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Exploring Managerial Commitment towards SPI in Small and Very Small Enterprises

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Abstract. This paper compares and contrasts the results of two similar studies into the software process practices in Irish Small and Very Small Enterprises. The first study contains rich findings in relation to the role and influence of managerial experience and style, with particular respect to the company founder and software development managers in small to medium sized enterprises (SMEs), whilst the second study contains extensive findings in relation to people and management involvement / commitment and SPI goal planning in very small enterprises (VSEs). By combining these results of these two studies of Irish SMEs/VSEs we can develop a rich picture of managerial commitment towards SPI and in particular explore the similarities between Small and Very Small Enterprises.

Keywords: Software process improvement, SME, VSE

1 Introduction

For many SME software companies, implementing controls and structures to properly manage their software development activity is a major challenge. Administering software development in this way is usually achieved through the introduction of a software process. All software companies are not the same. They vary according to factors including size, market sector, time in business, management style, product range and geographical location. For example, a software company operating in India may have a completely different set of operational problems to contend with to a software company in Israel or Ireland. Even within a single geographical area such as Ireland, the range of operational issues faced by a small Irish-owned firm can be radically different to those affecting a multinational subsidiary. The fact that all companies are not the same raises important matters for those who develop both software process and process improvement models. To be widely adopted by the software industry, any process or process improvement model should be capable of handling the differences in the operational contexts of the companies making up that industry. But process improvement models, though highly publicised and marketed,

are far from being extensively deployed and their influence in the software industry therefore remains more at a theoretical than practical level.

There is evidence [1, 2, 3] that the majority of small and very small software organisations are not adopting existing standards / best practice models because they perceive the standards as being orientated towards large organizations, thus provoking the debate in terms of number of employees, size does actually matter.

1.1 Size matters

Small and very small companies are the fundamental growth of many national economies. It is important to notice that the contribution from the small companies should be seen as important and significant as compared to the large companies. The majority of software companies are “*small*” [4] however the definition of “*Small*” and “*Very Small*” Enterprises is challengingly ambiguous, as there is no commonly accepted definition of the terms. For example, the participants of the 1995 Capability Maturity Model (CMM) tailoring workshop [5] could not even agree on what “small” really meant. Subsequently in 1998 SEPG conference panel on the CMM and small projects, small was defined as “*3-4 months in duration with 5 or fewer staff*”. [6] define a small organization as “*fewer than 50 software developers and a small project as fewer than 20 software developers*”.

To take a legalistic perspective the European Commission defines three levels of small to medium-sized enterprise (SME) as being: Small to medium - “*employ fewer than 250 persons and which have an annual turnover not exceeding 50 million Euro, and/or an annual balance sheet total not exceeding 43 million Euro*”; Small - “*which employ fewer than 50 persons, and whose annual turnover or annual balance sheet total does not exceed 10 million Euro*” and Micro - “*which employ fewer than 10 persons and whose annual turnover*” [7].

To better understand the dichotomy between the definitions above it is necessary to examine the size of software companies operating in the market today. In Europe, for instance, 85% of the Information Technology (IT) sector's companies have 1 to 10 employees. In the context of indigenous Irish software firms 1.9% (10 companies), out of a total of 630 employed more than 100 people whilst 61% of the total employed 10 or fewer, with the average size of indigenous Irish software firms being about 16 employees [1]. In Canada, the Montreal area was surveyed, it was found that 78% of software development enterprises have less than 25 employees and 50% have fewer than 10 employees [1]. In Brazil, small IT companies (companies with less than 50 employees) represent about 70% of the total number of companies [1].

Another perspective on “very small” is provide by ISO/IEC 29110 [1] as “*any enterprise, organisation, department and project having up to 25 people*”.

1.1 Study One

Large software organisations have used ‘best practice’ process improvement models such as the Capability Maturity Model Integrated (CMMI) and the International Organisation for Standardisation (ISO) 9000 series. Although commercial SPI models

have been highly publicised and marketed, they are not being widely adopted and their influence in the software industry therefore remains more at a theoretical than practical level.

In the case of CMMI, evidence for this lack of adoption can be seen by examining the SEI CMMI appraisal data [8] where it is clear that the published figures represent a very small proportion of the world's software companies and company in-house developers. In addition there is evidence that the majority of small software organisations are not adopting standards such as CMMI [9, 10].

The motivation for this first study [11] originates in the premise that in practice software companies are not following 'best practice' process improvement models. On this basis we set out to answer the following research question: *What software processes are software companies using?* Preliminary investigation of this question raised the following linked sub-questions: *How are software processes initially established in a software company?* and *How do the operational and contextual factors present in organisations influence the content of and adherence to software processes?* A major output of this study was a deeper understand of the *Influence of Managerial Experience and Style* in the formation and evolution of a companies software development processes. These aspects of the study are highlighted in section 2 below.

1.2 Study two

In software business, the pressure to produce a software product that is relevant with the market needs and to stay competitive is a great challenge for all software companies. However for very small companies with very limited resources the management, work and organizational culture may be different from the large companies [4]. And thus have a major impact on software development processes.

Considering their lack of resources especially in term of employees and unique management, work and organization culture, the organizational commitment in small software companies for SPI has to be taken into account as an important factor for successful improvement initiatives and implementation. Their commitment to improve their practices in their development work and process are significant for the SPI success. Moreover previous study in this issue currently is more concentrating mainly on the large companies and least focus on small companies in general and very small companies in particular. This has lead to an unclear situation in such very small companies. Therefore study two [12] presents a case study of SPI commitment in Irish Software VSEs, that is companies who employ less than 25 people. The focus is on gaining a more comprehensive understanding of software VSEs commitment and planning towards SPI

1.3 Common Study Context

Both study one and study two share a common context and scope follows: To ensure the participation of software development professionals who would be familiar with the considerations involved in using both software process and process improvement

models, we decided to limit the scope to software product companies. In addition, given the geographical location of the researchers, we chose to confine the study to indigenous Irish software product companies who naturally operate within the same economic and regulatory regime. Furthermore, restricting the study to indigenous Irish software product companies significantly increased the prospects of obtaining the historical information required to understand process foundation and evolution which would not be the case with non-Irish multinationals operating in the country, as their process would likely have been initially developed and used within the parent company prior to being devolved to the Irish subsidiary.

The only significant difference is in terms of company size along the SME / VSE divide. The average number of employees involved in software development in study one companies was 36, whilst the average number of employees involved in software development was 4, thus allowing us to better understand the differences between SME and VSE management commitment to SPI.

2 Study one - Influence of Managerial Experience and Style

This Grounded Theory [13] study was divided into three distinct phases: firstly a Preliminary Phase to assist with framing the study and test the interview guide and approach; a Detailed Phase which developed the initial concepts and categories and enabled evaluation of the theoretical sampling process; and a Final Phase which further developed the categories and concepts to produce the grounded theory. In total the three phases of the study involved 25 interviews across the 21 companies.

The study found that all of the companies were tailoring standard software processes to their own particular operating context such as the size of the company, the target market, and project and system type. In addition there was evidence from the data suggesting that managers instigate SPI as a reaction to business occurrences for which the current process did not adequately cater. The theoretical framework can be presented in a pictorial fashion (Figure 1) creating a clear image of how this theme, its categories and subcategories are interrelated.

Process Formation is a conceptual theme and is a predecessor of its two categories, *Background of Software Development Manager* and *Market Requirements*. The *Background of Software Development Manager* determines the *Process Model* used as the basis for the company's software development activity and this *Process Model* is then subject to *Process Tailoring*. The *Background of Software Development Manager* coupled with the *Background of Founder* of the company creates an associated *Management Style* and this, in conjunction with the tailored process model, creates the company's initial *Software Development Process*.

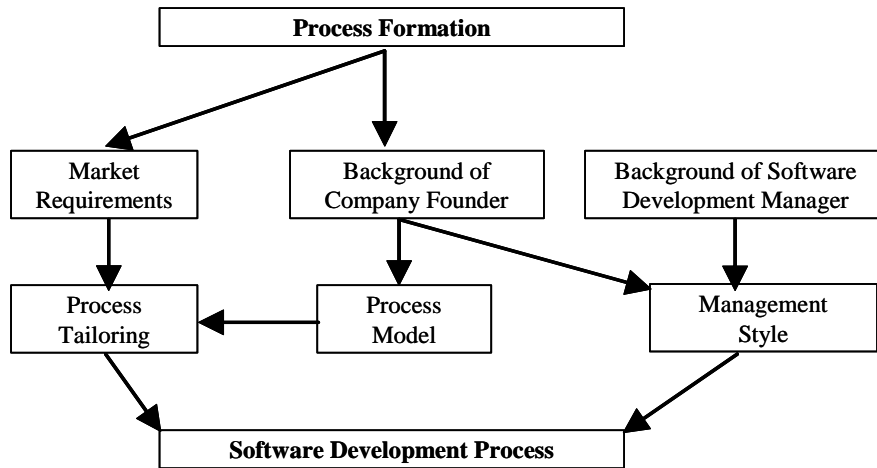


Fig. 1. Process Formation

2.1 Management Background and Experience

One of the key theoretical themes addressed by the research was *Process Formation*. The findings show that this depends on several factors, including the *Background of the Software Development Manager*, essentially the expertise that manager has accumulated over their working and educational lives, the demands of the market in which the company operates, the founder's *Management Style* and the organisational culture.

Within the different study companies the title given to the person with responsibility for process definition and implementation varied. In the start-up situation, where process was established, it was the person with responsibility for managing the software development effort who managed the process activity. Within this study, the generic individual with company responsibility for process is referred to as the '*Software Development Manager*'.

The majority of those interviewed had previously operated in a software development manager, or similar, role prior to joining their current company. From all of the interviews, it was clear that where the software development manager had worked before, what their responsibilities were, what process and process improvement model was used and the company culture shaped the process that the software development manager used in their current company. The link between the company's original process and the *Background of the Software Development Manager* was highlighted in a number of interviews.

If the managers had a prior positive experience with a particular process model and they understood it particularly well, then they opted for familiarity rather than something novel. This concept of bringing a particular model or tool with them was a common feature of the managers interviewed.

All managers brought with them something less tangible, namely 'experience'. This is simply defined within this study as '*knowing what to do in a given situation*'.

Whilst the background and experience of the software development manager helps to form the process, prior negative experiences can also work against certain process elements. For example, in relation to the adoption of the ISO9000 and CMMI standards, prior negative experience had an influence on software development manager's decisions in their current companies.

2.2 Management Style

Beyond the *Background of Software Development Manager*, the impact of culture, or more specifically *Management Style* also dictates how the process is implemented. This *Management Style* as it affects process is either the style favored by the software development manager or, as was often the case in the start-up companies, the style of the founder and the software development manager combined.

There was a sharp diversity between the *Management Styles* adopted within the different study companies. Some companies tend to be more enforcing of process, allowing little deviation whilst others give the developers more latitude within it. During this study, whilst it was clear that *Management Style* helped the initial formation of the process, it also had an impact on how the process was implemented on an ongoing basis. From the extracts, therefore, it was not possible to divorce completely *Management Style* issues at *Process Formation* from more recent management initiatives which influenced ongoing process adherence. From the study data, the key distinguishing factor in identifying the influence of *Management Style* on the formation of the process is company size, in that *Management Style*, particularly that of the founder, was more clearly evident in Start-up companies. This occurs as, with fewer employees, the founder enjoys a narrower span of control and therefore has more day-to-day influence over the process used. In addition, because of their maturity, older (as opposed to start-up) companies were in most cases further removed from the original *Management Style* of that of the founder and software development manager.

The category *Management Style* describes the way a leader discharges their administrative functions, and motivates and communicates with their staff [14]. There was a sharp diversity between the *Management Styles* adopted within the different study companies. Some companies tend to be more enforcing of process allowing little deviation, which we categorised as 'Command and Control', with strong similarities to McGregor's [15] 'Theory X' style.

In opposition to 'command and control' structures, many company managers operate what can be characterised for this study as an 'Embrace and Empower' regime, which has strong similarities to McGregor's [15] 'Theory Y' style. In this context, the opinions of subordinates are valued and included as part of software development policy and there is greater evidence of trust in development staff and their ability to carry out tasks with less direct supervision. Overall, there is greater delegation of responsibility, more participation by staff in decision-making, and, more generally, an environment where consensus prevails. Agile methods such as XP, with its advocacy of self-empowered teams and shared ownership, is more associated with this style of management and was more widely deployed in companies exhibiting this style of management.

3 Study Two - Organizational Commitment Towards SPI

In order to carry out this study, we developed and distributed a survey questionnaire to the Irish software VSEs in Ireland. These companies were selected using personal contacts of the researchers and were all directly involved in software product development, for a variety of business domains. The development of the survey questionnaire have adopted the Goal, Quality and Metric (GQM) approach [16] in order to ensure the survey validity and suitability. The survey consists of 12 close-ended questions that use 5 Likert point response scale. The close-ended questions examined the level of agreement of the related SPI process and activities as proposed in the literature, applied in their organization. Moreover in order to gain more input from the respondents regarding the study issues, several open ended question that related to the close-ended question have been asked in the survey.

Each received and completed questionnaire were compiled and analysis. The close-ended questionnaire were grouped according the issue and analyze using a statistical analysis. Three main statistical analysis were run in processing the data, which are the frequency, mean and descriptive analysis. For this purpose we use a statistical tool in processing the data. Meanwhile, on the open ended data, we analyze and categories the data according to the category that this study intends to understand. The answers were group, coded and list into a table in respect to the study category issues. In overall we adopted the qualitative contents analysis approach in analyzing the open-ended answer [17]. In additional we have merged the both analysis result in order to gain more understanding and validate the results. Moreover, in order to produce details analysis result, we have divided the survey respondents into 2 main group namely the Micro-VSE (1-9 employees) and Larger-VSE (10-25 employees) [1].

3.1 Process Improvement and Assessment

In analyzing the close-ended data in the survey questionnaire, we have regrouped the questions according to the categories of analysis as below:

- The software process changes / evolves overtime
- Management regularly assess software development process
- When software processes are updated / changed, software developer always follow the new process.
- We are follow an 'agile' type of software development methodology.

The results from the analysis as shown in table 1 indicated that in general respondents are agreed that their software development processes rapidly change and evolve overtime. They also claimed that their development process are regularly assesses and staffs always followed or applied the latest development process method. Table 1 also indicates that respondents claimed that they are following an agile development philosophy in their development process.

In relation to the above, the analysis on the open ended question that related to the same issues has highlighted that 90% of respondents felt that their development process evolve overtime. They stated that following the best practice, client requirement, team size growth, new idea and keep up with the technology change are the reasons for the improvement and evolution of development process.

Moreover that in question on related to the process loss issues shows that almost all or 80% of respondents' claimed that their software development processes are not affected by the process loss problem. They claimed that by using standard development tools, similar development process, having frequent guidance and mentoring activities, active in knowledge sharing and proactive coaching could avoid the process loss problems in software development process.

Employee Size Group		Change & Evolve	Regular Assess	Follow Update Process	'Agile' Type development
Micro VSE	Mean	3.80 (0.447)	3.40 (0.894)	3.20 (0.837)	4.20 (0.447)
Larger	Mean	4.00 (0.707)	3.60 (0.548)	3.20 (0.837)	4.20 (1.304)
VSE	Mean	3.90 (0.568)	3.50 (0.707)	3.20 (0.789)	4.20 (0.919)

Table 1. Process Improvement and Assessment

However the respondents also admitted that “laziness” attitudes among the staffs and practicing informal and rapid changes in software development process are among the factors that could lead the process loss problem in software development process.

3.2 People and Management Involvement and Commitment

The questions on this part are stress particularly on the level of team involvement in planning and setting the development process and procedure in the software development projects as shown below:

- Software development staff are directly involved in planning and improving software development processes
- Software developers have freedom in planning and managing their work.
- Software development staffs are actively involved in setting goals for SPI activities.
- Software development staff are actively involved in creating process and procedure for software development
- Software development staff regularly receives guidance and support from management.
- Software development staff are highly motivated.
- Software development staff receive recognition for their work
- Senior management actively supports SPI activities.

The results from the analysis as shown in table 2 and 3 indicates that the respondents were agreed that the level of development team involvement in software development process and planning are very significant. This could be identified with the average mean score for this question is relatively high. Moreover table 2 also clarified that even though the development staff working autonomously but they are

also actively involved in setting goals, planning and procedures in the company's software development process. Meanwhile, table 3 shows the level of management commitment in the improving current software development process. From this table, researchers could indicate that the management has provided their full support in SPI process. This situation is shown in the total mean score for each questionnaire on this issues which more on the positive rather than negative. Therefore, this gives an indicator of the seriousness and high commitment of management in software development process

Size Group		Direct Involvement Dev Process Planning	Autonomous Work	Team SPI Setting Goals	Direct Involve Dev. Process & Procedure
Micro VSE	Mean	4.20 (0.837)	4.20 (0.447)	3.80 (0.447)	4.00 (0.000)
Larger VSE	Mean	4.40 (0.548)	4.40 (0.548)	3.40 (0.548)	4.00 (0.707)
Total	Mean	4.30 (0.675)	4.30 (0.483)	3.60 (0.516)	4.00 (0.471)

Table 2. People Involvement and Commitment

From the feedback indicated by the respondents as in questionnaire, we could understand more details about the above issues. The results in this part of analysis gave a pattern and indication that in VSEs development and management team are very supportive and serious in improving their development process in order to produce a quality product

Size Group		Guide Support &	Staff High Motivated	Staff Recognition	High Support in SPI process
Micro VSE	Mean	4.20 (0.447)	4.80 (0.447)	4.40 (0.548)	3.00 (0.707)
Larger VSE	Mean	4.20 (0.447)	4.20 (1.304)	4.00 (1.225)	3.00 (0.707)
Total	Mean	4.20 (0.422)	4.50 (0.972)	4.20 (0.919)	3.00 (0.667)

Table 3. Management Involvement and Commitment

3.3 SPI – Goal and Planning

In order extend our understanding on software development process activities in VSEs. We have grouped all the questions that are more specific towards the companies' goal and planning toward SPI as shown below:

- We have established SPI goals.
- There is a broad understanding of SPI goals and policy within our organization.
- Our SPI goals are closely aligned with organizational business goals.
- We have a good balance between short term and long term SPI goals.
- Software development staffs always understand projects goals.

Table 4 indicates that the respondents were agreed that in general they are clear about the specific goal of the companies' software development projects. This can be identified with the high score in mean analysis regarding these issues. However, table 4 also highlighted that VSEs do not have a proper plan and well understand on software process improvement issues. In details, the analysis in table 4 shows that all respondents agreed that the companies do not have a proper SPI goal either for short term or long term. They also admitted that the companies SPI goals are not aligned with their business goals. It is also indicates that the size of the companies give an influences in setting and planning companies SPI goals and objectives.

Size Group		Establish SPI Goal	Broad Understand SPI Goal	SPI Goal Aligned Business Goal	Balance Short & Long Term SPI
Micro VSE	Mean	2.00 (1.000)	2.60 (0.548)	2.60 (0.894)	2.60 (0.548)
Larger VSE	Mean	3.60 (0.548)	2.80 (0.447)	3.00 (1.000)	2.80 (0.837)
Total	Mean	2.80 (1.135)	2.70 (0.483)	2.80 (0.919)	2.70 (0.675)

Table 4. SPI- Goal and Planning

The comparison between table 1 and table 4 provides an indication that in VSEs the improvement process has been done in a rapid way but in a small scale and informal process. It is also showed that VSEs did not have a specific procedures or documented specific plans in improving their development process but more toward informal and direct improvement of the process. These findings also aligned with the first stage analysis which stated that the improvement processes are performed in an informal way or have been done at a small scale but in a rapid process.

5 Discussion

A common linkage across Indigenous Irish Software Product SME and VSEs is the observation that the companies software development process frequently change and evolved over time, which was agreed by respondents. They also agreed that they regularly assess and update their development processes. However the finding showed that the changed and evolved processes are informal, indirect and very reactive which depends or is linked to customer requirements, developers' initiatives and technology changes. In term of development process methodology, the majority of respondent stated that they had adopted an agile type development approach philosophy in the company's projects. This could be identified from the analysis which showed that the development processes are very informal, less documentation, customer oriented and active in communication. Overall although the results showed the high informal and

indirect culture in VSE in most of their development activities, the results also indicate that VSEs commitment towards SPI is very high and positive.

However, it is clear that the role of management commitment towards SPI remains a low priority. In a time when software quality is a key to competitive advantage, the use of ISO/IEC systems and software engineering standards remains limited to a few of the most popular ones. Research shows that VSEs can find it difficult to relate ISO/IEC standards to their business needs and to justify the application of the standards to their business practices. Most of these VSEs can't afford the resources - in number of employees, cost, and time - or see a net benefit in establishing software life-cycle processes. There is sometimes a disconnect between the short-term vision of the company, looking at what will keep it in business for another six months or so, and the long-term benefits of gradually improving the ways the company can manage its software development and maintenance. A primary reason cited by many small software companies for this lack of adoption of such ISO standards, is the perception that they have been developed for large multi-national software companies and not with the small organisation in mind [1]. Subsequently, VSEs have no or very limited ways to be recognized as enterprises that produce quality software systems in their domain and may therefore be cut off from some economic activities.

Accordingly there is a need to help such organizations understand and use the concepts, processes and practices. Work is currently underway to launch a new standard ISO/IEC 29110 'Lifecycle profiles for Very Small Entities' [18] aimed at such VSEs. This includes a series of support packages known as 'Deployment Packages' [19] to provide detailed guidelines and explanation presenting in more detail the processes defined in the ISO/IEC 29110. It is anticipated these developments will support Irish and International VSEs in increasing commitment and support for SPI initiatives.

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