secondary Sources/Follow up Work

9. References found in paper (to follow up)	
10. Secondary studies in paper (where authors have used enough detail that we can extract the work directly) Note number(s) 1 – 8 from table above, to indicate which RQ is being addressed	
11. Secondary studies embedded in paper that require analysis of original work before using in review	Give Reference and area of work interested in following up.
12. Author direct contact	If study is important, current, incomplete or suggests author is continuing to research in this area, note contact details here and what questions to ask them.
13. Does the author have other related work?	If likely, run secondary search on Author name.
14. Does the source (e.g. journal or conference proceeding) contain other related work?	If this is likely, run secondary search on the source.

If you fill in any secondary source fields (9 -14), save file in Secondary Sources folder (ensuring you fill in paper ID reference at top of form.

Record findings in the “Recorded in Paper” column. This can include direct quotes from the paper. Please complete all sections that are relevant, even if it appears to answer different RQ(s) to the one used for your search.

If you fill in any primary study fields (1-8) AND some secondary source fields (9-14) save file in both secondary sources folder AND accepted papers folder.

This completes all the possible entries you need in Endnote.

3.7 Data Synthesis

Data synthesis is performed after all Endnote Fields have been completed for all papers. Data synthesis uses: All Accepted papers: the Endnote form; the quality assessment and the results form. We have no fields in Endnote that relate to this part of the systematic review. For how we synthesise the data see section 4.1.8 in the body of the protocol.

APPENDIX B: Example of a completed MoMSE Results form (used for accepted papers and secondary study / follow-up work.

Paper study results/findings Form (Used only for ACCEPTED papers)

Reviewer Name	Sarah
Title of Paper	Motivated Humans for reliable software products
Paper ID	FR1998MOT
THE FOLLOWING REFER TO OUR RQs:	RECORDED IN PAPER
1. Software engineer characteristics (RQ1)	Engineers value quality of their work as most important asset “Everybody is doing everything so the IT industry has a lot of generalists and few specialists”
2. Software Engineer motivators (RQ2)	Recognition based on objective criteria Roles should be allowed to evolve, and then define roles and responsibilities (fit roles to people, not people to roles)
3. External signs or outcomes of motivated engineers (RQ3)	
4. Software Engineer ‘de-motivators’ (RQ2 – indirect)	<ul style="list-style-type: none"> • Teamwork that <ul style="list-style-type: none"> • Lacks trust • paper shuffles • Are physically separated • Fragments time • Has phoney deadlines • Reduces quality of product • Recognition based on management intuition or personal preference. • Company benefits based on company rank. • Noisy offices • Working long hours (unpaid overtime) • Lack of Meetings (or meetings that are disorganised or ill-conducted) • “There cannot be a more demoralizing bad practice than the loss of direct contact to all levels of management”
5. External signs or outcomes of de-motivated Sw engineers (RQ2 – indirect)	High turnover
6. SW Engineering as a motivator (e.g. what is motivating about the type of development used; task of coding, testing etc) (RQ4)	
7. Frameworks /models that reflect how software engineers are motivated (RQ5)	Euphoria quadrant – immediately assesses IT staff motivation. Based on hypothesis that IT staff are motivated by an <u>enhanced working environment</u> and <u>sound leadership</u> . – these seem to be the only factors measured.
8. Other observations	An experience report based on observation supported by findings from the literature The motivation assessment model “Euphoria quadrant” is still in experimental stage.

If you fill in any of the fields 1 – 8, please
a) link to ‘results form’ field in Endnote, and
b) save form in accepted papers folder.

Secondary Sources/Follow up Work

9. References found in paper (to follow up)	Crosby, P B “Quality without Tears: The Art of Hassle-free Management” 1984, McGraw Hill, NY New York.
10. Secondary studies in paper (where authors have used enough detail that we can extract the work directly) Note number(s) 1 – 8 from table above, to indicate which RQ is being addressed	
11. Secondary studies embedded in paper that require analysis of original work before using in review	Give Reference and area of work interested in following up.
12. Author direct contact	Frangos states that model is still in experimental stage. We should contact the author to find out whether this model was developed further.
13. Does the author have other related work?	Do search on Frangos – may give details of development of the motivation model or related work.
14. Does the source (e.g. journal or conference proceeding) contain other related work?	Try journal of Microprocessors and Microsystems for other work on Motivation.

If you fill in secondary sources fields (9 or 10), please save this file in Secondary Sources folder, for later follow up work. Please ensure you fill in the paper ID reference at top of form.

Appendix C: Complete set of search terms for each database

Research Questions:

RQ1: What are the characteristics of Software Engineers?

RQ2: What (de)motivates Software Engineers to be more (less) productive?

RQ3: What are the external signs or outcomes of (de)motivated Software Engineers?

RQ4: What aspects of Software Engineering (de)motivate Software Engineers?

RQ5: What models of motivation exist in Software Engineering

Search RQ1

Basic search terms: *Software Engineer AND Characteristics*

Search RQ2

Basic search terms: *Software Engineer AND motivation AND productivity*

Search RQ3

Basic search terms: *Motivation AND impact AND Software Engineering*

Search RQ4

Basic Terms: *Aspects AND software engineering AND Motivation AND software engineers*

Search RQ5

Basic Terms: *Model AND motivation AND software engineering*

Databases:

IEEE Explore

ACM Digital library:

Google scholar (scholar.google.com)

Cite Seer library (citeseer.ist.psu.edu)

UH University's electronic library (voyager.herts.ac.uk)

Inspec (www.iee.org/Publish/INSPEC/)

ScienceDirect (www.sciencedirect.com)

EI Compendex (www.engineeringvillage2.org/Controller/Servlet/AthensService)

ISI Web of Science

Each database has its own set of search terms that relate to each of the five research questions. These search strings are copied and pasted into the database to initiate the review.

PLEASE USE THE LOOKUP TABLE to copy and paste SEARCH STRING (into Database) and SEARCH STRING REFERENCE (into Endnote Search_String field).

1. ACM

Date	Search string	Search Identifier	Comments
4.Mar.2006	(in must have all window): Personality OR characteristics AND (in must have any of the following words or phrases window): "Software engineering" "information technology" "information system" "systems engineering" IT IS AND (engineer* OR developer* OR professional* OR programmer* OR personnel OR people OR analyst* OR {team leader}* OR {project manager}* OR practitioner* OR maintainer* OR designer* OR coder* OR tester*) wn TI) AND (((characteristic* OR types OR personality OR {human factors} OR different OR difference* OR psychology OR {psychological factors} OR motivator* OR prefer* OR behavio*r*)wn TI	ACM1	Piloting year 2005 only Search 'abstract' only
4.Mar.2006	(in must have all window): motivation AND (in must have any of the following words or phrases window): engineer developer professional programmer "Information Systems Developer" "Information Systems Professional" Analyst tester "team leader" "project manager"	ACM4	Piloting year 2005 only Search 'abstract' only
4.Mar.2006	(in must have all window): motivation AND (in must have any of the following words or phrases window): model replica represent version copy framework paradigm example pattern standard prototype exemplar archetype structure frame skeleton outline context	ACM5	Piloting year 2005 only Search 'abstract' only

2. EI Compendex (www.engineeringvillage2.org/Controller/Servlet/AthensService)

COMPENDEX SEARCH TERMS LOOKUP TABLE

Compendex® is the most comprehensive interdisciplinary engineering database in the world. Compendex contains over 9 million records and references over 5,000 international engineering sources including journal, conference, and trade

publications. Coverage is from 1969 to present and the database is updated weekly.

PLEASE USE THIS LOOKUP TABLE TO

1. CUT AND PASTE **SEARCH STRING** INTO COMPENDEX DATABASE SEARCH WINDOW and
2. PLACE **SEARCH IDENTIFIER** INTO ENDNOTE SEARCH STRING REFERENCE # FIELD.

Researcher Name:
Table 8. Search identifier

Date	Search string wn TI = within Title wn AB= within Abstract wn ALL = within ALL * = truncation. { } encapsulates terms.	Search Identifier	Comments
16 March 2006	((((software OR {information technology} OR {information system*} OR system* OR comput* OR IT OR IS)wn TI AND (engineer* OR developer* OR professional* OR programmer* OR personnel OR people OR analyst* OR {team leader}* OR {project manager}* OR practitioner* OR maintainer* OR designer* OR coder* OR tester*) wn TI)) AND (((characteristic* OR types OR personality OR {human factors} OR different OR difference* OR psychology OR {psychological factors} OR motivator* OR prefer* OR behavio*r*)wn TI)))	RQ1	Expert Search
		3 separate searches	
		COMP 1.1	Year 1980-1989
		COMP 1.2	Year 1990-1999
		COMP 1.3	Year 2000-2006
16 March 2006	((((software OR {information technology} OR {information system*} OR system* OR comput* OR IT OR IS)wn TI AND (engineer* OR developer* OR professional* OR programmer* OR personnel OR people OR analyst* OR {team leader}* OR {project manager}* OR practitioner* OR maintainer* OR designer* OR coder* OR tester*) wn TI)) AND ((motivat* OR demotiv* OR de-motiv* OR satisf* OR inspir* OR prompt* OR morale OR encourage* OR manage OR induc* OR provoke* OR {trigger off} OR caus* OR incentive* OR drive* OR morale OR enthusias* OR impetus OR stimul* OR spur OR {driving force}* OR impuls*)wn AB AND (productiv* OR factor* OR output OR efficien* OR interact OR yield OR production OR creat* OR prolific OR industrious OR fruitful OR dynamic OR hinder OR resist* OR increase OR decrease)wn AB))	RQ2	Expert search
		3 separate searches	
		COMP 2.1	Year 1980-1989
		COMP 2.2	Year 1990-1999
		COMP 2.3	Year 2000-2006
16 March 2006	((motivat* OR demotiv* OR de-motiv* OR satisf* OR inspir* OR prompt* OR morale OR encourage* OR manage OR induc* OR provoke* OR {trigger off} OR caus* OR incentive* OR drive* OR morale OR enthusias* OR impetus OR stimul* OR spur OR {driving force}* OR impuls*)wn TI AND (impact OR influence* OR impression* OR effect* OR bearing*)wn TI AND ({Software Engineering} OR {Software Development} OR {Information Technology} OR IT OR {information systems} OR IS OR {Agile Development} OR {Open Source Development} OR {Open Source Systems} OR OSS OR {Extreme Programming} OR XP OR {Agile Programming} OR {Systems Engineering} OR {Systems Development} OR computing)wn TI)	RQ3	Expert search
		One search	
		COMP 3	Year 1980-2006

16 March 2006	((aspect* OR feature* OR characteristic OR part OR side OR view)wn ALL AND ({Software Engineering} OR {Software Development} OR {Information Technology} OR IT OR {Agile Development} OR {Open Source Development} OR {Open Source Systems} OR OSS OR {information systems} OR IS OR {Extreme Programming} OR XP OR {Agile Programming} OR {Systems Engineering} OR {Systems Development})wn AB AND (motivat* OR demotiv* OR de-motiv* OR satisf* OR inspir* OR prompt* OR morale OR encourage* OR manage OR induc* OR provoke* OR {trigger off} OR caus* OR incentive* OR drive* OR morale OR enthusias* OR impetus OR stimul* OR spur OR {driving force}* OR impuls*) wn AB AND ({Software Engineer}* OR {Software Developer} OR {IT professional}* OR {Information Technology programmer}* OR {Systems Developer}* OR {software practitioner} OR {Information Systems Developer}* OR {IS professional}* {Information Systems Professional}* OR programmer* OR {Software Engineer}* OR {Systems engineer}* OR {Systems Analyst}* {software tester}* OR {software team leader}* OR {software project manager}*)wn AB)	RQ4	Expert search
		3 separate searches	
		COMP 4.1	year 1980 - 1989
		COMP 4.2	Year 1990-1999
		COMP 4.3	Year 2000-2006
16 March 2006	((model* OR replica* OR represent* OR version OR copy OR framework OR paradigm OR example OR pattern OR standard OR prototype OR exemplar OR archetype OR structure OR frame OR skeleton OR outline OR context)wn TI AND (motivat* OR demotiv* OR de-motiv* OR satisf* OR inspir* OR prompt* OR morale OR encourage* OR manage OR induc* OR provoke* OR {trigger off} OR caus* OR incentive* OR drive* OR morale OR enthusias* OR impetus OR stimul* OR spur OR {driving force}* OR impuls*) wn AB AND ({Software Engineering} OR {Software Development} OR {Information Technology} OR IT OR {Agile Development} OR {Open Source Development} OR {Open Source Systems} OR OSS OR {information systems} OR IS OR {Extreme Programming} OR XP OR {Agile Programming} OR {Systems Engineering} OR {Systems Development} OR computing OR {Software Engineer}* OR {Software Developer} OR {IT professional}* OR {Information Technology programmer}* OR {Systems Developer}* OR {software practitioner} OR {Information Systems Developer}* OR {IS professional}* {Information Systems Professional}* OR programmer* OR {Software Engineer}* OR {Systems engineer}* OR {Systems Analyst}* {software tester}* OR {software team leader}* OR {software project manager}*)wn TI)	RQ5	Expert search
		COMP 5.1	Year 1980-1989
		COMP 5.2	Year 1990-1999
		COMP 5.3	Year 2000-2006

**APPENDIX D: Independent Review of the MoMSE Protocol v3
(plus responses from researcher)**

**Evidence Based Software Engineering
Checklist for peer-review of a protocol**

Title of Protocol MOMSE Modelling Motivation in Software Engineering

Name of Reviewer Barbara Kitchenhan

Area of expertise (domain expert, review expert, consumer) Review expert

Date of completion 19 April 2006

When providing feedback on this protocol, please feel free to complete all sections or just those the sections that you find relevant to your area of expertise. Additional comments may be provided where necessary.

*Name of Researcher (addressing feedback): Sarah Beecham
Post-meeting updates made 9/10th May 2006*

Researcher responses given in italics with heading: 'Response'

General

1. Is the protocol well structured, clearly written and does it cover all relevant issues?
Yes

Comments:

It would benefit from some forward references:

Section 4.1.2 Should reference Appendix A 3.2 for quality criteria

Section 4.1.5 Should reference the Arbitration process in 10.2 and 11.2 and 12.2

Response:

Forward references now included in the two sections above.

Cover sheet

2. Does the sheet include the names of the reviewers and contact details of the main reviewer?
Yes

Yes

Comments: _____

Response: None required

3. Is the title clear and does it reflect the subject of the protocol?
Yes

Comments: _____
Response: None required

Background

Have the author(s) described:

3. The problem?

Yes

Comments:

4. The significance of the problem?

Yes

Comments: The authors might consider describing some of the mixed messages (with references).

Response: This required more background reading and explaining what some of the mixed messages are. E.g. whether software engineers are
(a) a homogeneous group of people (e.g. all introverted);
(b) a group with different characteristics and needs – a job that attracts different personality types.

Propose adding the following to our introduction:

The literature is presenting mixed messages relating to software engineer motivation. For example, a body of work found that programmers and analysts have lower measured needs for social interaction and higher growth needs than the general population (e.g., Couger and Zawacki, 1980; Couger, 1986; Couger and Adelsberger, 1988). The literature often characterises IT employees as a homogeneous group of high achievers (Couger & Zawacki, 1980). These studies suggest that IT employees are somehow different to non-IT employees, a view reinforced by a more recent study where Wynekoop and Walz (1998) found “important differences in personalities exist between IS employees and the general population”. On the other hand, Ferratt and Short (1986) question the existence of differences between IT and non-IT employees. They found that IT employees within the technical-professional and managerial sub-occupations of IT employees were not more motivated by achievement needs than corresponding subgroups of non-IT employees. Although they did find that meaningful work was the highest motivator for these IT subgroups.

There is a prevalent view in the IT literature that IT employees are homogeneous in their needs suggesting that IT employees are motivated by the same employment arrangement (e.g., see Wynekoop and Walz, 1998). Yet according to a recent study (Enns et al. 2006) “managers should look beyond the stereotypes and strive for a richer understanding of their IT professionals”. We therefore construct several research questions to gain a broad view of the research on software engineer characteristics and software engineer motivation.

5. Current practice regarding the problem (inc. previous reviews, if any)?

No

Comments: Are motivational issues generally addressed empirically or theoretically? Are there standard study approaches?

Response:

There don't appear to be 'standard' study approaches in the area of SE motivation. This is possibly due to the multi-disciplinary nature of the research questions. Motivational issues are addressed both empirically and theoretically. Empirical studies include ethnographic observational studies, action research, questionnaires, individual interviews and focus groups. Theoretical studies are those where an expert makes observations and may draw on some of the motivational literature more associated with psychology and sociology and business organisation. Until the literature review is completed, it is not possible to predict whether there is a general approach to recognising SE motivation issues.

Action: I have included a categorisation of study approaches in our quality assessment form to allow us to perform sensitivity analyses.

6. Is the background clear and understandable for the non-expert?

Yes

Comments: Could be more detailed.

Response: By adding to what the mixed messages are (item 4) and the types of studies that exist, we will be giving more detail and background to the work.

Objectives

7. Are the specific objectives and the research questions for the review clearly stated?

Yes

Comments:

Response: None required

8. Does the proposed review address an important software engineering question?

Possibly

Comments: The purpose of the review is to assess this issue

Response: None required – however we need to be clear that the SE question is important – even if we find that SE motivators are no different to non-SE motivators, isn't that relevant and important to find out?

Search strategy for identification of studies

9. Is the search strategy reasonably unbiased, comprehensive and adequate for the study question?

Yes

Comments:

The researchers have only tested one resource. Constructing search strings for some other sources may be different in particular ACM.

Response: In our pre-pilot studies we explored ACM, IEEE Xplore and are aware of some of the different strings and syntax of each of these search engines. When using new search engines we will check that key papers are included when making the search. We will amend the method / string to ensure these are included if necessary. We use the lookup table to copy and paste the string into the database. We do not need to amend our procedure, but add to section 4.1.1:

"When we develop our search strings for each database on our list we place them in Appendix C and give them a unique reference. This is necessary as databases tend to have proprietary search methods (e.g. different syntax, nesting allowances, etc). All search strings will be tested to ensure that key texts (known to be in the particular database) are extracted in the search."

10. Are the resources to be searched, the search constraints (for example, years covered), and the validation process clearly outlined?

Yes

Comments: The review includes a rigorous and well-thought out validation process.

Response: None required

Criteria for considering studies for the review

11. Are the inclusion/exclusion criteria clearly stated? Are these appropriate?

11.1: Yes, 11.2: No

Comments:

For this type of systematic review, you need to beware of multiple publications based on the same work. If one study is reported in several different articles, you may think that some characteristics is more important than it is (based on a count of the number of articles that reference it). Also note some people do not reference their own previous work (when it is the same study) and may have different titles for their repeated primary studies. This means you need to check that papers with the same authors (perhaps in a different order or perhaps just a subset of authors) are reporting different studies. If not include either the most upto date study or the one that includes most detailed information.

Response: Procedure now includes a section after all papers have been accepted that checks for multiple publications. There is also a field for this in Endnote with +++which means we fill this in only when paper is accepted. – In reality we cannot fill this field in until the end of the data extraction process.

Using the quality criteria as an exclusion criteria has problems:

1. A practical problem is that you have a Yes/No criterion for each question but the questions each decompose into several sub questions and it is not clear how you arrive at a Yes or No if some sub questions indicate good quality and some indicate poor quality.

*Response: It is difficult to be totally scientific and objective when assessing quality issues. The general idea is that if any of the quality issues are No, we need to think about excluding it. However, it might be better not to exclude paper on this basis, but to rank them. I.e. a poor quality paper is included but given a weighting.
Need to discuss this with team*

For now I have created a draft procedure for handling /assessing quality matters. See under item 19.

2. It is often better to use the quality criteria to guide interpretation rather than initial inclusion/exclusion criteria.

This topic is discussed further below (see question 19).

Response: Need to discuss further with team. Barbara doesn't want to see another copy of the protocol so this is up to us to work out and agree.

Another issue concerns the Endnote forms. The protocol suggests that the field Notes and Research Notes are mandatory but I can't see any definition of what should be written in those fields.

*Response: they should not be mandatory, have amended with * to show that Notes is an optional field (In fact 'notes' is the field Endnote uses for all the data uploaded from Databases that do not match existing fields – therefore we must keep this field, even if we don't enter anything here ourselves manually). Have deleted Research Notes from list as we did not find a need to use it during any of our pilot studies.*

Finally, don't destroy information about closely related SE issues – it might be a valuable resource for other systematic reviews (e.g. cognitive behaviour studies).

Response: We do not delete any papers that we upload from databases as based on face value. Paper references that are excluded or don't meet our inclusion criteria remain in our 'all papers' library. In the decision field we will give reason for rejection, which will include 'cognitive study' (and all exclusion criteria as a potential category).. Later we can look at all papers in each library to see whether they may be useful in another study that is independent of this literature review. I will not change anything relating to this as I believe our system covers this requirement.

12. Is bias in the selection of articles likely to be avoided?

No

Comments: Possible sources of bias have been recognised and the secondary search process is likely to reduce the problem. However, it might be appropriate to consider contacting active researchers directly. Also I believe there are social science databases for PhD thesis

Response: Have highlighted contacting authors directly in the acceptance form and as a possible resource. We restrict direct contact to the few key authors in the area of SE motivation. We do not include social science databases in our searches as it is outside the scope of this study. We will not attempt to access PhD theses.

13. Will the selection of studies be carried out independently by at least two people?
Yes

Comments: The review has a very well defined selection process
Response: No action required

14. Are the types of studies that are considered for inclusion appropriate to the review?
Yes

Comments:
Response: No action required;

The following questions relate to the Population, Intervention, and Outcomes identified in the protocol.

Are the following appropriate for the review:

15. The types of participants considered (i.e. the Population)?
Yes

Comments:
Response: No action required

16. The types of interventions considered?
This issue is inappropriate for this study.

Comments:
Response: No action required

17. The types of outcome measures to be considered (i.e. validated, when available with an adequate period of follow-up)?
Yes

Comments:
Response: No action required

Assessment of study quality

18. Is the criteria used for assessing the quality of studies reported?
Yes

Comments: See above

19. Is the criteria used for assessing study quality appropriate?
No

Comments:

I would recommend:

1. Breaking the quality criteria down into the sub questions and extracting answers to each sub question in your data collection form.

Response: This proved too cumbersome as it involves coding and long list of questions.

2. Concentrating on questions that indicate a high quality study not questions that indicate a poorly reported study (as suggested by Andrew Booth, Keynote address, EASE06). For example for empirical studies in addition to the questions related to soundness of methodology you could consider:

Response: The newly created form has a section for empirical studies that include these sub-sections and indicate high quality:

- a. How many subjects? Quality issue - the larger the sample size the better.
- b. Were the subjects a random sample of practitioners? Quality issues – a non-random sample has problems with generalisation.
- c. For non random samples, were the subjects representative of practitioners? Quality issue - student subjects, self-selected subjects may give systematically different answers to “normal” practitioners.
- d. How was information obtained? Questionnaire, Interview, Other. Quality issue – different methodologies may have different degree of reliability.
- e. Do the conclusions arise from the study results? Quality issue – you can only use the conclusions if they arise from the study results. (This is an example of a quality issue that might guide inclusion/exclusion.)

You need to consider what quality means in the context of a theoretical study. Perhaps you can just label the study as empirical or theoretical or both and use that characteristic to subset results for sensitivity analysis (e.g. do theoretical papers and empirical papers identify different characteristics?).

Response: Have amended study type field to have only three categories: Empirical, Theoretical, Both.

Suggest Endnote has only one field for quality

Quality Criteria (score): (Appendix A 3.3)see quality assessment form for score

4.1.3 Document: Quality Assessment

This form, as shown in Table 2, is embedded in the Quality Assessment and Results form field in Endnote. The form is completed for ALL papers that have passed the exclusion and inclusion assessments. The quality assessment form lists and aggregates quality criteria. The objective is to provide a rough guide to the quality of the paper before completing the accepted papers form. This assessment does not act as an exclusion criterion but guides interpretation. The score alone has little meaning; to understand the quality we need to look at the criteria and context of the assessment and cannot compare quality of different papers as based on the score alone.

Endnote has only one field that allows a file attachment. We will use this field for both this quality form AND the accepted papers form (explained in next section 4.1.4).

Table 2: Scoring Endnote Quality Fields

Item	Assessment criteria	Score between 0 – 1	Response options for Score
1	Does study report clear, unambiguous findings based on evidence & argument?	1	Yes = 1 /No = 0
For empirical studies:			
2	Is sample unbiased?	1	Random Sample = 1 Non-random sample representative of sub-group = .5 Not representative = 0
3	Could you replicate study?	1	Yes = 1/ No = 0
4	Number of participants?	1	See coding and scores in table 2.1 below. Give sample size here
5	For a questionnaire, what is the response rate?	1	No response rate given = 0 Over 80% = 1 Under 20% = 0 Between = .5
For theoretical studies:			
6	Is the paper well/appropriately referenced?		Yes = 1 Moderately = .5 No = 0
Total Quality Score		5	Enter this score in Accepted papers 'Quality score' field

Table 2.1: Coding and Scoring Data collections

Data collection Method	Code	Score (Sample No)
Questionnaire/Survey (self completed)	1	Unit = 1 person <=5 = 0; >5<50 =.5; >50 = 1
Face to face interviews	2	Unit = 1 person Depends on depth of interview. Heuristic <3 = 0; ≥3 ≤5 = .5; >5 = 1
Observation	3	Unit = 1 person Depends on depth and time spent. Heuristic <3 = 0; ≥3 ≤5 = .5; >5 = 1
Focus Groups	4	Unit = Group Depends on depth and time spent. Heuristic <3 = 0; ≥3 ≤5 = .5; >5 = 1
Theoretical Study (no data collection)	5	n/a
Secondary Data used (e.g. systematic literature review)	6	n/a
<i>If method not included in this table, Add new row and number here and update protocol accordingly – creating a new version number.</i>		

The problem is then deciding how you aggregate the answers into a quality assessment! I would suggest:

- a. Organise Yes/No questions so Yes is good and count the number of Yes's.
- b. For other questions e.g. size of sample construct a score based on the range of possible values e.g. <5 scores poorly (0), >50 scores highly (1) other ranges of value score in between. Note the score might be different for different study types 3-5 people might be appropriate for in depth interviews but not for self-completed questionnaires.
- c. Nominal values can be used to subset the data, for sensitivity analysis (e.g. do you get different results looking at studies based on questionnaires compared with studies based on interviews

Response: See table 2 & 2.1 above. I have tried to carry out these instructions systematically.

20. Will this quality and validity of studies be assessed in a reliable manner, using a recommended criteria list?

Yes

Comments: The current process is good and could be applied to a longer list of questions

Response: No changes required

21. Will the assessment of quality be performed independently by at least two reviewers?

Yes

Response: No changes required

Data collection/extraction

22. Is the process of data collection clear?

No

Comments:

The protocol refers to a "list" of factors. However it is not clear at what level of detail the factor is described. I think you will need a name for the factor and a definition to be able to identify similar concepts given different labels

Response: I believe this refers to the data synthesis. Until we actually carry out the review and identify factors (not already implied by the RQ) – we cannot pre-empt this.

23. Will the reviewers record all relevant data?

No

Comments:

I think more quality data is required and more information about the nature of data to be extracted is required.

Response: Have addressed this in the new quality assessment form.

24. Will attempts be made to retrieve missing information?

No

Comments: I did not see any process for approaching authors about missing information.

Response: Have addressed this by highlighting authors as a general resource and have a section to contact authors in our results form. – However not sure if this is adequate, since this was also noted on protocol sent to Barbara.

25. Will data extraction be performed independently by at least two reviewers?

Yes

Comments:

Analysis (data synthesis)

26. Is the primary outcome defined in advance?

Yes

Comments:

27. Are the methods (qualitative or quantitative) used to combine the findings of the relevant studies reported and are they appropriate?

No

Comments:

Currently the aggregation tables are based on each paper, however in order to answer the research question they need to be organised around the characteristics and (de)motivation factors. This should include identifying how many papers identified each factor.

You will need to analyse the extracted data to look for common concepts in different papers (perhaps labelled differently, or worse the same labels used to refer to different concepts).

Response: I have organised the aggregation tables around the characteristics inherent in each RQ as listed below. To focus more on the characteristics rather than the Paper ID requires a further stage. I will retain 'Data Synthesis Form 1' which will feed into a more themed synthesis around factors (form 2) and sensitivity analysis (form 3). Not sure whether I have understood Barbara's concerns. PLEASE COMMENT>

Data Synthesis Form 1: Research Question 1
 # of papers accepted that relate to this question (completed at end):

<i>RQ1: What are the characteristics of Software Engineers?</i>						
Paper ID	Quality (score)	Population (e.g. age group, experience level)	Geographical location	year of study	Type of Study	SW Engineer Characteristics (list)
Paper ID	Quality	Population (e.g. age group, experience level)	Geographical location	year of study	Type of Study	SW Engineer Characteristics (list)
etc						

Data Synthesis Form 2: Counts of Identified factors

<i>RQ1: What are the characteristics of Software Engineers?</i>		
SW Engineer Characteristic A (identified in Form 1)	# of papers	
SW Engineer Characteristic B (identified in Form 1)	# of papers	
etc		

A data synthesis for all RQs will be performed based counts of identified factors reported in Form 1.

Data Synthesis Form 3: Sensitivity Analysis based on population for RQ1

<i>RQ1: What are the characteristics of Software Engineers?</i>			
Population	# of papers	Differences	Similarities
e.g. Students	e.g.		
e.g. Computer Operators			
e.g. Novices			
e.g. Experienced Practitioners			

Sensitivity analyses (highlighting similarities and differences) will be performed for ALL RQs based on: Population; Geographical Area; Chronology; Study Type, Data collection method. When populating the results forms for each individual paper we may find further categories to investigate.
 (The example above is just for RQ1).

When findings have been recorded in these forms, a finer-grained classification of themes can be conducted. We cannot predict what these themes will be until we have reached this stage. When we are sure of the quality of the paper we can start doing counts of say SE characteristics when appropriate. However in a qualitative study such as this, we are not sure what conclusions we can draw from counts. We may merely draw up lists that are independent of each other and based on specific communities and calendar years.

28. Have methods for the assessment of statistical heterogeneity been defined?

No

Comments: This question is inappropriate for the current study

Response: No action required

29. Have plans for appropriate subgroup analyses been defined?

No

Comments:

Quality criteria and type of paper should be considered for subgroup analysis

Response: This has now been addressed – see response to item 27.

30. Have plans for appropriate sensitivity analyses been defined?

No

Comments:

Quality criteria and type of paper should be considered for sensitivity analysis.

Response: This has now been addressed – see response for item 27.

31. Have plans for reporting the results been stated?

Yes

Comments:

The authors should consider IST which has explicitly requested systematic reviews.

Response: Have noted this in our section on plans for publishing our results

The authors should produce a technical report including all their results (i.e. including the data extraction forms) in case they have to publish a shortened version of the paper.

Response: Have noted this in our section on plans for publishing out results

Note. Potential conflict of interest: I am Assistant Editor of systematic reviews for IST so have a vested interest in soliciting papers.

Potential conflict of interest

32. Have any potential conflicts of interest been declared?

No

Comments:

The authors should identify the process for handling any papers that they co-authored

Response: Have added to the validation section:

Potential conflict of interest: Co-investigators, Dr Nathan Baddoo and Dr Tracy Hall have authored/co-authored papers on Software Engineer motivation that may be included in the review. These researchers will not be involved in evaluating or arbitrating any of their own papers. The key researcher, Dr Sarah Beecham, has not published papers in this area and all quality and acceptance decision made by the key researcher will be checked by a second researcher. Should the search reveal any papers that are authored or co-authored by any of the researchers involved in this review, the author(s) will not be involved in the selection process.

Validation of the Protocol

33. Are the procedures for validating the protocol clearly outlined?

Yes

Comments: Very good and thorough validation process.

Review Timetable

34. Is there a timetable given for the review?

Yes

Comments:

35. Is it suitably detailed in terms of stages of the review?

No

Comments:

Perhaps working back from the end might help scheduling. In addition, writing the final report is extremely quick if you have a good protocol and have produced appropriate aggregation tables. You probably wont need more than 5 days to get the first draft ready for review

Response: Have made some amendments, but cannot foresee being ready for publication before July.

Updated schedule given in body of the report.

Overall Recommendation

Major revision needed

Comments:

The search and extraction process are very well defined. The main weakness is:

1. The quality criteria (both the nature of the criteria and how they are used)

2. The data aggregation – I recommend trying to aggregate data from several papers in order to devise an appropriate aggregation method.

Response: The quality criteria and data aggregation have been amended. The team now needs to agree the new format.

Please indicate here if you would like to receive the reviewer response to your feedback:

No

Please indicate here if you would like to receive a copy of the revised protocol:

Yes This protocol has a lot of exemplary features I would like to see it available as a technical report (or a paper) in its own right to help other people construct good protocols

Thank you for your input