What Motivates Software Engineers Working in Global Software Development?

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Abstract. Context: Working in a distributed environment poses new challenges to software engineer motivation.
Problem: Where should global project managers focus their efforts so that they have the best chance of motivating their teams, for higher staff retention, increased productivity and improved software quality?
Method: We asked a group of software engineers attending a workshop on global collaboration to complete a survey on software engineer motivation. We then identified motivation themes in the responses. Finally, we mapped these themes to software engineer motivators identified in previous research.
Results: Thirteen participants completed the survey. Analysis of the results yielded 27 motivation categories. The vast majority (23 of 27) were partially or wholly mapped to *Intrinsic* motivators.
Implications We conclude that Global Software Development projects that relegate some teams to performing routine tasks (such as maintenance or testing) will experience lower productivity and quality due to demotivation. Finally, we hypothesize that GSD introduces new motivators, such as opportunities to travel and interact with different cultures.

Keywords: Global Software Development; GSD; Software Engineer; Motivation; Empirical Software Engineering

1 Introduction

Highly motivated engineers working in distributed software development have a significant influence on project success [8]. Motivation can be viewed in terms of needs, and the key need for software engineers is to "identify with their task," which requires being given a task that is challenging, and understanding the purpose and significance of the task in relation to the complete system being developed. Software engineers' needs are complex: they also require regular feedback, trust, appreciation, rewards, a career path and sustainable working hours. Furthermore, among other fixed environmental factors, these motivators require sensitive tuning in line with a software engineer's personality and career stage [2].

Although motivation is a well-researched area, existing theories have not kept pace with today's fast changing software engineering environment [1]. The move towards developing software globally places particular demands on software engineers, who are often required to work in globally distributed teams around the clock, communicate

and collaborate with people with mixed values and cultural styles, and share code and development issues with team members they have never met in person. Global Software Development (GSD) is fast becoming the norm, regardless of the risk it poses to motivation [12].

Despite the depth of research conducted in GSD, there is a lack of understanding of motivational issues [8]. However before developing a model of motivation for GSD, we need a better understanding of how the software engineer's personal needs match the demands of the job [1]. For example, a mature and established strand of research based on the Job Characteristics Theory [5] is predicated on the belief that motivating software engineers depends on a good personality/job fit, where if you want an engineer to do a good job, "give them a good job to do [15]."

In this paper we conduct an empirical study to explore the characteristics and motivational needs of software engineers working in GSD. We particularly ask the question, "Do software engineers engaged in GSD share similar characteristics with the general population of software engineers?" Having some insight into the potential differences of the global software engineer is important, because if software engineers working in multi-site teams have different needs, then we need to re-think how they are managed. Alternatively, if the characteristics of software engineers working in GSD environments appear similar to those in the wider community of software engineers, then, we need to check whether their motivation is compromised by the environment. So the study we conduct here is a starting point to answering the wider question of how the global software engineer can survive and grow within a GSD environment.

2 Background

The power that motivation has on people in general and on the workplace in particular has given rise to many theories, that try to explain the conscious or unconscious decisions people make to expend effort or energy on a particular activity [22]. These theories inform techniques managers can adopt to motivate their software engineers to engage fully in their tasks, increase their commitment to the organization, improve their productivity, and produce higher quality software [2]. Creating the right conditions can also stimulate innovation [12]. Conversely, a demotivated workforce can lead to project failure [26].

Looking at motivation in a GSD context, we argue that some of the issues found in GSD can be addressed (even if partially) by meeting the motivational needs of software engineers [20]. For example, GSD is known to suffer from high staff turnover [7, 16], and since motivation can in some instances have a positive effect on staff retention [14], ensuring that software engineers are motivated might be one way to reverse this trend.

So the question now remains, how can we motivate software engineers working in a distributed environment?

2.1 Software Engineer Characteristics

A review of the literature found that in nearly three-quarters (73%) of the cases software engineers form a distinct identifiable occupational group [2]. This finding indicates

that studying motivation for software engineers as a separate profession could benefit managers of software engineers.

Of the many software engineer characteristics identified in the literature, “growth oriented”, “introverted,” and “need for independence” were the most cited, which indicates these occur across many different contexts (although not that they are the most important). However, some characteristics contradict each other, such as “introverted” (with a low need for social interaction), and “need to be sociable” and “identify with a group or organization.” The view that software engineers are introverted reflects findings from the many studies coming from Couger and colleagues, that began in the 1980’s, who measured the “Social Needs Strength” of engineers [5] in their Job Diagnostics Survey. This view is not universal as some studies characteristic software engineers as sociable people [2].

2.2 Software Engineer Motivation Factors

Table 1 presents an aggregation of the motivators from three motivation literature reviews covering over 150 empirical studies in software engineer motivation [2, 9, 11]. Since these reviews had many overlapping themes, we just give the original source in the right column. These distinct aspects are presented in Table 2, where Problem Solving, Team Working, Change, Challenge, and Benefit are some of the reasons people work in software engineering.

Examined chronologically, each review finds new factors. For example, França et al’s 2011 review [11] found that software engineers are motivated by having fun, innovating, and even by punitive penalty policies. The importance of relationships with stakeholders outside the team is also new, suggesting that the task of developing software is enhanced if you know why and for whom the software is being developed. The most recent review included here, conducted in 2012 by De Farias et al [9], looked at motivation of software engineers in a GSD context. They found that the GSD practitioner has specific and new needs, such as recognition of cultural differences and individuality. Clearly, new motivators are emerging, yet no work has been conducted to test whether all the historic motivators still apply.

Findings from Tables 1 and 2 are explored further in Section 4.

2.3 Demotivation and Herzberg’s Two Factor Theory

Although motivation is important, managers of teams distributed across multiple sites need to be particularly concerned with factors known to demotivate, that are challenged by working in multi-site teams. According to Herzberg’s two factor theory [15], Hygiene Factors (extrinsic motivators) have the power to demotivate if absent, but when present do not trigger the long term desired impetus and positive energy of Motivator Factors (intrinsic motivators). Table 1 distinguishes these two factors in the ‘Type’ column.

Software engineers working in a multi-site team are likely to face many demotivating factors. These factors are discussed in full by the first author in [1], where a case study of an organization engaged in GSD found many instances where demotivators identified in a review of the literature [2] were causing problems. These demotivators are summarized in Table 3 and elaborated below.

Table 1. Software Engineer Motivators

ID.	Motivator	Type	Source
M1	Rewards and incentives	Ext	[2]
M2	Development/ training needs addressed	Int	[2]
M3	Variety of work	Int	[2]
M4	Career Path	Int	[2]
M5	Empowerment/ responsibility/ shared leadership	Int	[2]
M6	Good Management	Ext	[2]
M7	Sense of belonging/team spirit	Ext	[2]
M8	Work/life balance	Ext	[2]
M9	Working in successful company	Ext	[2]
M10	Employee participation	Int	[2]
M11	Feedback	Ext	[2]
M12	Recognition	Int	[2]
M13	Equity	Int	[2]
M14	Trust/respect	Int	[2]
M15	Technically challenging work	Int	[2]
M16	Job security/stable environment	Ext	[2]
M17	Identify with the task	Int	[2]
M18	Autonomy	Int	[2]
M19	Appropriate working conditions/infrastructure	Ext	[2]
M20	Making a contribution/task significance	Int	[2]
M21	Sufficient resources	Ext	[2]
M22	Team quality	Ext	[11]
M23	Creativity/Innovation	Int	[11]
M24	Fun (playing)	Int	[11]
M25	Professionalism/setting standards	Ext	[11]
M26	Having an ideology	Ext	[11]
M27	Non-financial benefits (availability of rewards)	Ext	[11]
M28	Penalty Policies	Ext	[11]
M29	Good relationship with users/customers	Int	[11]
M30	Recognition of cultural differences	Int	[9]
M31	Recognition of individuality	Int	[9]

Inequity Remote working may mean the engineer misses out on training, growth, and promotion opportunities, may not share the same holiday allowances as colleagues, and may need to work anti-social hours or longer hours to communicate with colleagues in other locations.

Interesting work going to other parties It is sometimes the case that complex tasks are retained at the "home" site, and that less motivating tasks such as testing or maintenance go to the remote teams.

Unfair reward system Performance may not be rewarded fairly if the remote software engineer is only noticed when there is a problem.

Poor communication Since these factors were identified outside of the GSD research, this demotivator is particularly significant, since many GSD related issues can be traced back to poor communication. Poor feedback, and loss of direct contact with other team members and management can become a real barrier to motivation.

Bad relationship with users and colleagues The social side of working in a co-located environment is often lost when working remotely; this lack of face to face contact can result in mistrust and difficulty in building good relationships with colleagues. This factor was identified by Franca et al [11] as an emerging issue.

Poor working environment Being physically separated from the rest of the team, or the home site, is considered demotivating. This is often a pre-condition of working

Table 2. Motivating and Demotivating Aspects of software engineering [2][11]

ID.	Motivating Factor
Asp 1	Problem solving (process of understanding/solving a problem in programming terms)
Asp 2	Team working
Asp 3	Change
Asp 4	Challenge (Software Engineering as a challenging profession is in itself motivating)
Asp 5	Benefit (creating something to benefit others or enhances well-being)
Asp 6	Science (observing, identifying, describing, investigating, and explaining phenomena)
Asp 7	Experiment (trying something new, experimentation to gain experience)
Asp 8	Development practices (Object Oriented, XP and prototyping practices)
Asp 9	Lifecycle software development, project initiation and feasibility studies, maintenance
Asp 10	Creativity
ID.	Demotivating Factor
De-asp. 1	Software process/lifecycle maintenance (also found to be a motivating activity)
De-asp. 2	Boredom (repetitive tasks)

in multi-site teams, so very little can be done to change this despite the introduction of many GSD specific communication tools [23].

Role ambiguity Our previously published case study [1] showed that when working in remote teams, each member was expected to take on many different roles, and when asked to define his role; one person even admitted he had several business cards with different titles, one of which was left blank to be filled-in on-demand. While this ambiguity addresses the intrinsic need for variety and challenge, people can be overstretched, and also this ambiguity makes it difficult for team members to know where to go to for help and support.

Lack of influence Having no voice and being left out of decision making can easily occur when working in multi-site teams. In our case study [1], Project Managers working remotely with a client were clearly demotivated by head office interference when senior management discussed issues with the client without involving the on-site project manager.

Other demotivators specifically concerned with the software engineering task are listed in Table 2 as "De-asps." De-motivators are not necessarily the opposite of motivators, and so should be treated separately.

2.4 GSD environmental impact on Motivation

Although some research suggests that the needs of a global software engineer are similar to those of the general population of engineers [8], we still do not understand how working in a distributed environment places specific challenges to these motivators.

To clarify the impact multi-site development has on software engineer motivation, we consider factors associated with GSD that may trigger discontent, as suggested in Šteinberga and Šmite [27], and our previous work [1], and summarized in Table 4.

Table 4 ignores factors from Table 1 that are similar in both collocated and GSD contexts. The factors are an aggregation of findings from Šteinberga and Šmite's theoret-

Table 3. Demotivation Factors selected from [2, p.869] fuelled by GSD

ID[a]	Demotivator factor fuelled by GSD (related motivator from Table 1)	Source
D3	Inequity (M13)	[1, 27]
D4	Interesting work going to other parties (M15)	[1, 27]
D5	Unfair reward system (M1)	[1]
D6	Lack of opportunities; stagnation; career plateau; monotony; poor job fit (M4, M17)	[1, 27]
D7	Poor communication (M11, M6)	[1]
D10	Bad relationship with users and colleagues (M22, M29)	[1]
D11	Poor working environment (M19)	[1]
D14	Poor cultural fit/stereotyping/role ambiguity (M30, M31)	[1]
D15	Lack of influence/not involved in decision making (M10)	[1]

a Beecham's [2, p.869] original numbering retained.

ical study [27], and our previous empirical study [1]. For transparency, the source of the inhibitor is included in the table. Also, since the treatment and outcome of motivators are likely to be predicated on whether the motivator is a hygiene factor or a motivator, the table is also divided into Intrinsic and Extrinsic needs. We also add new factors introduced by De Farias [9], since these factors are all associated with GSD.

Table 4 contains twice as many intrinsic motivators as extrinsic motivators that are potentially compromised by working in GSD. This is extremely important, as intrinsic motivators have longer-term effects on motivation.

The research literature doesn't as yet explain whether GSD attracts a different type of engineer to the type of engineer who traditionally worked in a collocated team. Therefore, before we plan how to motivate our software engineers who work in multi-site teams, we need to establish who exactly we are dealing with. It could be that what we have learned about software engineer motivation previously needs to be revisited. The current state of practice in GSD motivation is unclear, leaving us asking:

"Do software engineers engaged in GSD share similar characteristics and needs to those engineers in the general population?"

To address this question, we conduct an empirical study, with a group of practitioners working in GSD, which we discuss next.

3 Method

We conducted an empirical study to investigate the research question posed in Section 2: RQ: "Do software engineers engaged in GSD share similar characteristics and needs to those engineers in the general population?"

Data collection. We held a two day workshop on GSD with a diverse a group of practitioners who work in a multi-national organization, and are all involved in developing software in distributed teams across Europe. During a session dedicated to motivation, participants answered a survey on what motivates them.

Table 4. Motivation Factor inhibited by GSD (related motivators/aspects from Table 1/Table 2)

ID	Intrinsic motivators/aspects	Source
I1	Team work (Asp 2)	[27]
I2	Equity (M13)	[1]
I3	Development practices (Asp 8)	[1, 27]
I4	Technically challenging work (M15)	[1, 27]
I5	Identify with the task (M17)	[1]
I6	Autonomy (M18)	[27]
I7	Empowerment and responsibility (M5)	[1, 27]
I8	Trust and respect (M14)	[1, 27]
I9	Employee participation (M10)	[1, 27]
I10	Career Path (M4)	[1]
I11	Making a contribution (M20)	[1]
I12	Recognition (for doing a good job) (M12)	[1]
I13	Recognition of cultural differences (M30)	[9]
I14	Recognition of individuality (M31)	[9]
ID	Extrinsic motivators/aspects	
I15	Sense of belonging (M7)	[1, 27]
I16	Feedback (M11)	[27]
I17	Rewards and incentives (M1)	[1]
I18	Good Management (M6)	[1]
I19	Work/life balance (M8)	[1]
I20	Appropriate working conditions (M19)	[1]
I21	Sufficient resources (M21)	[1]

The survey, as shown in Table 5, was an adaptation of a set of motivation questions created by Helen Sharp and Mark Dalgarno for use in industry motivation workshops [24], and was designed specifically to reveal what motivates practising software engineers. The survey comprised two parts: a set of questions about the respondent's background and experience, and a series of questions about the respondent's motivation.

Note that we retained the word 'satisfaction' in our survey since 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 [4] that is used extensively to measure software engineer motivation.

This survey exercise was followed by an interactive presentation on software engineer Motivation that included a summary of what are considered typical characteristics and motivators of software engineers according to the systematic literature review on software engineer motivation [2].

Data analysis. We aggregated the responses to four demographic questions to create a picture of the respondents background and experience as a group. We then analyzed the responses to the questions in part 2 of the survey, grouping the survey responses into themes (see Section 4) using content analysis [19].

Validation. At the end of the motivation session, two final questions were posed to the practitioners: “Do you think you form a distinct group of professionals, that are different to other professions?” and “Given the list of characteristics, do you think you are typical?” There was a unanimous agreement with both questions.

4 Results

Our sample represented practitioners from six different countries, who all participated in the global collaboration workshop held in Turkey (a venue chosen specifically as a neutral place since none of the participants were based in Turkey). The participants comprised a team of software engineers who were all working on the same software development project. Many of these engineers had not met face to face before the workshop (since they were based in different countries). This group had (on average) been working in their current roles for just under seven years with an average total software engineering experience of nearly twenty-seven years. The current roles of all participants require them to develop software across globally distributed teams; we can therefore assume that this group have, on average, a minimum of seven years experience in GSD. These figures are summarized in Table 6.

As mentioned in Section 3, we assigned a category to each phrase or statement in a survey response. In total, 97 such statements or phrases were analyzed and grouped into 27 categories. In some cases, a phrase fell into more than one category; regardless, the majority of statements fell into the top seven categories.

Table 7 shows how the respondents answered each question in the survey; the results are presented as the number of respondents who responded in a given category, and the number of responses in each category. These results indicate that creating working software products (as represented by the “Construction/delivery/completion” category) is the aspect of software engineering that the most respondents mentioned (11 total), and is also mentioned most often (17 responses) overall, and the most often as the most satisfying aspect of software engineering (Question 1, 10 responses). This category comprises statements such as “Get things done (and working),” “Seeing product through to implementation,” and “seeing disparate parts come together to complete a project.” One respondent even identified “Construction” explicitly as the aspect from which he received the most satisfaction.

Table 5. Motivation Survey Questions

Individual Background	**What Motivates software engineers?**
1. What role in software development are you aligned to?	1. What aspects of your work in software engineering do you get most satisfaction from?
2. What is your nationality?	2. What makes you stay working in software engineering?
3. How many years experience do you have in software development in your current role?	3. What factors attracted you to work in software engineering?
4. How many years experience in software engineering do you have? (If different roles, please list all and number of years for each).	4. What makes software development worthwhile to you?

Table 6. Demographics of Survey Respondents

Experience (years)					Min.	Max.	Avg.
In current role					< 1	20	6.5
Total Software Engineering					4	34	26.5
Nationalities	France	Germany	Spain	UK	India	Argentina	
Num. respondents	1	4	3	3	1	1	
Roles	Developer		Project Mgr.		Senior Mgr.		
Num. respondents	5		4		4		

Table 7. Response Categories, Motivators, and Aspects relating to the Task

Category	# Resp.	# Statements Q1	Q2	Q3	Q4	Tot	Motivators (Table 1)	Aspects (Table 2)	Ex-/In-trinsic
Construction/delivery/completion	11	10	3	3	1	17	New	New	Int
Problem solving	8	4	2	4	2	12	M15, 23	Asp 1	Int
Impact (economic/lasting)	7	2	2	1	5	10	M20	Asp 5	Int
Dynamic challenge/change/variety/flexib'y	7	2	3	2	3	10	M3, 15	Asp 3, 4	Int
Familiarity with task/role/aptitude	7		2	4	1	7	M17	–	Int
Technical innovation/novelty/creativity	6	4	3	3	3	13	M23	Asp 10, 7	Int
Vibrant market/profession/field/opp'nities	5	1	2	1	2	6	M1, 4, 9	Asp 3, 4	Both
Economic reward/necessity	5		2	2	1	5	M1, 16	–	Ext
Intellectual challenge/complexity	4		2	2	1	5	M15	Asp 4	Int
Sense of achievement	4			2	3	5	M17, 20	–	Int
Teamwork	4	1	1	1	1	4	–	Asp 2	Both
Intellectual curiosity	3	1	2	2	0	5	M23	Asp 6, 7, 10	Int
Tangible recognition of contribution	3	2			1	3	M1, 11, 12	–	Both
Sense of competency/knowledge sharing	3		2		1	3	M17	–	Int
Sense of belonging/friendship/community	3		1	1	1	3	M7, 10, 22	Asp 2	Both
Seeing the big picture	3	3				3	M17, 20	Asp 5	Int
Personal growth and development	3				3	3	M2, 4	–	Int
Customer/user satisfaction	3	3				3	M29	–	Int
Promoting teamwork	2	2	1			3	M7, 22	Asp 2	Both
Enjoyment/fun/play	2		1		2	3	M24	–	Int
Job stability	2		1		1	2	M16	–	Ext
Inertia	2		2			2	M16	De-asp 2	Ext
Travel	1		1			1	M27, 30	–	Both
Interaction	1	1				1	M1, 7, 10, 30,	Asp 2	Both
Goal oriented	1	1				1	M17	–	Int
Equity	1			1		1	M13	–	Int
Cultural mix	1		1			1	M30	–	Int

"Construction…" was followed by challenge and creativity ("Problem solving," "Technical innovation/novelty/creativity," and "Dynamic challenge/change/variety/flexibility"), "Impact", and "Familiarity with task/role/aptitude." Statements such as, "Solve problems, finding errors," "It allows me to show a creative side of me," and "Challenges:

working in a dynamic environment" capture challenge and creativity; one respondent went so far as to say he found satisfaction in the fact that software engineering was "Unpredictable - never sure what you will be doing next year."

Extrinsic motivators, such as salary or other rewards, were mentioned rarely by this group. One respondent did mention that it "would be difficult to switch to something else at same pay level," and another said there was "Good money" in the profession; but overall, barely 5% (5 responses total) mentioned monetary reward at all, and none identified this as the most satisfying.

When asked, "what makes you stay working in software engineering?" extrinsic motivators were more commonly cited, but the majority still favored intrinsic motivators. Intrinsic motivators were also the majority reason for choosing the field in the first place (Question 3).

Question 3 elicited responses indicating an aptitude for thinking logically and problem solving, as represented by statements such as "Computers are not vague; there is an optimal solution," "Fits my logical way of thinking," and "Technical subjects were easy at school." Others seemed attracted by the opportunity to respond to challenge with creativity: "Build something that do[es] not exist before," "Challenge to overcome," and "Creativity" are examples.

In contrast to Question 1, when asked "What makes software development worthwhile to you?" (Question 4), "Impact" was the most common response category, as exemplified by statements like "Knowing that what I do has an economic impact" or "Solving problem[s] helping others." One respondent went so far as to claim, "The result is ageless…" Impact was followed by challenge and creativity, such as "Challenging yourself" and "Creating something new." As with the other questions, intrinsic motivators dominate the responses to this question.

This effect is summarized in Table 7. This table shows, in descending order of frequency, the response category, number of respondents who made statements falling into that category, number of statements from all questions that fall into that category, and Motivators from Table 1 that apply to the category. Also shown is whether the category represents Intrinsic or Extrinsic motivation, or both; and Aspects from Table 2 that apply to the category. As can be seen from the last column ("Ex-/Intrinsic") in this table, the vast majority of categories seen in the survey responses represent intrinsic motivators, and only one of the top *twenty* response categories is wholly extrinsic.

5 Discussion

The motivation literature does not, as yet, include comprehensive guidelines for motivating software engineers engaged in Global Software Development. However, before going forward with specific guidelines, we need to know whether engineers who are engaged in GSD are similar to those engineers drawn from the general population. Our research question, "Do software engineers engaged in GSD share similar characteristics and needs to those engineers in the general population?" addresses this point.

The needs of software engineers are changing, as reflected in the new motivation factors found in reviews of motivation [9, 11] that update the initial study of software engineer motivation published in 2008 [2]. And in our empirical study here, we have

Table 8. Motivators Not Expressed in Survey Responses

ID.	Motivator	Type
M5	Empowerment/responsibility/shared leadership	Intrinsic
M6	Good Management	Extrinsic
M8	Work/life balance	Extrinsic
M14	Trust/respect	Intrinsic
M18	Autonomy	Intrinsic
M19	Appropriate working conditions/infrastructure	Extrinsic
M21	Sufficient resources	Extrinsic
M25	Professionalism/setting standards	Extrinsic
M26	Having an ideology	Extrinsic
M28	Penalty Policies	Extrinsic
M31	Recognition of individuality	Intrinsic

found new motivators: “Construction, delivery and completion of the product,” “travel” and “cultural mix.” This growing list of motivators (see Table 1) suggests that there might be a shift in what today’s software engineer needs. However, what isn’t clear from this research is whether all those historical factors listed in Table 1 are still important to the global team member.

Results of our empirical study with a small, but experienced group of practitioners working in distributed teams, found many familiar factors were important, as shown in the mapping of survey responses to known motivators in Table 7. And indeed, the engineers themselves felt they fit the general software engineer profile. However, a closer inspection of their survey responses revealed some differences.

This group of developers are highly motivated by intrinsic factors (19 of the top 20 motivators were partly or entirely intrinsic). Also, they found 20 of the 31 factors in Table 1 as motivating. Of note is that most of the eleven motivators that they did not identify with are extrinsic (Table 8), such as having a work/life balance, working conditions, sufficient resources, and good management.

These results are consistent with Herzberg’s two factor theory, which states that *lack* of extrinsic motivators can be demotivating, but their *presence* is not necessarily motivating over the long term. A typical extrinsic motivator is “right office conditions,” where an excessively-noisy, over-heated office can demotivate, but having the right noise level and temperature won’t be exciting long term (or perhaps even short term). It is clear that if an engineer has an excessively hot office, or too much noise (extrinsic demotivator) he or she many not be able to take advantage of the challenging job (the intrinsic motivator). A further concern is that a workforce that focuses on extrinsic motivators, such as salary, visiting exotic countries, and mixing with different cultures, may only be motivated in the short term. Travel and salary may attract a software engineer to a job, however it is the interest and engagement with the job itself that will keep the engineer in the job, and will excite him or her to produce better software. As such, those managers who can influence motivation not only need to ensure that extrinsic motivators are not acting as a barrier to motivation, but also need to promote intrinsic motivation.

Tapping into the intrinsic motivation needs of the software engineer – those motivators associated with the job itself – correlates to desirable outputs such as low staff turnover, higher productivity, and better quality software [2]. Even though motivation is just one of many complex factors that reduce software defects [8], the message is, "ensure the workforce have the right intrinsic motivators in place," such as the right level of challenge, variety, recognition, participation, etc. But beware: if the extrinsic motivators are not also addressed, intrinsic motivators, even if in place, will not have the power to motivate.

Of the areas we identified as potentially challenged by working in GSD (Table 4), a worrying nine of 14 intrinsic motivation factors (I1, I2, I4, I5, I9, I10, I11, I12, and I13) potentially inhibited by Global Software Development would be considered important by our survey respondents. However, there is no indication that factors such as I3 ("Development Practices"), I6 ("Autonomy"), I7 ("Empowerment and responsibility"), I8 ("Trust and respect"), and I14 ("Recognition of individuality"), were important intrinsic reasons for them to work in software engineering. This might be a reflection of the fact that the majority of respondents were highly experienced people in senior positions; as such, they would likely have a great deal of autonomy and command respect, and would not be so concerned with development practices themselves (although they might be concerned about which practices their teams use). Regardless, it's clear that in contrast, only I15 ("Sense of belonging"), I16 ("Feedback"), and I17 ("Rewards and incentives") were considered to be important extrinsic reasons to be in the field.

More importantly, only *one* demotivating factor (D11 "Poor working environment") would *not* be considered relevant to this group.

These results have important implications for project managers in charge of Global Software Development projects: to the extent that our respondents are representative of practitioners working in GSD, their motivational needs are not the kind that can be satisfied by "throwing money at the problem." Giving the teams fancy offices with powerful workstations and free food is not going to result in a lasting motivational effect. Rather, managers must understand and cater to each team's need for technically challenging work developing, in a team context, a product that has impact, with opportunities for career growth.

Returning to the research question posed in Section 2: "Do software engineers engaged in GSD share similar characteristics and needs to those engineers in the general population?" we find that our survey participants share many motivation factors with software engineers in general. However, two important differences are apparent.

First, our respondents appear to be more motivated by intrinsic factors than the general software engineer population, and seem to be less interested in hygiene factors: the bulk of factors (7 of 11) listed in Table 8 as not being present in the survey responses are extrinsic.

Second, there appears to be a new factor – "Construction/delivery/completion" – that is important to this group, but has not been identified by previous research.

These differences imply that, while the software engineer working in GSD looks very similar to the engineer working in the general population, he or she is even more interested in intrinsic factors, and less influenced by hygiene factors. Therefore, we need to think carefully about those intrinsic motivators that are challenged by GSD.

5.1 Hint at a solution

To stimulate individual intrinsic motivation (and, in turn, a team's motivation), hygiene factors must be considered, since a lack of these factors can lead to demotivation. Motivation is a social process that defines how people join, remain part of, and perform adequately in, a human organization [17]. The global organization is a social arrangement comprising members who must be motivated to join, to stay, and to perform at acceptable levels. It is within a social context that teams working remotely are encouraged to work harder and more effectively. Some research suggests that social interaction itself can be motivating [22].

Developing software is essentially a human intellectual and social activity [3, 10, 13, 18, 25]. If the work is viewed as repetitive, boring, and fragmented, then the individual may not feel part of the overall organization and may perceive his or her work to be meaningless. It is important for engineers' motivation that they perceive that their contributions matter [6, 13]. Research shows that monotony creates apathy, dissatisfaction and carelessness [6, 21, 25], especially when an individual does not develop new skills. However, an under-researched need is career advancement in GSD, which can be problematic. For example, if a programmer desires to become a software architect, he or she needs to see a career path and be given an opportunity to learn related new skills. Working remotely can mean the individual either doesn't have the scope to advance up the career ladder, or may be overlooked due to lack of visibility to upper management.

6 Conclusions

This paper attempted to answer the question, are software engineers who work in Global Software Development contexts motivated by different factors than software engineers working in a co-located setting?

We started with a list of thirty-two factors from the literature that have been shown to motivate software engineers in a co-located development environment. These are divided into intrinsic and extrinsic motivators. We then compared these factors to a set of motivators identified from a survey of software engineers engaged in Global Software Development.

What we discovered is that, whether working in a co-located or distributed environment, software engineers are motivated by the same factors, especially, a need for challenging, creative work with impact for customers and users. However, our results indicate software engineers working in Global Software Development are less interested in extrinsic than intrinsic factors. This has important implications for managers of distributed software development projects, as certain aspects of distributed software development can interfere with many intrinsic factors [1].

We also identified a new motivator having to do with building and delivering a working product. This was the most commonly cited factor, and means that managers need to ensure all teams contribute meaningfully to creating and delivering the product.

It appears that the global software engineer profile is changing; there is less interest in those environmental factors that can act as barriers to motivation. This research suggests, that those engineers that remain in globally distributed teams for the long term, are resilient to the demotivating factors that are inherent in GSD.

6.1 Limitations

As with any empirical study, the results presented in this paper are subject to certain limitations and threats to validity.

Construct Validity The chief threat to construct validity involves how we determined what motivates this group: do the questions we asked actually reveal the motivators of our respondents?

Our survey is derived from a earlier survey used by Helen Sharp [24]; so, to the extent that the original survey is valid, ours is too. Further, the survey explores motivation from four perspectives using four different questions (satisfaction, remaining in post, attraction to post, and what make the job worthwhile), so we do not rely on a single construct to measure motivation.

Internal Validity Two threats to internal validity are present in this study. The first is selection bias due to the fact that all participants were working for the same company. This could introduce a confounding factor due to some characteristic of the organizational culture or the domain in which it operates that are inherently motivating.

The second threat is researcher bias. The coding process relies heavily on researcher interpretation of statements written by the respondents; the researcher's background or experience could influence this interpretation. However, this bias is mitigated by having two researchers with different backgrounds and cultures independently analyze all statements; this increases the likelihood that the final agreed category for each statement is based on the statement's actual meaning.

External Validity The participants in this study share certain characteristics that are different from the general population of software developers engaged in GSD. First, they were all male, highly experienced, and more than half were project managers or senior management (however all were involved in the software development). In addition, all but two were of European background, and all were currently working in Europe. As such, they are unlikely to be motivated by some of the things that might motivate junior developers, and may not share the same motivators as their counterparts in Asia or North America (although we have no reason to believe they do not). We should, therefore, be cautious about generalizing the results seen here.

We also note that the sample size of 13 participants is very small, and our future plans are to extend this short, easy to administer, survey to capture the motivators of the wider population of Global software engineers. Also, we need to add specific GSD questions in the new survey to include recognition of a) Development process applied, and b) Whether the participant is working at a central office or a remote/satellite location. Nevertheless, results from our small sample, allow us to form hypotheses for future research which we put forth below.

6.2 Future Directions

While this paper has focused on the factors in GSD that can demotivate software engineers, there are likely to be many aspects unique to GSD that can tap into both the intrinsic and extrinsic needs of software engineers. To motivate further research in this area, we propose the following hypotheses derived from our observations:

Global Software Development projects in which some teams are not directly engaged in creation of new products or significant new functionality will experience lower productivity due to lack of motivation This hypothesis is based on the observation that "construction/delivery/completion" is the category with the most responses from our survey. It follows that teams who are not given a significant role in the development and delivery of the product will lack this important motivator, and as a result the project as a whole will experience lower productivity and quality.

Global Software Development projects in which some teams are allocated routine tasks will experience issues due to lack of motivation This hypothesis stems from the frequency that intellectual challenge, innovation, and creativity were cited by respondents as important motivators. Teams who are solely responsible for routine maintenance or testing will not have the same intellectual challenges as teams involved in creating new products or significant new features. And, such teams may lack a sense of belonging to the core contributors, or even perceive the difference in task allocation to be implicit negative feedback on their performance. The absence of such extrinsic motivators can be *demotivating* [15].

Some team members may find aspects of Global Software Development to be motivating Many of our respondents cited interacting with different teams and customers to be motivating. One specifically cited "... a chance to travel and work with colleagues from other countries" as a reason for *staying* in software engineering. Cultural differences and geographic separation are frequently cited as barriers to be overcome[20]. But these characteristics of global software development may also emerge as motivators, and therefore additional advantages of GSD.

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