# Motivation in Software Engineering: A Systematic Literature Review

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OBJECTIVE - In this paper we present a systematic literature review of motivation in Software Engineering. The objective of this review is to plot the landscape of current reported knowledge in terms of what motivates developers, what de-motivates them and how existing models address motivation.

METHOD - We perform a systematic literature review of peer reviewed published studies that focus on motivation in Software Engineering. Systematic reviews are well established in medical research and are used to systematically analyse the literature addressing specific research questions.

RESULTS - We found 92 papers related to motivation in Software Engineering. 56% of the studies reported that Software Engineers are distinguishable from other occupational groups. Our findings suggest that Software Engineers are likely to be motivated according to three related factors: their 'characteristics' (for example, their need for variety); internal 'controls' (for example, their personality) and external 'moderators' (for example, their career stage). The literature indicates that de-motivated engineers may leave the organisation or take more sick-leave, while motivated engineers will increase their productivity and remain longer in the organisation. Aspects of the job that motivate Software Engineers include problem solving, working to benefit others and technical challenge. Our key finding is that the published models of motivation in Software Engineering are disparate and do not reflect the complex needs of Software Engineers in their career stages, cultural and environmental settings.

CONCLUSIONS – The literature on motivation in Software Engineering presents a conflicting and partial picture of the area. It is clear that motivation is context-dependent and varies from one engineer to another. The most commonly cited motivator is the job itself, yet we found very little work on what it is about that job that Software Engineers find motivating. Furthermore, surveys are often aimed at how Software Engineers feel about 'the organisation', rather than 'the profession'. Although models of motivation in Software Engineering are reported in the literature, they do not account for the changing roles and environment in which Software Engineers operate. Overall, our findings indicate that there is no clear understanding of the Software Engineers' job, what motivates Software Engineers, how they are motivated, or the outcome and benefits of motivating Software Engineers.

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## 1. INTRODUCTION

In this paper we present findings from our systematic literature review on motivation in Software Engineering (SE). Since Bartol and Martin's literature review in (1982) no comprehensive body of research has been published to provide a complete picture of the available material on motivation in Software Engineering. By updating work in this area we help SE managers, Software Engineers and interested researchers to determine the current state of research in Software Engineering motivation. Our systematic approach to analyzing published studies enables us to identify reliably where the literature has recurring themes, where it presents conflicting findings, and where are there gaps in the existing body of work.

Motivation in Software Engineering is reported to have the single largest impact on practitioner[1] productivity (Boehm 1981) and software quality management (McConnell 1998), and continues to be 'undermined' and problematic to manage (Procaccino et al. 2005). While there is increasing recognition amongst practitioners and the academic community that motivation is an important issue, no systematic literature review has been undertaken to bring together the published work of motivation in a Software Engineering setting (MoMSE(cfs) 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. 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. As McConnell (1998) points out,

> "Motivation is a soft factor: It is difficult to quantify, and it often takes a back seat to other factors that might be less important but are easier to measure. Every organisation knows that motivation is important, but only a few organizations do anything about it. Many common management practices are pennywise and pound-foolish, trading huge losses in motivation and morale for minor methodology improvements or dubious budget savings."

Some 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 (Tanner 2003; Ramachandran and Rao 2006).

Given the importance of motivating Software Engineers, we conduct a systematic literature review of what motivates Software Engineers and whether Software Engineers are indeed a homogeneous group with similar needs. A systematic literature review evaluates and interprets all available research relevant to a particular research question or topic area. It aims to present an evaluation of the literature relative to a research topic by using a rigorous and auditable methodology. We have followed guidelines derived from those used by medical researchers, adapted and applied by Kitchenham et al (2004; 2006) to reflect the specific problems of Software Engineering research. We summarise evidence that establishes what motivates Software Engineers and how existing theoretical frameworks represent motivation in Software Engineering. We look to the literature to answer 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?*

[1] The way Software Engineer (as a practitioner) and Software Engineering (as a field) have been referred to over the 26 years covered in this study has evolved significantly. IT, IS, SE, analysts, developers, programmers are examples of some of the terms used for the practitioner role/field. In this survey we use the term 'Software Engineer' (SE) to refer to any of these roles and Software Engineering to refer to the field. However, when quoting or referring to a particular paper, we use the term used in the study.

*RQ5: What models of motivation exist in Software Engineering?*

In this review the literature often characterises Software Engineers (SE's) as a homogeneous group of high achievers (Couger and Zawacki 1980; Capretz 2003). These studies suggest that Software Engineers are somehow different to non-Software Engineers, 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 (including IT managers) within the technical-professional sub-occupations 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.

Couger and Zawacki's (1980) seminal work on motivation in software engineering was conducted over 20 years ago. Yet, this work has been used throughout the period of this review as the central model of Motivation in Software Engineering. The environment for software engineering has changed considerably since that time, e.g. with the increase in outsourcing, open source development, new technical concepts and languages, new lightweight development methods and so on. So, in this review we consider whether this work is still as valid as it was.

This paper is organised as follows. In Section Two we describe the method we used for our systematic literature review, this involves producing and following rules in a protocol that is independently validated. We also report on the quality of the included papers in this section. Section Three presents results of our synthesis of the literature, including geographical spread, temporal aspects and publication details. Section Four reports the results of our synthesis of identified themes based on our five research questions. In Section Five we discuss our key findings. Section Six presents some limitations of this study, and finally in Section Seven we present our conclusions.

## 2. METHOD

### 2.1 Introduction

In accordance with systematic review guidelines (Kitchenham 2004) we take the following steps:

1. Identify the need for a systematic literature review (MoMSE(cfs) 2005)
2. Formulate review research question(s)
3. Carry out a comprehensive, exhaustive search for primary studies
4. Assess and record the quality of included studies
5. Classify data needed to answer the research question(s)
6. Extract data from each included study
7. Summarise and synthesise study results (meta-analysis)
8. Interpret results to determine their applicability
9. Write-up study as a report

These steps are detailed in our protocol (See (Beecham et al. 2006) or http://homepages.feis.herts.ac.uk/~ssrg/MOMSEProto.htm). We developed our protocol by running three separate pilot studies involving four researchers who performed searches based on rules given in the protocol. After several refinements the protocol was peer reviewed by an independent expert in systematic review development in Software Engineering.

The remainder of this methodology section summarises the process presented in our protocol. Where more information is required please refer to (Beecham et al. 2006).

### 2.2 Resources Searched

Key words and synonyms were drawn up for each research question. Then the following databases were searched using these key words:

- ACM Digital library
- EI Compendex
- Google scholar
- IEEE Explore
- Inspec
- ISI Web of Science
- ScienceDirect
- UH University's electronic library (voyager.herts.ac.uk)

To ensure we did not overlook any important material, additional searches were performed directly on key conference proceedings, journals and authors.

### 2.3 Document Retrieval

Our searches elicited over 2,000 references. Evaluating the title and abstract enabled us to reject approximately 1,500 of these. We then looked at 519 papers in full to establish a final list of 92 papers.

### 2.4 Procedures for Including and Excluding Studies

Any published work that directly answers our research questions and was published between 1980 – date is considered for inclusion in our review. To be included the study must also be published in a journal paper, conference proceedings, or empirical experience report based on theoretical or previous rigorous research. Studies are excluded that are opinion pieces or viewpoints that do not reference any other study or are not based on empirical work. We also excluded studies external to Software Engineering, which focus on cognitive behaviour, general group/team motivation and dynamics, manager motivation, user/end user motivation and acceptance of technology, gender differences and education (e.g. motivating IT students to learn).

We included studies that focus on motivation and satisfaction in Software Engineering. We included satisfaction as it is often used to measure Software Engineer motivation. For example, satisfaction is considered in great detail in the Job Diagnostics Survey for Data Processing Personnel (JDS/DP) tool (Couger and Zawacki 1980) that is used extensively to measure Software Engineer motivation.

### 2.5 Study Quality Assessment Checklists

Each accepted study is assessed against a quality checklist. Scores are given according to whether the study presents clear, unambiguous findings based on evidence and argument. Quality scores for the 92 papers are given in Table 1:

| Table 1: Quality scores of Accepted Papers | | | | | | |
|---|---|---|---|---|---|---|
| | QUALITY (scores) | | | | | Total |
| | Poor (<26%) | Fair (26%-45%) | Good (46%-65%) | Very Good (66%-85%) | Excellent ( >86%) | |
| Number of Studies | 6 | 10 | 32 | 32 | 12 | 92 |
| Percentage of papers | ~6.5% | ~10.5% | ~35% | ~35% | ~13% | 100% |

Over 82% of papers included in our literature review have quality scores that are good to excellent.

### 2.6 Data extraction and synthesis

We used Endnote version 9 (www.endnote.com) to record reference details for each study. How each study answers the research question(s) was recorded on a separate results form. We synthesised the data by identifying themes emanating from the findings reported in each accepted paper. These identified themes gave us the categories reported in our results section. In our results section we present frequencies of the number of times each theme is identified in different studies. We give each occurrence the same weight. The frequencies merely reflect how many times a given characteristic or motivator is identified in different papers, not how important it may be.

A sensitivity analysis was performed on these studies based on population, location, year and type of study. The sensitivity analyses gave us information on where the data might be biased. They are also reported in our results section. Our protocol provides full details of this process.

### 2.7 Validation

We performed two validation exercises:

**A. Inter-rater reliability:** We ran an inter-rater reliability test on the 519 paper references we found in our initial search. A group of primary researchers looked at each of these papers in greater detail (9 papers proved unobtainable). 95 papers were accepted by the primary researchers. An independent researcher looked at 58 randomly selected rejected and accepted papers (approx every $10^{th}$ paper from an alphabetical list of the 519 papers). A 99.4% agreement was recorded with the original assessments. This high level of agreement gives us considerable confidence in our acceptance/rejection decisions.

**B. Independent assessment:** We performed a final validation exercise on the 95 'accepted papers'. An independent expert in motivation in Software Engineering recorded how each paper addressed our research questions. Again there was a high level of agreement between the primary researchers and the independent expert (99.8%), and any disagreements were discussed. There were only three papers that could not be agreed on, and these went to arbitration with a third, independent researcher who determined whether the papers should be included and how each study addressed our research question(s). This process resulted in 100% agreement. Three of the accepted papers were rejected as a result of this exercise, leaving 92 papers for inclusion.

## 3. RESULTS - BACKGROUND

### 3.1 Type of study

Figure 1 shows that out of the 92 studies, 86% are empirical, i.e. findings are based on direct evidence or experiment. The 11% theoretical or conceptual studies are based on an understanding of the field from experience and reference to other related work. There are a small number of studies (3%) that are either reviews of the literature or secondary studies, where empirical work is re-examined.

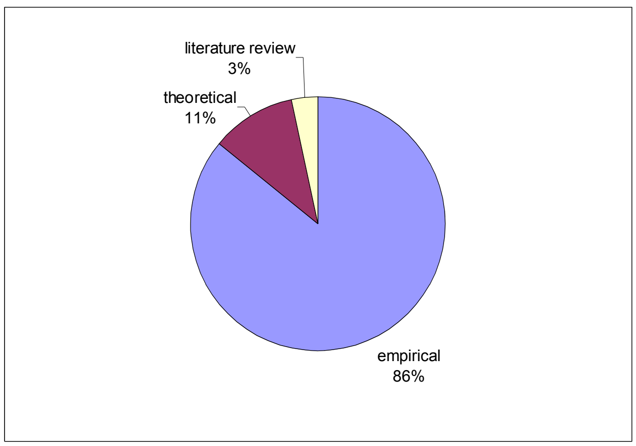



Figure 1: Types of studies in our accepted papers

Data collection methods used in the empirical studies include: surveys and questionnaires, field studies, structured and semi-structured interviews (face-to-face and by telephone), analysing results of programming tests, data reviews, case studies, focus groups and controlled experiments.

Out of the 79 studies that are empirically based, only 5 studies do not include questionnaires. Figure 2 shows how these data collection methods are divided with 94% (78% + 16%) of the empirical studies employing questionnaire survey instruments:

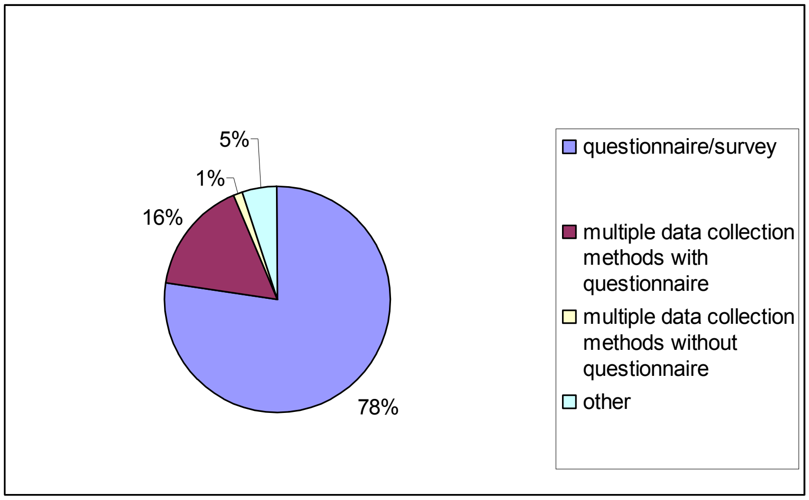



Figure 2: Data collection methods used in the empirical studies

### 3.3 Temporal view of publications

Figure 3 shows that over the last 26 years there is a recent increase in published papers covering Software Engineer characteristics and motivation in Software Engineering.

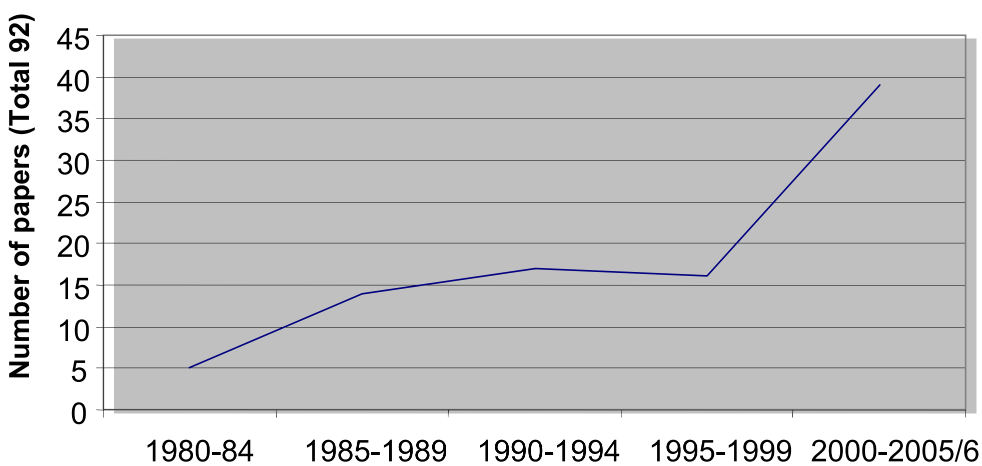



Figure 3: Number of papers included in the review by five year intervals

This recent increase may be a reflection of a growing awareness of the importance of motivation in Software Engineering. Alternatively, this increase may just match a general rise in published papers in Software Engineering.

### 3.4 Data Sources

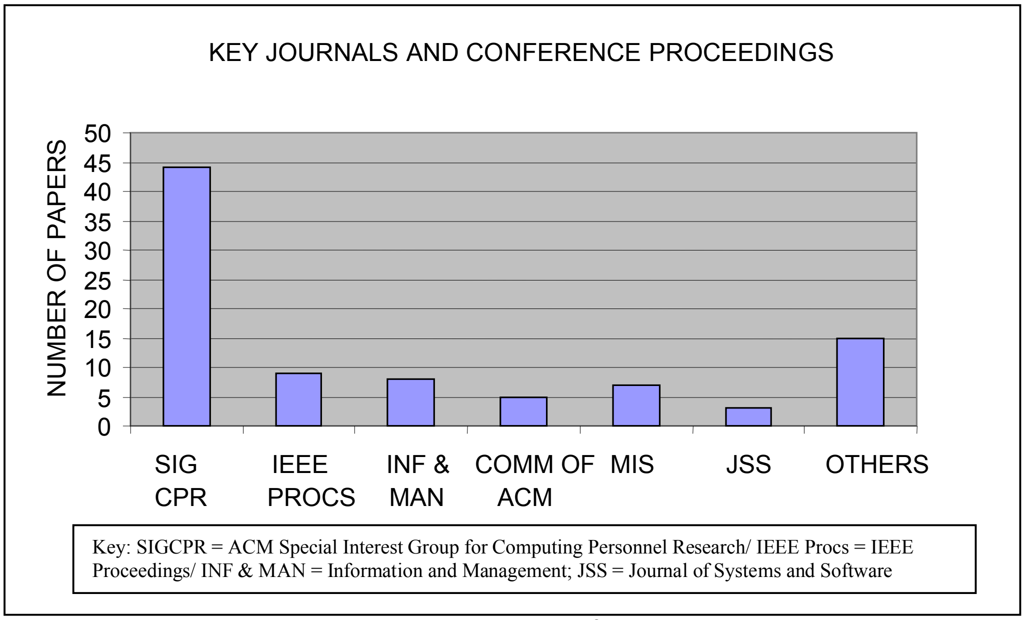



Figure 4: Publication sources of our included studies

Figure 4 gives a breakdown of where our 92 papers are published. The majority are published by the special interest group on computer personnel research with fewer papers reaching the more widely known journal publications.

### 3.5 Geographical distribution of papers

A high percentage of the empirical studies in our review are concentrated on work carried out in the USA (56%), as shown in Figure 5:

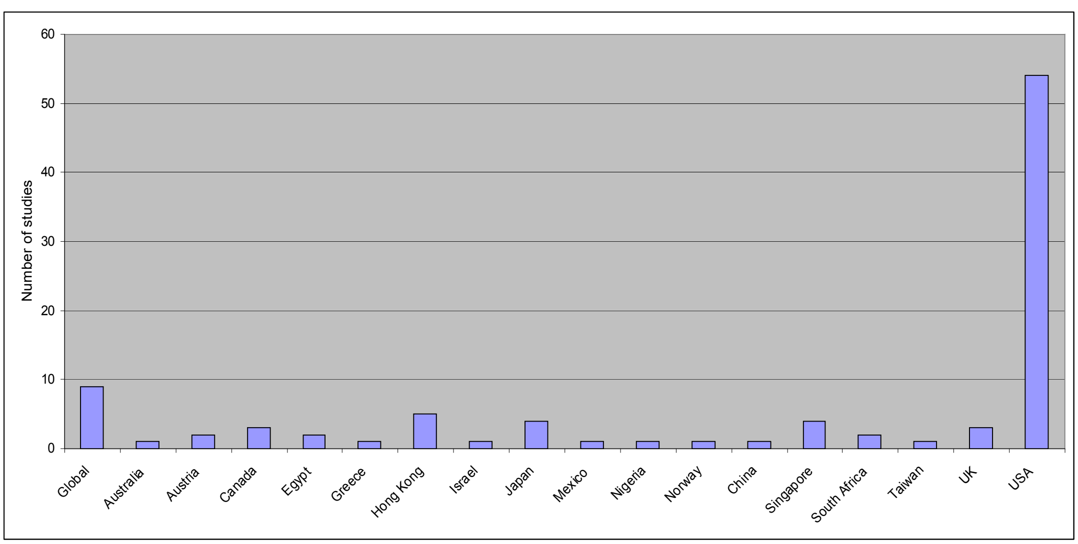



Figure 5: Countries represented in the empirical studies

Seventeen countries are represented, and although the nine global studies involve all continents, countries such as India are not well represented in the literature. It is clear that when we synthesise findings from all the studies we are giving a predominantly Western view of motivation in Software Engineering.

## 4. RESULTS - MOTIVATION IN SOFTWARE ENGINEERING

This section reports on how the literature represents motivation in Software Engineering. Figure 6 gives an overview of how our research questions work together to give a comprehensive view of our topic. Citations for the 92 papers included in this section are given in numeric form with a bibliography in Appendix 1.

By investigating the five research questions in Figure 6, we aim to gain a broad picture of what the literature is reporting on motivation in Software Engineering. We collected information on Software Engineer characteristics (RQ1) to broaden our understanding of the underlying constructs relating to what (de)motivates Software Engineers to be more/less productive (RQ2). We then took a more in depth view of Software Engineer (de)motivators to uncover areas specific to the Software Engineering task itself (RQ4). To see how motivation is measured and the potential benefits or otherwise of motivating Software Engineers, we researched the external signs of (de)motivated Software Engineers. Finally, we looked at how all aspects of motivation are modelled in the Software Engineering literature (RQ5).

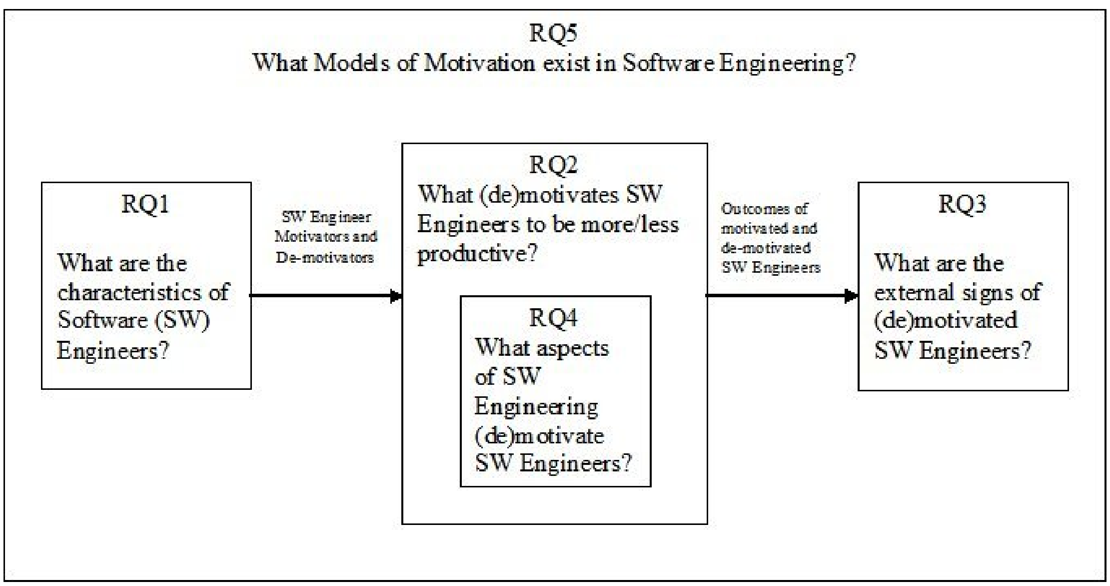


Figure 6: The relationship between our five Research Questions

### 4.1 Do Software Engineers form a distinct occupational group?

Figure 7 shows that papers fall into three categories when considering whether Software Engineers form a distinct occupational group.

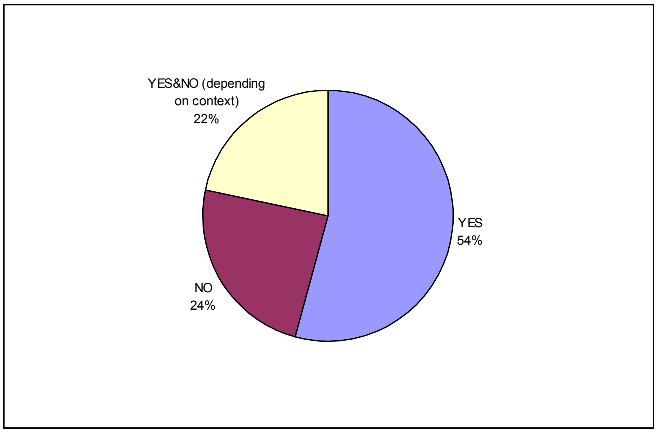



Figure 7: Do Software Engineers form a Distinct Group?

Figure 7 shows that 76% (54% plus 22%) of papers find that Software Engineers do form a distinct occupational group, albeit that in 22% of the cases this is context dependent. However, 24% of papers report that Software Engineers do not form a distinct occupational group and in some contexts this rises to 46% (24% + 22%). Six papers included in our software characteristics group of papers do not cover this question and are therefore excluded from this analysis.

The following sub-sections look at each of our research questions in more detail.

### 4.2 RQ1 - Software Engineer Characteristics

43 papers were identified as answering Research Question 1 (RQ1), "*What are the characteristics of Software Engineers?*"

These 43 papers identify 24 attributes which relate to 'characteristics' of SEs. However a closer inspection shows that these attributes can be structured into three linked categories. The first category contains the 'raw' characteristics of Software Engineers. The second contains factors that control whether or not a particular individual will have those characteristics. The third contains moderators which determine the strength of a characteristic within an individual. Figure 8 shows how Characteristics, Control Factors and Moderators seem to relate to one another: an individual will have a given *Characteristic* (e.g. need for stability) depending on their *Control Factors* (e.g. their Myers Briggs Type Index (MBTI) score), and the strength of this characteristic is *Moderated* by contextual factors, such as the country they live and work in. This structure implies a different profile of characteristics for every individual Software Engineer, and that over time, an individual's motivation changes. Both of these implications are consistent with findings in the literature.

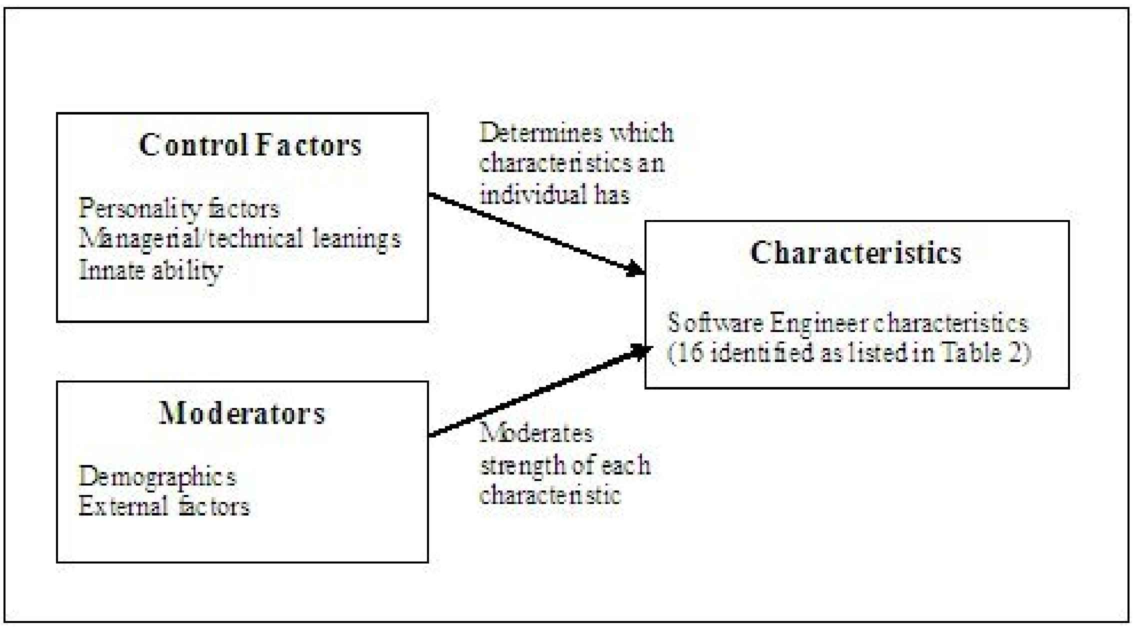



Figure 8: Determinants of software engineer characteristics

Using this structure, we have identified 16 'raw' Software Engineer characteristics of which growth oriented, introverted and need for independence are the most cited. The literature often uses the term 'Career Anchor' to describe a person's characteristics. A person's career anchor is (1) his or her self concept of talents and abilities; (2) his or her self concept of basic values; and (3) the individual's evolved sense of motives and needs (Schein 1996).

Table 2 presents our literature review results for characteristics.

| TABLE 2: Software Engineer Characteristics | | |
|---|---|---|
| **Ch: Software Engineer Characteristics** | **Paper references** | **Frequency (# of studies)** |
| Ch.1 Need for stability (organisational stability) | [1-5]; | 5 |
| Ch.2 Technically competent | [1, 3, 6-8] | 5 |
| Ch.3 Achievement orientated (e.g. seeks promotion) | [2, 9-11] | 4 |
| Ch.4 Growth orientated (e.g. challenge, learn new skills) | [4, 7, 9, 12-17] | 9 |
| Ch.5 Need for competent supervising (e.g. needs respect and appreciation, given a clear job to do and goals) | [2, 3, 8, 18] | 4 |
| Ch.6 Introverted (low need for social interaction) | [12-14, 19-22] | 7 |
| Ch.7 Need for involvement in personal goal setting | [14] | 1 |
| Ch.8 Need for feedback (needs recognition) | [14, 15] | 2 |
| Ch.9 Need for Geographic stability | [3] | 1 |
| Ch.10 Need to make a contribution (needs worthwhile/ meaningful job) | [3, 4, 8] | 3 |
| Ch.11 Autonomous (need for independence) | [3-5, 11, 13, 17, 22] | 7 |
| Ch.12 Need for variety | [3, 5, 17, 23] | 4 |
| Ch.13 Marketable | [5, 17] | 2 |
| Ch.14 Need for challenge | [5, 11, 17, 20] | 4 |
| Ch.15 Creative | [17, 24] | 2 |
| Ch.16 Need to be sociable/identify with group/organisation/supportive relationships | [4, 8, 9, 17, 25] | 5 |

Control Factors relate to an individual's personality, their internal make-up and their strengths and weaknesses. These control factors seem to determine the existence of various 'raw' characteristics.

Table 3 presents our literature review results for control factors.

| TABLE 3: Software Engineer Controllers | | |
|---|---|---|
| **Con: Controllers** | **Paper references** | **Frequency (# of studies)** |
| Con.1 Personality Traits ( e.g. introverted, thinking) | [6, 10, 19, 24, 26-28] | 7 |
| Con.2 Career Paths (Managerial/Technical) | [3, 4, 29] | 3 |
| Con.3 Competencies (how good they are at their job) | [6, 11, 30, 31] | 4 |

Table 3 shows there are many studies that report personality traits of Software Engineers. Our findings suggest that an engineer's personality, career path preference and competencies will control whether each of the 16 characteristics listed in Table 2 form part of his or her make-up.

Moderators are external factors that influence characteristics, for example, environmental conditions, type of work and role are moderators. Our findings suggest that moderators change the strength of a particular Software Engineer characteristic. Table 4 presents our results for moderators.

| TABLE 4: Software Engineer Moderators | | |
|---|---|---|
| **Mod: Moderators (context)** | **Paper references** | **Frequency (# of studies)** |
| Mod.1 Career stage (age & experience, e.g. Apprentice, colleague, mentor, sponsor) | [6, 26, 32-37] | 8 |
| Mod.2 Culture (relating to different countries) | [2, 5, 9, 13, 15, 20, 25, 38] | 8 |
| Mod.3 Job type/role/ occupational level | [16, 20, 39, 40] | 4 |
| Mod.4 State of IT profession (a snap shot of an evolutionary process) | [22, 37, 39, 41, 42] | 5 |
| Mod.5 Type of organisation (e.g. promotion opportunities/rules) – relating to lifestyle | [4] | 1 |

Finally, Table 4 shows that career stage and culture are often cited in the literature as moderating an engineer's characteristics. To a lesser extent the literature considers that the type of job and the type of organisation will also moderate an engineer's characteristics. This means that these factors are likely to moderate the strength of each characteristic an individual software engineer has.

### 4.2 Research Question 2

62 papers answered Research Question 2, "*What (de)motivates Software Engineers to be more (less) productive?*"

This section is divided into papers that identify Motivators; De-motivators; and Implementation Factors. Implementation factors are issues that need to be considered when applying motivators and influence the effectiveness of motivators. Table 5 summarises the frequencies of papers relating to motivators:

| **TABLE 5: RQ2 – Motivators in Software Engineering** | | |
|---|---|---|
| **Motivators** | **References** | **Frequency (# of studies)** |
| M.1 Rewards and incentives (e.g. scope for increased pay and benefits linked to performance) | [7, 23, 36, 43-53] | 14 |
| M.2 Development needs addressed (e.g. training opportunities to widen skills; opportunity to specialise) | [3, 7, 22, 25, 43, 44, 48, 49, 54-56] | 11 |
| M.3 Variety of Work (e.g. making good use of skills, being stretched) | [9-11, 25, 29, 37, 43, 44, 48, 50-52, 55, 57] | 14 |
| M.4 Career Path (opportunity for advancement, promotion prospect, career planning) | [3, 9, 11, 25, 29, 37, 43, 44, 47, 48, 50-52, 55, 57] | 15 |
| M.5 Empowerment/responsibility (where responsibility is assigned to the person not the task) | [7, 11, 44, 54, 57, 58] | 6 |
| M.6 Good management (senior management support, team-building, good communication) | [7, 10, 18, 22, 25, 37, 44, 46, 48, 49, 51, 53, 54, 56, 59, 60] | 16 |
| M.7 Sense of belonging/supportive relationships | [8, 10, 21, 22, 25, 43-45, 49, 56, 61-64] | 14 |
| M.8 Work/life balance (flexibility in work times, caring manager/employer, work location) | [4, 25, 43-45, 64, 65] | 7 |
| M.9 Working in successful company (e.g. financially stable) | [4, 44] | 2 |
| M.10 Employee participation/involvement/working with others | [23, 33, 43, 44, 49, 52, 54, 58, 60, 66, 67] [10, 25, 49, 63, 68] | 16 |
| M.11 Feedback | [9, 10, 20, 23, 33, 37, 45, 56, 67, 69] | 10 |
| M.12 Recognition (for a high quality, good job done based on objective criteria -different to M1 which is about making sure that there are rewards available). | [7, 8, 10, 22, 23, 25, 46, 48, 49, 51, 54, 68] | 12 |
| M.13 Equity | [52, 67, 70] | 3 |
| M.14 Trust/respect | [8, 33, 58, 70] | 4 |
| M.15 Technically challenging work | [11, 22, 42, 46, 48, 54, 59, 64, 65, 67, 68] | 11 |
| M.16 Job security/stable environment | [23, 25, 43, 46-48, 50, 56, 59, 71] | 10 |
| M.17 Identify with the task (clear goals, personal interest, know purpose of task, how it fits in with whole, job satisfaction; producing identifiable piece of quality work) | [7-9, 11, 18, 20, 22, 23, 33, 47-51, 53, 54, 56, 67, 68, 72] | 20 |
| M.18 Autonomy (e.g. freedom to carry out tasks, allowing roles to evolve) | [7, 9-11, 33, 56, 67-69] | 9 |
| M.19 Appropriate working conditions/environment/good equipment/tools/physical space/quiet | [4, 7, 47, 64, 67, 73] | 6 |
| M.21 Making a contribution/task significance (degree to which the job has a substantial impact on the lives or work of other people) | [8, 9, 11, 33, 48, 61] | 6 |
| M.22 Sufficient resources | [25, 48] | 2 |

Table 5 shows that the most frequently cited motivators in the literature are, ‘the need to identify with the task’ such as having clear goals, a personal interest, understanding the purpose of task, how the task fits in with the whole, having job satisfaction; and working on an identifiable piece of quality work. Having a clear career path and a variety of tasks is also found motivating in several papers.

Table 6 lists the de-motivators found in the literature.

| **TABLE 6: RQ2 – De-Motivators in Software Engineering** | | |
|---|---|---|
| **De-Motivators** | **References** | **Frequency (# of studies)** |
| D.1 Risk | [1] | 1 |
| D.2 Stress | [43, 66, 69, 74, 75] | 5 |
| D.3 Inequity (e.g. recognition based on management intuition or personal preference) | [7, 43, 56, 66] | 4 |
| D.4 Interesting work going to other parties (e.g. outsourcing) | [45] | 1 |
| D.5 Unfair reward system (e.g. Management rewarded for organisational performance; company benefits based on company rank not merit) | [7, 70] | 2 |
| D.6 Lack of promotion opportunities/stagnation/career plateau/boring work/poor job fit | [37, 56, 61, 76, 77] | 5 |
| D.7 Poor communication (Feedback deficiency/loss of direct contact with all levels of management) | [7, 13, 20, 39, 56] | 5 |
| D.8 Uncompetitive pay/poor pay/unpaid overtime | [7, 13, 20, 56, 77, 78] | 6 |
| D.9 Unrealistic goals/ phoney deadlines | [7, 13, 23, 42, 56, 77] | 4 |
| D.10 Bad relationship with users and colleagues | [42, 51, 56, 74] | 4 |
| D.11 Poor working environment (e.g., wrong staffing levels/unstable/insecure/lacking in investment and resources; being physically separated from team) | [4, 7, 10, 22, 23, 56, 73, 74, 79] | 9 |
| D.12 Poor management (e.g. poorly conducted meetings that are a waste of time) | [7, 20, 22, 23, 42, 47, 56, 79] | 7 |
| D.13 Producing poor quality software (no sense of accomplishment) | [7, 23, 56] | 3 |
| D.14 Poor cultural fit/stereotyping/role ambiguity | [42, 51, 63] | 3 |
| D.15 Lack of influence/not involved in decision making/no voice | [23, 56] | 2 |

Table 6 shows that poor working conditions and lack of resources are reported as de-motivating in 9 separate studies.

| **TABLE 7: RQ2 – IMPLEMENTATION FACTORS** | | |
|---|---|---|
| **IMPLEMENTATION Factors** | **References** | **Frequency (# of studies)** |
| IMP 1: Job Fit | [12, 13, 15, 22, 37, 38, 63, 75, 80] | 9 |
| IMP 2: Tailoring practices | [11, 43, 59, 62, 71, 75] | 6 |
| IMP 3: Long term/ short term strategies | [43] | 1 |
| IMP 4: Temporal effects | [1, 42, 56, 72, 78, 81] | 6 |
| IMP 5: Individual differences | [5, 29, 55, 56, 67] | 5 |

The literature reports that to implement the motivators noted in Table 5, factors listed in Table 7 need to be considered. How the job fits with an individual’s needs is considered important in 9 separate studies. Here, motivation is viewed as a function of the ‘fit’ between the individual and the organisational job setting. The concept of ‘job-fit’ is detailed in the work of social scientist McClelland in 1975.

### 4.3 Research Question 3

18 papers were identified as answering Research Question 3, "RQ3: What are the external signs or outcomes of (de)motivated Software Engineers?"

Table 8 lists the external signs associated with motivated or de-motivated software engineers, as identified in these 18 papers.

| **TABLE 8: External signs of motivated and de-motivated software engineers** | | |
|---|---|---|
| **External signs** | **References** | **Frequency (# of studies)** |
| Ext1: Retention | [21, 25, 32, 38, 43, 45, 50, 52, 57, 62, 66, 81] | 12 |
| Ext2: Project delivery time | [16, 82] | 2 |
| Ext3: Productivity | [6, 21, 58, 68, 73] | 5 |
| Ext4: Budgets | [81] | 1 |
| Ext5: Absenteeism | [50] | 1 |
| Ext6: Project Success | [68] | 1 |

The majority of the studies cited retention as the major outcome of motivated or de-motivated software engineers. Twelve studies showed that motivated engineers tend to stay in their jobs longer than de-motivated engineers. Five studies reported that productivity is affected by motivated/de-motivated engineers.

### 4.4 Research Question 4

Eighteen papers answered research question 4, "What aspects of Software Engineering (de)motivate Software Engineers?"

Table 9 identifies themes based on (de)motivators relating to the software engineering activity itself. Factors related to salary or other motivators extraneous to software engineering itself have not been included in this analysis. This question is an offshoot of our research question 2 that takes a more general view of all motivators found in software engineering.

| **TABLE 9: Aspects of Software Engineering that motivate Software Engineers** | | |
|---|---|---|
| **Motivating Aspects of software engineering field** | **References** | **# of studies** |
| Asp1: Problem Solving (the process of understanding and solving a problem in programming terms) | [10, 22, 83] | 3 |
| Asp2: Team Working | [61, 84] | 2 |
| Asp3: Change | [2, 11, 42, 85] | 4 |
| Asp4: Challenge (Software Engineering is a challenging profession and that in itself is motivating) | [22, 42, 61, 65] | 4 |
| Asp5: Benefit (creating something to benefit others or enhances well-being) | [10, 61, 83] | 3 |
| Asp6: Science (making observations, identifying, describing, engineering, investigating and theorising, explaining a phenomena) | [77, 83] | 2 |
| Asp7: Experiment (trying something new, experimentation to gain experience) | [55, 83] | 2 |
| Asp8: Development practices (Object Oriented, XP and prototyping practices) | [85, 86] | 2 |
| Asp9: Software process/lifecycle – Software development, project initiation and feasibility studies, *maintenance (*also found a de-motivating activity) | [77] | 1 |

We found comparatively few studies that identified specific tasks that motivate software engineers. A key study in this area is Alstrum (2003)/[83], who asked the question "What is the attraction to Computing? We have built on some of the themes identified by Alstrum such as benefit, science and experiment.

| Table 9.1 De-motivating Aspects of Software Engineering | References | # of studies |
|---|---|---|
| De-Asp1: Software process/lifecycle – maintenance (note that maintenance was also found motivating under some conditions) | [12, 85] | 2 |

Table 9.1 shows that only two studies considered what aspects of the lifecycle de-motivated software engineers, both identified the maintenance task.

| Table 9.2. Implementation Factors (as in table 7) | References | # of studies |
|---|---|---|
| IMP1. Job-Fit | [15, 20, 37, 82, 85] | 5 |

Similar to our findings relating to research question 2; Table 9.2 highlights that 5 studies found that the degree that an engineer finds aspects of the software engineering job motivating on de-motivating will depend on his or her personal job-fit.

### 4.5 Research Question 5

17 papers were identified as answering Research Question 5, "*What models of motivation exist in Software Engineering?*"

We searched for models that try to explain how motivation works or why motivation works the way it does. A breakdown of the themes we identified in the literature is presented in Table 10.

| TABLE 10: Models of Motivation in Software Engineering | | |
|---|---|---|
| **Explicit Models of motivation** | **References** | **Frequency (# of studies)** |
| Mod1: Job Characteristics Theory Model (JCT) of Software Engineer (SE) Motivation (development, enhancement or validation) | [14, 15, 89-91] | 5 |
| Mod2: Models of leadership influence on SE motivation | [7, 59, 91] | 3 |
| Mod3: Models of Open Source Developer SE Motivation | [59, 87, 88] | 3 |
| Mod4: Model of Task Design influence on SE motivation | [67] | 1 |
| Mod5: Model of Career Progression influence SE on motivation | [60] | 1 |
| **Implicit Models of motivation** | | |
| Rel1: Models focussing on Software Engineer Job Satisfaction | [50, 52, 53, 56, 62] | 5 |
| Rel2: Model drawing on expectancy theory, goal-setting theory, and organizational behaviour specific to the software development process | [92] | 1 |
| Rel3: Social support influence on Software Engineer turnover | [62] | 1 |

The literature presents a disparate set of models that are mostly hypothesised from theoretical studies and validated through empirical surveys. A commonly-cited model of motivation is the Job Characteristics Theory (JCT) Model (Hackman and Oldham 1976). The basic tenet of the JCT is that Software Engineers will experience internal motivation and satisfaction if their Growth Need Strength's (GNS) are matched by the Motivational Potential Score (MPS) of the jobs they do. This implies that Software Engineers with low GNS will be satisfied with low MPS in a job, in much the same way as those with high GNS will need high MPS in a job. Optimum internal motivation and satisfaction is achieved when Software Engineers' GNS's are matched with the appropriate MPS's in a job.

Five papers in our review explicitly build upon the JCT to extend it (e.g. with role ambiguity/conflict and leadership styles), validate it using comparisons with countries outside the USA, such as Japan, or enhance it, e.g. looking at employment fit (which is similar to job fit, but includes working conditions). A further five papers presented models that focus on job satisfaction, which is an element of the JCT and is therefore linked to motivation. For example, [56] suggest that managerial, team member or self-control of tasks influences the level of job satisfaction felt by an employee.

Three papers explicitly investigate the motivation of open source developers. [87] considers whether two social science models (one focusing on voluntary action and one focusing on small teams) adequately explain OSS developers' motivation. [59] focuses on leadership styles, and [88] investigates the relationship between intrinsic, extrinsic and internalised extrinsic motivators.

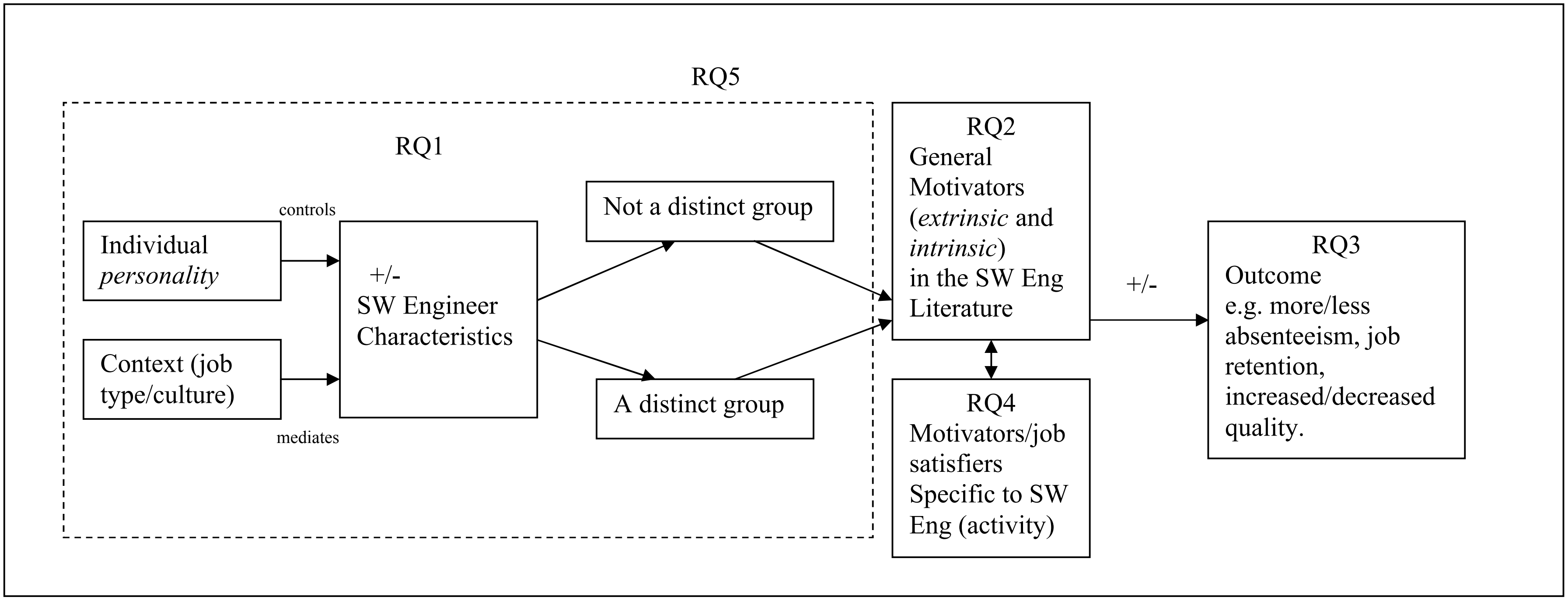
Two papers focus on job or employment fit of some kind. For example, [89] focuses on validating an instrument to measure employment arrangement fit. This reflects findings from other literature identified under RQ1 where the influence of career anchor is highlighted. In addition, RQ4 identifies job fit as being a (de)motivator for SEs.

## 5. DISCUSSION

In this section we discuss how the literature in our systematic literature review assists us to understand the underlying constructs of motivation in software engineering. Figure 9 shows our enhanced understanding of our research topics introduced in Figure 6.

### 5.1 Software engineers as a homogeneous occupational group

Figure 9 shows that the literature is divided as to whether Software Engineers form a distinct occupational group. However, the majority of included studies support the idea that these practitioners do form a recognisable group with similar needs. This view is consolidated in the many studies from Couger, Zawacki and colleagues, e.g. (Couger and Zawacki 1978; Couger and Zawacki 1980; Dittrich et al. 1985; Couger and McIntyre 1987; Couger and McIntyre 1987-1978; Couger 1988; Couger and Adelsberger 1988; Couger 1989; Couger et al. 1990; Burn et al. 1992; Couger 1992; Couger and Ishikawa 1995) based on a comparison of job perceptions and needs of more than 6000 people from both Software Engineers [Data Processors/IT professionals] and the general public. These studies reported that Software Engineers found their work less meaningful and rated their jobs less favourably than other professionals. Their need to interact with others was negligible. Software Engineers displayed very high growth needs and were concerned about learning new technology. Myers (1992) refined the studies of Couger and Zawacki and colleagues to show that although Software Engineers formed a distinct group, they varied among themselves by job type. More recent work that presents Software Engineers as a distinct group include: (Kandeel and Wahba 2001; Capretz 2003; Garza et al. 2003; Tanner 2003; Darcy and Ma 2005; Ramachandran and Rao 2006).




| Key | Results | Definitions |
|---|---|---|
| *RQ1: What are the characteristics of Software Engineers?* | Table 2-4 | ***Extrinsic factors**: External to the job practitioners do, e.g. work conditions.* |
| *RQ2: What (de)motivates Software Engineers to be more (less) productive?* | Table 5-7 | *These factors just maintain practitioners in their jobs (Baddoo and Hall 2002)* |
| *RQ3: What are the external signs or outcomes of (de)motivated Software Engineers?* | Table 8 | ***Intrinsic factors**: Primary determinant of motivation and satisfaction. Related to Job itself, e.g. work itself, recognition, achievement (Baddoo and Hall 2002)* |
| *RQ4: What aspects of Software Engineering (de)motivate Software Engineers?* | Table 9 | ***Personality**: more or less permanent characteristics of an individual's* |
| *RQ5: What models of motivation exist in Software Engineering?* | Table 10 | *state of being, (e.g. shy, extrovert, conscientious) (Chelsom, 2005).* |

Figure 9: Model of Motivation in Software Engineering

However, several studies take a contrary view. For example, Ferratt and Short (1986; 1988) found that Software Engineering employees and non-Software Engineering Employees [IS and non-IS employees] could be motivated equally using the same underlying constructs. Im and Hartland (1990) although disputing Ferratt and Short's (1986) methodology, supported their outcome. More recent work that presents Software Engineers as a group that cannot be distinguished from other occupations when considering motivation include (Enns et al. 2006; Smith and Speight 2006).

These mixed findings from the 1980's to today lead us to conclude that whether or not software engineers form a homogeneous group with similar motivational needs depends on their individual context.

## 5.2 RQ1 - Software Engineer characteristics

The 43 papers that cover this question provide us with a broad picture of Software Engineer characteristics. As these characteristics are based on studies from different countries, practitioner roles, personality types, organisations, development processes and historical periods, we cannot assume that every characteristic relates to all software engineers. In fact is it clear that this would not be feasible, since some of the characteristics contradict each other. For example, engineers are seen to be sociable yet introverted, needing stability on the one hand and liking a variety of new tasks and challenges on the other. Therefore, to apply these characteristics to any individual we have extracted implicit findings from the papers and identified two new categories: 'moderators' (environmental and demographic influences) and controllers (internal constructs).

We do not report on the cognitive aspects of a Software Engineer's personality which go beyond the scope of this study. However, we note that cognitive processes and personality traits need to be considered and understood as these internal constructs will determine an individual's set of characteristics. As Chelsom et al (2005) note, the differences in people's personality are greater than the similarities, and "we cannot ignore the significance of individuality". The literature also shows that external factors such as career stage and culture need to be considered as these will 'moderate' the strength of each characteristic.

The characteristics cited most often in the literature are the need for growth and independence. The need for growth may be due to the engineer's internal make up, and/or the need be 'marketable' (another characteristic) and keep up with the fast changing technology. The need for independence is possibly linked to the type of person attracted to software engineering that is sometimes seen as a creative task that is not helped by overbearing management.

Many of the characteristics we identify reflect the findings and views of Couger and Zawacki (1980). This is not surprising as their job diagnostics survey for data processing personnel (JDS/DP) has been used in several of the papers included in our literature review, e.g ((Couger and McIntyre 1987; Couger and McIntyre 1987-1978; Couger 1988; Couger and Adelsberger 1988; Couger 1989; Couger et al. 1990; Couger 1992; Couger and Ishikawa 1995).

We have extracted from the literature a more structured view of the findings concerning SEs characteristics, noting that the characteristics of any one individual depend on controllers, such as personality trait and moderators such as career stage.

### 5.3 RQ2 – What motivates Software Engineers?

The 62 papers that answer this question create a list of 22 different motivators. The most frequently cited motivators in the literature are, 'the need to identify with the task' such as having clear goals, a personal interest, understanding the purpose of a task, how it fits in with the whole, having job satisfaction; and working on an identifiable piece of quality work. Having a clear career path and a variety of tasks is also found motivating in several papers. The literature suggests it is important to involve the engineer in decision making, and to participate and work with others, which appears to go against characteristics of independence and introversion which are cited in many papers. When looking at what Software Engineering activities motivate Software Engineers we need to consider that some of the findings might not apply today. For example, we have listed Object Oriented Design as a motivator that is reported as meeting a growth need in engineers. However, as this finding was reported in the 1990s, it may be that this fulfilled a growth need only because Object Oriented Design was a new skill at the time –this may no longer apply today. This is just one example of how a motivator may be context specific, relating to time, role, culture, experience, age, individual characteristic etc.

An aspect of Software Engineering found both motivating and de-motivating is the maintenance task. This could be due to several factors. For example this evolutionary phase of software development can consume between 40 – 80% of software costs. If it is the dominant activity within a group, then it may attract the recognition and challenges associated with motivation. Alternatively, as 60% of maintenance tasks are in fact enhancements (Glass 2003) this might also be regarded as problem-solving and challenging. Finally, bug-fixing may be regarded as motivating if the right person is given the job, i.e. the job-fit is right.

#### *5.3.1 Software Engineer De-motivators*

To give a balanced view, we also recorded what the literature reports on Software Engineer de-motivators. Working conditions and lack of resources are reported as de-motivating in 9 separate studies. These are classed as hygiene factors by Herzberg et al (1959), who developed the hygiene-motivator theory in the 1950s. This theory asserts that removing the de-motivator will not necessarily translate to motivating employees. It will simply maintain practitioners in their job and avoid dissatisfaction. Salary or rewards are an exception to this rule; a good salary can be motivating in unstable environments and early in an engineer's career, although salary is usually considered a hygiene factor.

#### *5.3.2 Motivating and de-motivating factors*

Finding a factor to be both motivating and de-motivating might be due the temporal effects of motivation as highlighted by Maslow's (1954) hierarchy of needs theory. What might motivate someone in the early stages of their career may end up de-motivating them in the latter stages of their career. For example, the newly recruited Software Engineer could be highly motivated by job security and close supervision, whereas these same factors, especially close supervision, could turn out to be de-motivating to a seasoned Software

Engineer. An experienced Software Engineer is more likely to be motivated by challenges, opportunities for recognition and autonomy.

### 5.4 RQ3 – The outcomes of motivating Software Engineers

Considering the large body of work on motivation, very little work covers the tangible benefits or outcomes of motivating engineers. Eighteen studies were found in this category (RQ3), where most dealt with turnover and absenteeism. Turnover and absenteeism focus on the likelihood of an individual staying in a particular job. As measures of motivation therefore they suffer from being a management and organisational view of motivation, i.e. they consider motivation from an organisation's perspective. We found little work that focused on understanding or measuring an individual's motivation to stay in Software Engineering as a profession.

Also, very few studies considered productivity improvements or increase in quality. This is possibly due to the difficulty in measuring motivation and associating motivation with actual output. Also the themes of turnover and absenteeism are part of the JDS/DP (Couger and Zawacki 1980) – a survey used by many of the studies included in this review.

### 5.5 RQ4 – What is motivating about Software Engineering

Although this review takes in a large range of studies relating to Software Engineering, only a very small proportion identify what is specifically motivating about this field. When looking at answers to RQ2 (Table 5) for instance, most of the motivators could apply to many professions.

The literature identifies Software Engineering as a challenging profession and often links challenge to change, as noted in (Almstrum 2003) "the reason for challenge is the pace of change of the field and the effort it took to keep pace with the changes. ..If you just want to learn something and do it for the rest of your life …. you don't want to go into IT". Challenge also relates to 'technical' challenges (not just coping with change).

Learning, exploring new techniques and problem solving would also appear to be motivating tasks,. 'Benefit' is a category identified by Alstrum (2003) and is supported in the work of (Hertel et al. 2003; Roberts et al. 2004; Li et al. 2006), where the three different studies show Software Engineers are motivated by "creating something that will benefit others"; "the usefulness in supporting other areas/fields"; and creating something that is "of value to the user".

As observed above, we found little work that explicitly focused on Software Engineering as a profession, and hence considering why Software Engineers remain in Software Engineering (even if they change jobs).

### 5.6 RQ5 – Modelling motivation in Software Engineering

We aimed to synthesise the findings on how motivation in software engineering is modelled in the literature. However, we found it very difficult to combine all the models as they tend to cover general aspects of motivation, have few commonalities and only partially cover the Software Engineering domain. exception to this is found in the recurring theme of models based on the Job Characteristics Theory (JCT) (Hackman and Oldman 1976) and the JDS/DP (Couger and Zawacki, 1980).

The results from RQ5 though difficult to assimilate fall into one of three camps:
those that use and adapt the JCT model and the JDS/DP e.g. to add leadership considerations,
those that try to provide an alternative to the JCT approach, and
those that take a totally different approach (e.g. using small-team theories to explain Open Source Development )
According to Couger and Zawacki (1980), the JCT (Hackman and Oldman 1976) was found useful for management in Software Engineering to analyse individual patterns of motivation. Couger and Zawacki augmented the underlying constructs of this model in the Job Diagnostics Survey for Data Processing Personal (JDS/DP) to provide a richer picture of how growth need strength (GNS) relates to Motivation Potential Score (MPS) in a given job.

Literature that uses the JDS/DP generally aims to validate the theory in different national cultural contexts and often uses the USA as the benchmark. It is helpful for cross-comparisons to use the same instrument with other professions and between and within given roles, showing the strength of feeling for certain needs and identifying differences and similarities. However, the JDS/DP comprises a tick list of factors, and so studies based on the JDS/DP will only be able to comment on motivating factors contained within the instrument rather than unearth any new motivators or emerging trends. The nature of the Software Engineer's job has changed considerably since the JDS/DP was first devised, and so it is questionable as to whether or not it is as applicable as it used to be.

We have not found a definitive model of motivation in Software Engineering that adequately captures the motivators and de-motivators we found in answer to RQ4, "*What aspects of Software Engineering (de)motivate Software Engineers?"*, nor the other facets of Software Engineer characteristics and motivation reported through RQs1-3.

## 6. LIMITATIONS

### 6.1 Completeness

We have conducted a very thorough review of the literature eliciting work from 70 different authors including some secondary studies (where we used the reference in the primary study to lead to another study). We note however that with the increasing number of works in this area we cannot guarantee to have captured all the material in this area.

Another area of concern is that few studies have been published on motivation in Software Engineering in countries such as India that are increasingly involved in Software Engineering (Yourdon 2005), suggesting that we cannot present a global view of this area. This is not a limitation of our approach, but a reflection of the limitations imposed on us by the available research in this area.

### 6.2 Data synthesis

As we have covered different countries and eras in Software Engineering we have grouped all Software Engineer roles together. Some studies have found that different roles are associated with different motivational needs and characteristics. By grouping all roles together, we may have lost some of this detail.

## 7. CONCLUSIONS

Our findings suggest an increasing awareness of motivation in Software Engineering since about 1995, as compared to the previous 15 years. Most of the studies in this area rely on the use of questionnaires, with 16% using multiple data collection methods and only 1% using multiple methods without questionnaire. Over half of the studies (54) were conducted in the USA. In addition, the majority of papers were published in the Proceedings of SIGCPR Computer Personnel Research rather than mainstream software engineering conferences or journals. Notwithstanding this, the 92 papers in our systematic literature review provide a broad understanding of the research conducted into what has motivated Software Engineers in 16 different countries over the past 26 years.

Mixed findings in the literature lead us to conclude that whether software engineers form a homogeneous group with similar needs depends on their individual context. Building on the work reported, we have structured the SE characteristics investigated in the literature into three related categories: 'raw' characteristics, moderators and controllers. Whether or not an individual has a particular characteristic depends on certain controllers, and how strong this characteristic is depends on the moderators.

The literature cites 22 different motivators for Software Engineers. The most frequently cited ones are, 'the need to identify with the task' such as having clear goals, a personal interest, understanding the purpose of a task, how it fits in with the whole, having job satisfaction; and working on an identifiable piece of quality work. However some factors are identified as being both motivators and de-motivators. It may be possible to account for this by considering the career stage of the individual.

Turnover and absenteeism are the most cited outcomes of (de)motivated engineers (maybe because these are mentioned in the JDS/DP). We found little work that focused on understanding or measuring an individual's motivation to stay in Software Engineering as a profession.

Learning, exploring new techniques and problem solving appear to be motivating aspects of SE. However little work has focused on the specific nature of software engineering itself, or of the impact of the changing environment in which software engineering is conducted.

Although we found a variety of models of motivation in Software Engineering in the literature, no model considered all the identified factors in our list of motivators, moderators, controllers and implementers. Neither did any of the models focus on the nature of the SE's job itself such as the reliance on tools or programming languages, the logical nature of problem solving, use of creativity, complex problem-solving, and so on. Yet 'the job itself' continues to be the principal motivator. Therefore, considering the changes in what the job demands, in terms of new skills and communicating with many different stakeholders, there appears to be a gap in defining what exactly it is about 'the job' that motivates engineers.

It is clear from the literature that there is a need for a comprehensive model of motivation in Software Engineering that includes what is particularly motivating about the job itself. We also need a better way to measure motivation, as basing it on turnover only reflects whether an engineer is motivated to stay in an organisation. It does not shed light on what motivates an individual to stay in the SE profession, to produce better quality software, increase productivity, and use and share skills in the wider Software Engineering community.

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# APPENDIX 1

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