GRafP
Risk Analysis

REPORT ON THE STATE OF SOFTWARE ENGINEERING AND INFORMATION TECHNOLOGY IN CANADA

April 27, 2010

Executive Summary

INTRODUCTION

This report presents the data collected through 30 assessments conducted in Canadian organizations involved in developing products or providing services drawing on Software Engineering and Information Technology (SE&IT). The size of the assessed organizations ranged from 10 SE&IT professionals to 250, with an average of 75.5, a standard deviation of 64.5 and a median of 55.

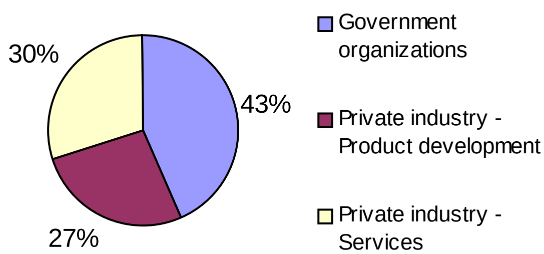

Figure 1 - Distribution of assessed organizations

Seventeen of these 30 assessments were performed in private industry; 13 were performed in government organizations. Out of the 17 private enterprises, 8 were developing and selling products whereas the remaining 9 were providing software development and maintenance services, either internally or to other organizations. This breakdown is shown in Figure 1.

Each assessment was performed in a separate organization. Some assessments examined only one project, whereas others included several (at times, up to five).

Three essential parameters are used to characterize the state of Software Engineering and Information Technology: the process capacity, the risk perception level and the likelihood of problems.

The process capacity corresponds to the mechanisms that are in place to prevent problems from occurring. Given the selected Information Technology (IT) framework and the scope defined for the assessments, this is equivalent to the capability of integrating human resources, methods, procedures and tools in order to develop an IT application that satisfies the needs for which it was undertaken, on budget and on schedule.

The risk perception level corresponds to the ability of anticipating problems. In an SE&IT context, it is equivalent to the capacity of professionals assigned to a project of anticipating potential problems and of taking whatever action is appropriate to prevent their occurrence. To some extent, this capacity depends on personnel experience and know-how. It also depends on the process capacity in the sense that a high capacity process will contribute to a higher capacity of anticipating problems, through the information provided by its risk mitigation components. In fact, such a process may compensate for the lack of experienced personnel. In other words, an organization may decide to hire very talented and experienced people (more expensive) and rely on them to develop the IT application with the help of a process reduced to its minimum (less expensive), or it can decide to implement a high capacity process (more expensive) and hire less experienced people (less expensive). A cost-effective compromise may be to hire a few talented and experienced people and have them develop and implement a high capacity process that captures their know-how and experience, which less experienced people can subsequently apply.

Finally, the likelihood of problems is the probability that risks will materialize. Given the selected information technology framework and the scope defined for the assessments, this is equivalent to the probability that serious problems will occur in terms of cost overruns, schedule slippages, and products or services that do not satisfy the needs for which they were undertaken, to the point of jeopardizing the project or making it a failure.

THE SE&IT ASSESSMENT FRAMEWORK

The types of SE&IT problems vary widely as a function of the type of product or service being investigated. The objective of this risk analysis was to remain at a relatively high level, in the sense that there was no wish to focus on a particular industry or on a specific sector in which Information Technology is applied.

Given the current state of the SE&IT practice, this amounted to computing the likelihood of problems to which IT projects are exposed in terms of cost overruns, schedule slippages and products or services that do not satisfy the needs for which they were undertaken in the first place. For an IT project, as for any project, it can be expected that if the delivery date keeps being postponed, the project sponsor is liable to cancel the project and to seek another solution; if the costs keep increasing, the same project sponsor is liable to get tired of putting money into a black hole and to reduce his or her losses by canceling it; and if the resulting product or service does not do enough of what it is supposed to do, it is liable to be abandoned shortly after having been delivered. In other words, the project is a failure.

The Capability Maturity Model® (CMM) developed at the Software Engineering Institute (SEI) was selected as the SE&IT process framework. The CMM provides organizations involved in software development and maintenance with guidance on how to gain control of their process and how to evolve toward a culture of software engineering and management excellence. The term “software process” in this context is defined as the way human resources, methods, procedures and tools are integrated in order to develop a software application. The CMM does not make any difference between development and maintenance; it assumes that when a project is initiated in order to implement several changes (or to implement a single major one), it effectively becomes a development project. By focusing on a limited set of activities and working to achieve them, a project or an organization can steadily improve its software process to enable continuous and lasting gains in its ability to improve the quality of its products and services. Other models were available but this one is relatively well known, it is well documented and there is plenty of support available to put it into practice.

The Taxonomy-Based Risk Identification, also developed at the SEI, was selected as the SE&IT risk perception framework. The Taxonomy-Based Risk Identification (risk taxonomy for short) is a comprehensive classification of situations that are most often encountered in the course of developing or maintaining software applications. It basically encompasses the entire software development life cycle and can be used to identify the issues that are most likely to cause trouble in a project or, for that matter, to determine the recurring problems that hinder projects in an organization involved in developing IT applications. The risk taxonomy has not received as much attention as the CMM, for one thing, because it is more recent. In addition, human nature is such that the term ‘risk’ makes people cringe. More often than not, risk management is associated with unproductive activities, even though it is widely recognized as the discipline that contributes the most to the success of a project. However, managing risks also means being able to determine how much to invest in something that may never happen or that may have little impact if it does, which, in itself, is not an easy task. People also tend to believe that they do manage their risks, even though they may only do it intuitively. The problem is that some people are very good at it whereas others are not so good and could learn to be so by adhering to a more methodical approach.

The ensuing data collection relied on this dual framework. The collected data was then analyzed with the help of a risk evaluation package developed by GRafP Technologies to compute the three aforementioned parameters, along with qualitative information that resulted in the information presented in the present document. This risk evaluation package relies on the assumption that it is theoretically possible for an entity to develop a process characterized by a given capacity, whatever this capacity may be, that is near-perfectly matched to the problems it faces, in the sense that the set of process-embedded risk mitigation mechanisms minimize the probability that these problems will materialize.

TAILORING THE SE&IT FRAMEWORK

Each framework had to be tailored to provide a suitable match to the pool of assessed organizations.

The CMM, in particular, proved to be well adapted to large organizations, particularly those involved in defense and aerospace. As the assessments targeted a broader range of organizations, some having only 10 software engineers, programmers or computer scientists, others hundreds, the model had to be tailored to take this aspect into consideration. The tailoring activity also had to take into account that some organizations were involved in developing management information systems whereas others were involved in developing industrial or engineering applications. Even though the tasks are often the same, their designation varies considerably from one field to another. Therefore, each Key Process Area (KPA) described in the CMM and each key practice were reviewed and the terminology used to describe it was adapted to make it understandable by personnel from all organizations. Two additional non-CMM Key Process Areas (KPA), Organizational Culture and Customer Service, were also added to the process framework.

® CMM and Capability Maturity Model are registered at the U.S. Patent and Trademark Office by Carnegie Mellon University

As for the risk taxonomy, tailoring involved flattening the structure to seven risk categories. This led to a regrouping of the situations liable to cause problems in a project, which facilitated the collection of meaningful information under each category. Each situation described in the risk taxonomy was reviewed and the terminology used to describe it was adapted to make it understandable by personnel from all assessed organizations.

Table 1 summarizes the final risk categories used to calculate the risk perception level. Within each category, a varying number of situations are documented and contribute to identifying and quantifying the potential difficulties facing the project.

Table 1 - Risk categories

Risk Category	Acronym	Description
Requirements	RE	The purpose of this category consists in eliciting potential problems related to end-product requirements dealing with both the quality of the requirements specification and the difficulty of implementing a system that satisfies these requirements, from either the perspective of in-house development or subcontracted development.
Design and Production	DP	The purpose of this category consists in eliciting potential problems related to the development effort itself, from the requirements, through the design, code and unit test, and up to the integration and acceptance tests.
Development Environment	DE	The purpose of this category consists in eliciting potential problems related to the development environment used to carry out the project. This development environment is typically made up, among other items, of project management tools, compilers, simulators, test equipment, test software, etc.
Development Framework	DF	The purpose of this category consists in eliciting potential problems related to the development framework in which the project is taking place, that is the procedures, methods and tools that are called upon to carry out the project and, in turn, to satisfy the customer's requirements.
Management	MA	The purpose of this category consists in eliciting potential problems related to the project management approach and, at a more general level as far as the project is affected by it, the management approach of the organization in which the project takes place.
Personnel	PE	The purpose of this category consists in eliciting potential problems related to personnel of the organization directly or indirectly involved in carrying out the project. These personnel issues typically include skills, responsibilities, the way people work together, etc.
External Constraints	EC	The purpose of this category consists in eliciting potential problems related to factors affecting the project for which the project team has little or no control. On the other hand, senior management in the organization in which the project takes place may have the influence and the authority to resolve or help resolve some of these issues.

Table 2 summarizes the final set of KPAs used to calculate the process capacity. Within each area, a varying number of key practices are documented and contribute to qualifying and quantifying the process used to carry out the project.

Table 2 - Key process areas

Key Process Area	Acronym	Description
Requirements Management	RMA	The purpose of this area consists in establishing a common understanding, between the party issuing the requirements (e.g. the customer, the marketing department, the program management office, etc.) and the project team, of the requirements that will be addressed by the project.

Key Process Area	Acronym	Description
Project Planning	PPL	The purpose of this area consists in establishing reasonable plans for carrying out the project.
Project Tracking	PTR	The purpose of this area consists in establishing adequate visibility into actual progress achieved in the project so that management can take effective actions when the performance deviates significantly from the plans.
Subcontract Management	SMA	The purpose of this area consists in selecting qualified subcontractors and managing them effectively.
Quality Assurance	QAS	The purpose of this area consists in providing management and the customer, as appropriate, with suitable visibility into both the process being used by the project and the products being developed.
Release and Change Control	RCC	The purpose of this area consists in establishing and maintaining the integrity of the products resulting from the development or maintenance effort throughout their entire life cycle.
Process Focus	PFO	The purpose of this area consists in establishing the responsibility for process activities undertaken to improve the overall process capability of a project, if its size warrants it, or of the organization in which the project takes place.
Process Definition	PDF	The purpose of this area consists in developing and maintaining a development and maintenance process that improves performance in and across projects, and provides a basis for cumulative, long-term benefits to the organization.
Training	TRA	The purpose of this area consists in developing the skills and the knowledge of individuals so that they can effectively and efficiently carry out the tasks to which they have been assigned.
Project Management	PMA	The purpose of this area consists in integrating the project planning and project tracking activities into a coherent, defined process that is a tailored version of the standard process described in the Process Definition process area.
Product Development	PDV	The purpose of this area consists in consistently performing a well-defined development process that integrates all the development and maintenance activities to effectively and efficiently generate correct and reliable software and IT products.
Intergroup Coordination	ICO	The purpose of this area consists in establishing a means for personnel having development responsibilities to participate actively with other personnel so the project is in a better position to effectively and efficiently satisfy the customer’s needs.
Peer Reviews	PRE	The purpose of this area consists in identifying and removing defects from the work products early and efficiently, in addition to developing a better understanding of these products and of the defects that can be prevented.
Organizational Culture	OCU	The purpose of this area consists in establishing a set of collective values that will evolve with time and that may be harnessed to sustain changes introduced in the project or in the organization.
Customer Service	CUS	The purpose of this area consists in providing quality products and services to the customers and end-users in the course of the development and maintenance effort, along with the support they need to operate the delivered system.

RESULTS OVERVIEW

The average value of each of the three aforementioned parameters, namely, process capacity, risk perception level and likelihood of problems, for all assessments combined, is shown in Table 3.

Table 3 - Summary of assessment results

Parameter	Average	Standard deviation
Process capacity	60.1%	9.1%
Risk perception level	38.0%	9.4%
Likelihood of problems	34.3%	11.0%

A process capacity of 60.1% means that on average, 60.1% of the key practices at level 2 and level 3 of the CMM, plus those associated with Organizational Culture and Customer Service, are implemented. This percentage takes into account that some key practices have more risk mitigation potential than others. A risk perception level of 38.0% can be interpreted as an indication that, on average, personnel will be able to anticipate, and possibly deal with one out of every 2.6 undesirable situations that are liable to happen and one out of every 2.6 desirable situations that are liable not to happen. Finally, a likelihood of problems of 34.3% indicates that, on average, an IT project has a 34.3% probability of experiencing serious schedule or budget problems, or problems related to products or services that do not adequately satisfy their requirements. Expressed in terms of frequency, 34.3% of IT projects can expect to experience such problems.

This 34.3% value appears to corroborate the finding of the Standish Group International documented in the report *Chaos – Application Project and Failure* published in 1995 in the United States, to the effect that 31% of IT projects are canceled before completion.

GOVERNMENT VS. PRIVATE INDUSTRY – SERVICES VS. PRODUCT DEVELOPMENT – SMALLER VS. LARGER

Table 4 - Assessment results for government organizations and private industry

	Government organizations		Private industry	
Parameter	Average	Standard deviation	Average	Standard deviation
Process capacity	62.9%	11.0%	57.9%	6.9%
Risk perception level	34.0%	10.7%	41.0%	7.2%
Likelihood of problems	34.3%	10.9%	34.2%	11.3%

Table 5 - Assessment results for enterprises providing services and enterprises developing products

	Private industry – Product development		Private industry – Services	
Parameter	Average	Standard deviation	Average	Standard deviation
Process capacity	57.1%	9.5%	58.7%	4.0%
Risk perception level	36.5%	6.3%	45.0%	5.6%
Likelihood of problems	40.0%	13.7%	29.1%	5.4%

Table 4, Table 5 and Table 6 provide a more detailed breakdown of the data shown in Table 3.

Table 4 shows process capacity, risk perception level and likelihood of problems for government organizations vs. private industry; Table 5 shows these three parameters for private enterprises developing and selling products vs. those providing software development and maintenance services; and finally, Table 6 shows the three parameters for organizations having fewer SE&IT professionals than the median (i.e. 55) vs. those having more.

Table 4 indicates that there is not much difference between the likelihood of experiencing problems in IT projects undertaken by government organizations versus those undertaken by private industry (0.1% lower in private industry). However, what is more significant is that the process capacity is slightly higher in government organizations (62.9%) than in private industry (57.9%). Conversely, the capacity of SE&IT professionals to anticipate problems and to take whatever action is appropriate is higher in private industry (41%) than in government organizations (34.0%).

On a qualitative basis, the analysis indicated that government organizations have a more mature process than private industry but that the flexibility of the work environment and the free flow of information are not as good as in private industry. The better process in government organizations may come from the fact that the use of centralized systems (mainframes) is still fairly common, where roles have been defined over the years to cope with the various responsibilities of working with equipment that called on different types of resources and skills. Conversely, initiative and performance, which are more likely to be promoted and rewarded in private industry, lead to a greater amount of flexibility and better communication.

When comparing private enterprises developing products and private enterprises providing services, the results shown in Table 5 indicate that the latter have a slightly higher process capacity than the former (58.7% vs. 57.1%), but that the capacity of enterprises providing services to anticipate problems is significantly higher (45% vs. 36.5%) than those developing products. The end result is that enterprises providing services are more likely to be on schedule and on budget, while providing services that satisfy their customers, than their counterpart who develop products.

Table 6 - Assessment results for smaller and larger organizations

	Smaller organizations (fewer than 55 SE&IT professionals)		Larger organizations (more than 55 SE&IT professionals)	
Parameter	**Average**	**Standard deviation**	**Average**	**Standard deviation**
Process capacity	59.6%	3.2%	60.6%	12.7%
Risk perception level	40.5%	7.4%	35.4%	10.7%
Likelihood of problems	32.4%	7.5%	36.1%	13.6%

Finally, Table 6 compares organizations that have fewer than 55 SE&IT professionals with those that have more than 55. It turns out that both have approximately the same process capacity (60.6% vs. 59.6%). On the other hand, smaller organizations have a slightly higher capacity of foreseeing problems (40.5% vs. 35.4%) than larger organizations, which translates into a somewhat lower probability of experiencing serious schedule or budget problems, or problems related to products or services that do not adequately satisfy their requirements.

CRITICAL VALUE OF LIKELIHOOD OF PROBLEMS

The compilation and analysis of the data collected through these assessments resulted in another finding of interest. The critical likelihood of problems appears to be approximately 40% that is, a project or an organization cannot sustain such a likelihood of experiencing problems for any significant duration relative to the planned or current activities. Out of the 30 assessments that were conducted, 8 (26.7%) exceeded this value and in all cases, major difficulties were observed during the 12 to 18 months that followed. Projects were indeed canceled, with the resulting losses or missed opportunities that this entailed, some organizations declared bankruptcy, and others went through a very difficult period. As a matter of fact, in many cases, the high likelihood of problems was only a symptom of deeper organizational problems.

This 40% threshold has also been observed in the financial industry (venture capital) where it has been noted that in a portfolio of 10 investments, a portfolio manager will tolerate 4 investments out of 10 not generating a profit. Anything higher than this ratio will result in restructuring the portfolio in order not to exceed the 40% limit, since this would result in a certain loss.

LIKELIHOOD OF PROBLEMS DISTRIBUTED OVER RISK CATEGORIES AND OVER KEY PROCESS AREAS

Figure 2 shows the likelihood of problems distributed over risk categories (acronyms for the risk categories are listed in Table 1). Management comes out as the area most likely to contribute to the difficulties experienced in IT projects, closely followed by the Development Framework, Design and Production, Development Environment and Personnel areas. The graph stresses that the contribution of Requirements to the likelihood of problems is low. Indeed, it was noticed, in the course of the assessments, that this area is well monitored and SE&IT professionals are very well aware of the impact that requirements have on their projects. Likewise, the contribution of External Constraints is also relatively low. As a matter of fact, more attention seemed to be paid to the external factors liable to affect projects than to the internal ones.

Figure 3 shows the likelihood of problems distributed over the 15 key process areas for all assessments (acronyms for the key process areas are listed in Table 2). This risk profile indicates how well the process capacity is matched to the problems facing a project or an organization.

The contribution of the Requirements Management process area to the overall likelihood of problems is relatively small. In fact, one finding of interest that came out of the data analysis is that it is not so much the lack of process to manage requirements that contribute to problems IT projects are experiencing as the lack of peer reviews, which in turn translates into a lack of understanding of requirements, and the poor coordination and communication between groups participating in these projects.

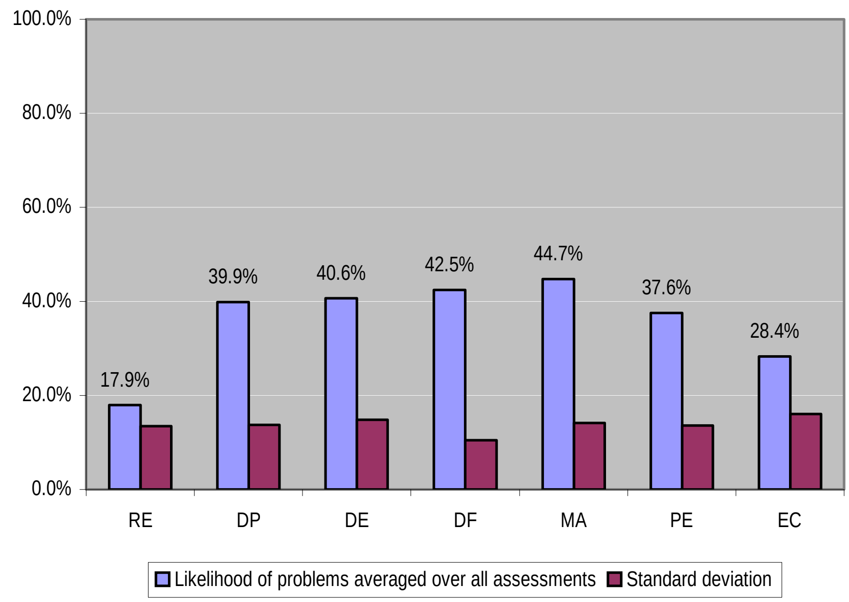

Figure 2 - Likelihood of problems distributed over risk categories

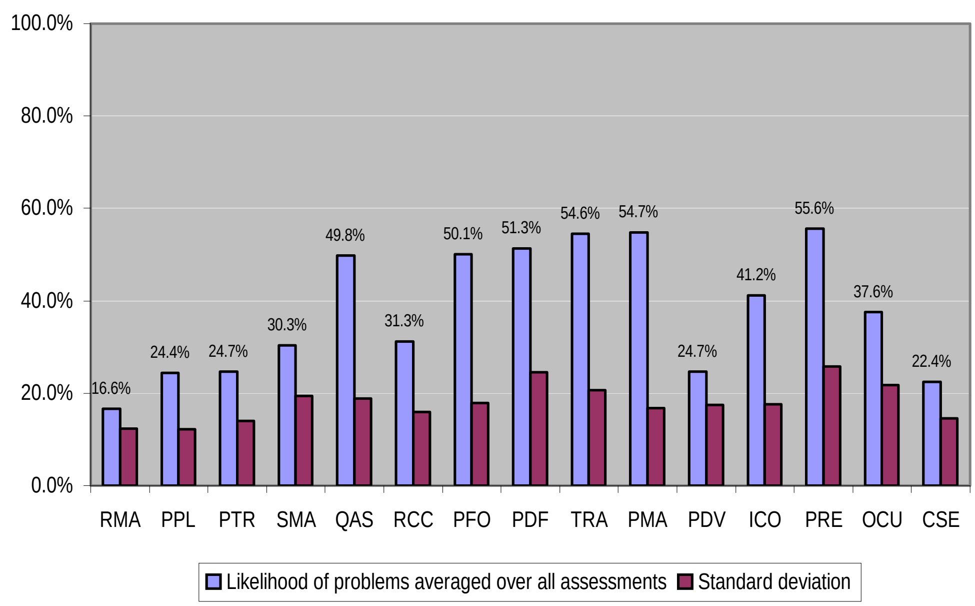

Figure 3 - Likelihood of problems distributed over key process areas

The lack of peer reviews and poor project management contribute the most to the likelihood of problems, closely followed by deficiencies in the Training, Process Definition and Process Focus process areas. It was also observed that the Organizational Culture process area had a major impact, not so much on the likelihood of problems but on the success of implementing remedial actions. In all projects and organizations where the contribution of Organizational Culture to the overall likelihood of problems was high (significantly higher than the likelihood of problems obtained in a given assessment), major difficulties were experienced when attempts were made to rectify the situation. In light of the assessment results and the qualitative observations made during these assessments, Organizational Culture would probably warrant its own appraisal methodology.

ADDITIONAL CHARACTERIZATION PARAMETERS

Additional parameters are used to obtain more information on IT projects and organizations. These parameters are the Software Quality Index (SQI), the number of Potential Instances of Problems (PIP) and the number of Potential Failure Modes (PFM).

SOFTWARE QUALITY INDEX

The Software Quality Index provides a practical scale of the products and services quality that can be expected out of IT projects. It is calculated with the following expression:

$$SQI = \log_e [1+(PC/(RPL \times LOP))]$$

where PC is the process capacity, RPL is the risk perception level and LOP is the likelihood of problems.

One can expect sustained quality products and services from organizations that are characterized by a high process capacity and a low likelihood of problems. The risk perception level does play a role, but for a given process capacity, a low value of risk perception will result in a higher likelihood of problems and a high value of risk perception will result in a lower likelihood of problems. Therefore, multiplying these two parameters will result in a number whose value essentially depends on how well the process capacity is matched to the potential problems facing the organization. In any case, one can expect that a high value of risk perception is likely to result in good quality products or services; the question is: can this quality be sustained and how much dependence is there on the individuals who are assigned to the IT project?

The ratio PC/(RPL x LOP) theoretically ranges from 0 to infinity. In practice, it ranges from 1 to 50. To reflect this range of values, the Software Quality Index numeric scale is translated into an alphabetic scale with the help of the following expressions:

$$\begin{array}{ll} 0 < SQI \leq 1 & E \\ 1 < SQI \leq 2 & D \\ 2 < SQI \leq 3 & C \\ 3 < SQI \leq 4 & B \\ 4 < SQI & A \end{array}$$

Table 7 - Software Quality Index

Organizations	Software Quality Index
All	1.72
Government	1.86
Private industry	1.63
Smaller (<55 SE&IT professionals)	1.70
Larger (>55 SE&IT professionals)	1.74

Table 7 shows the software quality index for all organizations, government organizations, private industry, smaller organizations (fewer than 55 SE&IT professionals) and larger organizations (more than 55 SE&IT professionals). As can be seen, despite all their failings and when everything has been taken into account, the software quality index is higher for government organizations than for private industry (notwithstanding the fact that the average rating is D for all groupings).

While the Software Quality Index is a parameter that helps assess an IT project or an organization involved in developing products and services drawing on Software Engineering and Information Technology, it is not equivalent to the likelihood of problems, which focuses on the probability of failure if no corrective actions are implemented. For instance, a product or a service may have a high quality, but it may not be readily available and as a result, the project may be considered a failure. This is precisely where the risk perception level makes the difference.

POTENTIAL INSTANCES OF PROBLEMS AND POTENTIAL FAILURE MODES

The Potential Instances of Problems (PIP) parameter provides an indication of the number of problems that arise on average in a given risk category. In the assessments, this parameter was calculated by counting the number of risks resulting from inadequate process-embedded risk mitigation mechanisms, averaging it over all situations that were investigated as being a source of potential problems, and dividing the resulting value by the number of assessed organizations. In the analysis performed on the collected data, this parameter only took into account the number of potential problems, not their importance.

The Potential Failure Modes (PFM) parameter is the equivalent of PIPs for key process areas. It corresponds to the number of ways a failure can occur, on average, in a given process area. It is obtained by counting the number of times inadequately implemented process-embedded risk mitigation mechanisms occurred within a given process area, averaging it over all the mechanisms that were investigated as being a source of potential failures and dividing the resulting value by the number of assessed organizations. As for the potential instances of problems, this parameter only took into account the number of potential failure modes, not their importance.

Figure 4 shows areas proportional to the number of potential instances of problems and areas proportional to the effort invested to resolve them. Not surprisingly, the number of PIPs is the highest in the Requirements and Development Framework risk categories, and the effort invested in order to resolve them is the highest in the Requirements risk category (no difference is made between effort invested to prevent problems and effort invested to correct them). Relatively speaking, little effort is devoted in resolving problems in the Development Framework risk category despite the fact that it is associated with a large number of PIPs.

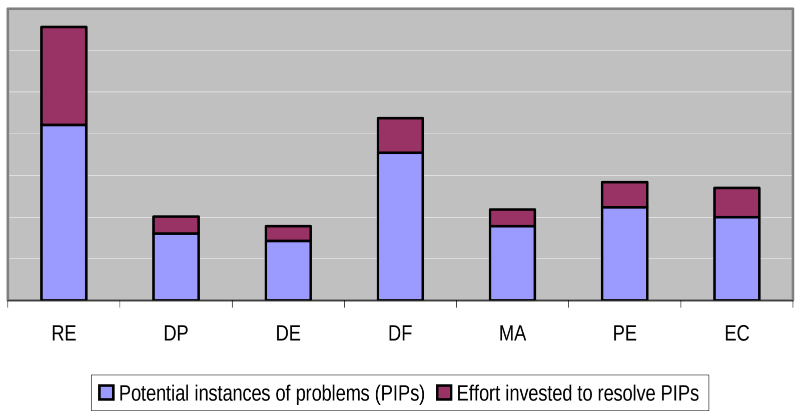

Figure 4 - Potential instances of problems and effort invested to resolve them

In order to provide a comparative basis, Figure 5 shows the same profile for a successful and profitable offshore organization (a division of a large company with over 100 SE&IT professionals) characterized by a process capacity of 81.8%, a risk perception level of 28.5%, a likelihood of problems of 10.7% and a software quality index of 3.3, corresponding to a B rating.

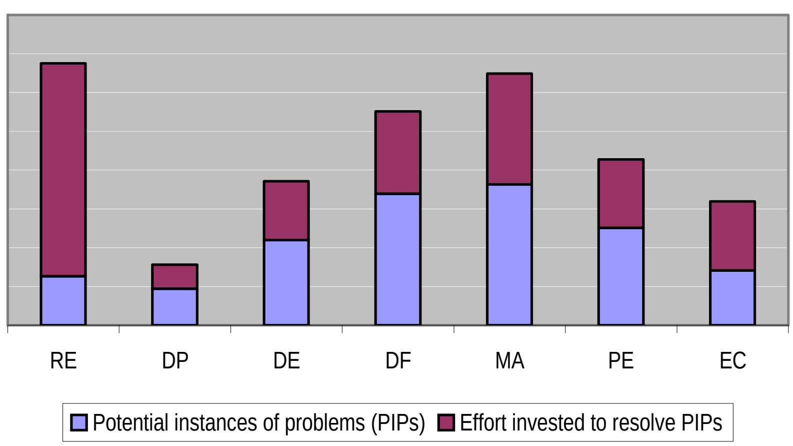

Figure 5 - Potential instances of problems and effort invested to resolve them in a successful organization

Figure 6 shows areas proportional to the number of potential failure modes and areas proportional to the effort invested in taking action on them.

The three key process areas that stand out in terms of failure modes are Quality Assurance, Training and Peer Reviews. It therefore appears that in IT projects, what provides the most opportunities for problems to occur is the lack of skills and knowledge to plan and to carry out the work, the lack of attention paid to verify that the work is performed in accordance with the mandated approach and that the resulting products and services satisfy the specifications that describe them, and the lack of peer reviews, inspections, walkthroughs, etc.

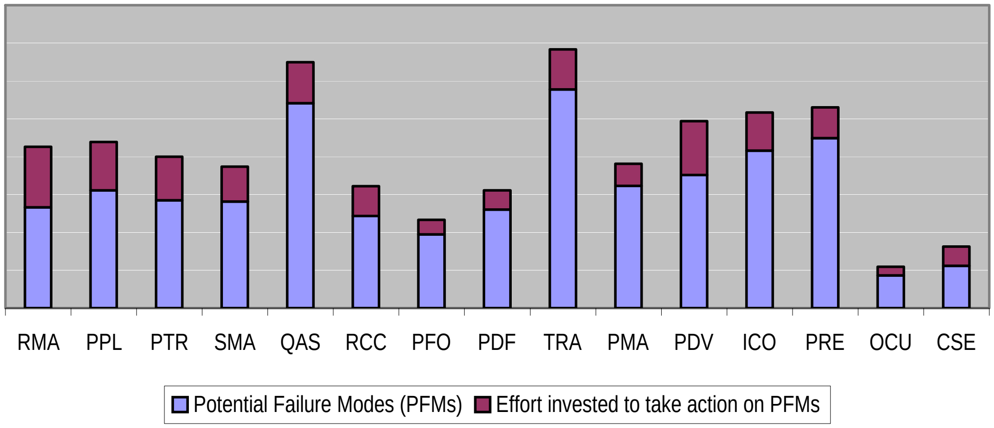

Figure 6 - Potential failure modes and effort invested to take action on them

As a comparative basis, Figure 7 shows the same profile for the aforementioned offshore organization. The effort invested in Quality Assurance and in Release and Change Control is noticeable. For this organization, these are two process areas deemed essential, as it has to maintain an independent quality certification to be in business and it has to maintain several versions of its products that are used by a large number of customers. It is also noticeable that in this organization, no significant failure modes are encountered in Product Development.

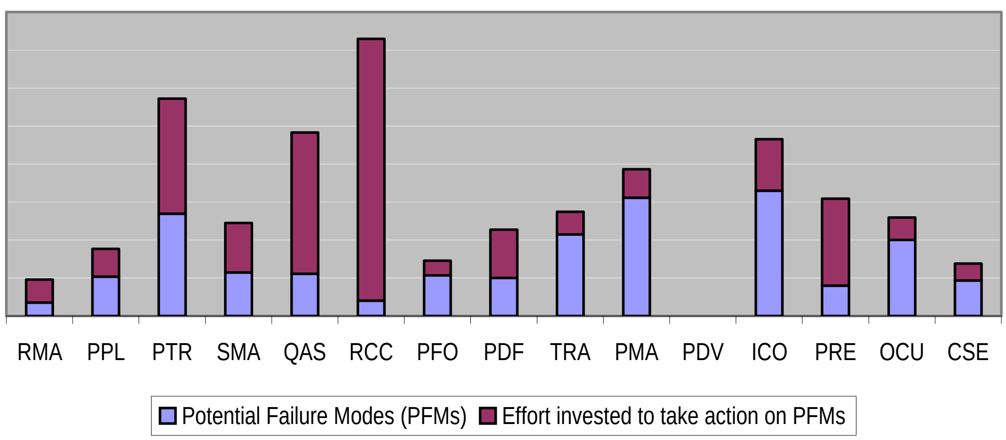

Figure 7 - Potential failure modes and effort invested to take action on them in a successful organization

Conclusion

The picture provided in this report is not overly heartening, but it is believed to be realistic. Canadians can take solace in the fact that things are not much better elsewhere. All the same, given the importance of information technology products and services in Canada and the export potential they offer, governments and industry alike should continue paying particular attention to this industry.

While recognizing that other sectors, such as education, environment and health, also compete for resources and support, and the fact that the information technology industry does not yet employ as large a workforce as the manufacturing industry, decision makers should nevertheless take into account that the situation could change significantly over the next 20 years.

Canada is benefiting from its proximity to the United States in terms of commercial trade, but this proximity also makes this industry vulnerable. The United States has been aggressively pursuing an improvement of its business and industrial capability in this area since the mid 1980's, and Canada could find itself in the unenviable position where an exceedingly large part of its information technology industrial complex is made up of subsidiaries of U.S. companies.

As the importance of SE&IT has grown steadily over the last 10 years, it is indeed of strategic significance that government economic programs and private initiatives rely on hard data to be able to take advantage of the potential this industry offers. The future belongs to those who will be able to harness its potential, by ensuring that the available resources are invested where they offer the highest return.

ABOUT THE AUTHOR

Mr. Poulin is President of GRafP Technologies Inc. and a special collaborator at the Applied Software Engineering Center. He has been involved in assessing the capability of IT organizations and in developing hazard evaluation, hazard monitoring and hazard prevention tools and methodologies applicable to various fields. He holds a Bachelor degree in Engineering Physics, a certificate in Naval Engineering and a Master's degree in Electrical Engineering. He has 25 years experience in the military, industrial and public sectors where he held various management positions. Mr. Poulin has extensive project management experience in fields encompassing software and systems engineering, air navigation, explosives and weapons detection, and embedded control systems. As a technical manager, he was involved in the software development of military helicopter mission systems and shipborne anti-submarine warfare systems as part of major defense procurement programs. Prior to his active involvement in software engineering, Mr. Poulin served in the Canadian Navy as a Combat Systems Engineering Officer. He is a senior member of the Institute of Electrical and Electronics Engineers, a Fellow of the Engineering Institute of Canada and an Officer of the International Association of Professional Lead Appraisers.

GRafP Technologies inc.

GRafP Technologies Inc.
Telephone: (514) 234-5422
e-mail: lpoulin @ grafp.com
Fax: (514) 634-3350