

MEASURING SOFTWARE PROCESS IMPROVEMENT: THERE'S MORE TO IT THAN JUST MEASURING PROCESSES!

David A. Reo, Nuria Quintano, Luigi Buglione

European Software Institute
Parque Tecnológico de Zamudio, 204
E-48170 Zamudio (Bizkaia) – SPAIN
Tel: +34 94 420 9519
Fax: +34 94 420 9420
Email: {david, nuria, luigi}@esi.es

ABSTRACT

High failure rates in improvement programmes, be they software, business or otherwise, indicate that a series of human and socio-economic factors play an important role during any change process. This has been well documented by numerous authors (Drucker, Senge, Edvinsson, et al), yet for many years has been relegated to the academic community since the concepts suggested are both ambiguous and seen as producing intangible results that could not be measured by common quantitative methods. An organisation's ability to mutate in the face of ever-changing market conditions is seen as critical for survival, yet so few organisation's have developed the ability to do so.

To deal with this, we are currently extending the Infrastructure and Innovation perspective of ESI's Balanced IT Scorecard (BITS)¹ Generic Model². In conjunction with the Method and the Application Support Material (other components of the BITS technology), this model is used for identifying a series of goals, drivers and indicators that organisations can use to align improvement programmes with top-level business objectives. It also provides the framework for quantitatively managing Software Process Improvement initiatives and evaluating the impact of these on business results.

Index – 1. Introduction; 2. Focusing on your raw material – it's a people issue; 3. In Search of Process Excellence; 4 Creating the Right Organisational Climate; 5. Conclusions; References

¹ The Balanced IT Scorecard developed at ESI adapts the concepts of Kaplan and Norton's Balanced Scorecard [5] to the needs of Software Intensive Organisations (SIO) to link Software Process Improvement (SPI) initiatives to top-level strategic business goals and quantitatively monitor the performance and impact of such initiatives.

² This work is being performed within the framework of the BASEIII (Building A Software Engineering Infrastructure for Improvement and Innovation) project.

1. INTRODUCTION

When an organisation introduces a new process, a change takes place. While the new process may not be an innovative one (i.e. implementing code inspections), its novelty in the organisation undoubtedly classifies it as an innovation. This change must be managed from conception to birth to maturity. When implementing a Software Process Improvement (SPI) programme, just as any change initiative, many organisations focus on process and technical issues. These issues are addressed by process models such as SPICE and CMM and are supported by continuous improvement cycles such as IDEAL. However, processes are just one element that must be managed in any change initiative.

Since the Infrastructure and Innovation perspective of the Balanced IT Scorecard (BITS) [5,6] builds the foundation for introducing a sustainable software process improvement programme, we have focused on integrating a set of goals, drivers and indicators for various issues to highlight the importance of more than just processes. These issues are:

- ☞ People
- ☞ Process³
- ☞ Organisation

Our approach is to extend the quantitative methods of the BITS for managing the infrastructure issues related to organisational change that must take place for a SPI programme to be successful and, as such, provide Software Intensive Organisations (SIO) with a framework for managing a *complete* SPI programme, not just technical issues.

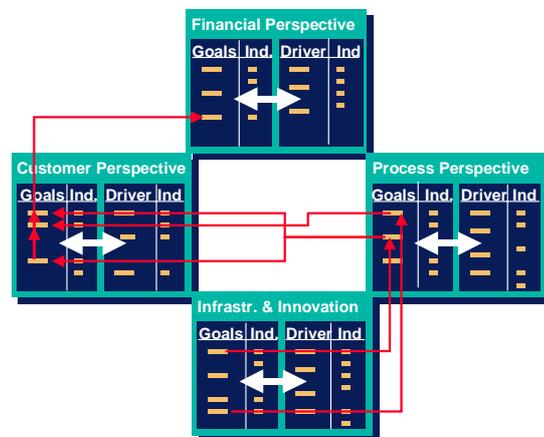


Figure 1 - ESI Balanced IT Scorecard

Figure 2 illustrates the relationships between the different elements considered within the framework of the Infrastructure & Innovation Perspective of the European Software Institute's (ESI) Balanced IT Scorecard.

Our approach focuses on identifying a series of factors that an organisation should consider in order to create a stimulating work environment that is conducive to innovation and continuous improvement which, together, will lead to higher levels of organisational learning. Within this environment, the primary actors are processes and people. Organisations must focus on maturing their processes in a staged fashion so that they can evolve from simply doing what they need to do (effectiveness) to increasing their capability in a controlled and predictable manner. Simply focusing on process and organisational issues would be futile if

³ Prior to continuing, the reader should have a clear understanding of the differences between the *Process Perspective* of the Balanced IT Scorecard and the *Process Elements* of the Infrastructure & Innovation Perspective. In the *Process Perspective*, business-oriented goals, drivers and indicators based on time, cost and quality are set for process **performance**. The *Process Elements* of the Infrastructure & Innovation Perspective are a set of goals, drivers and indicators for process **improvement** that will support process performance.

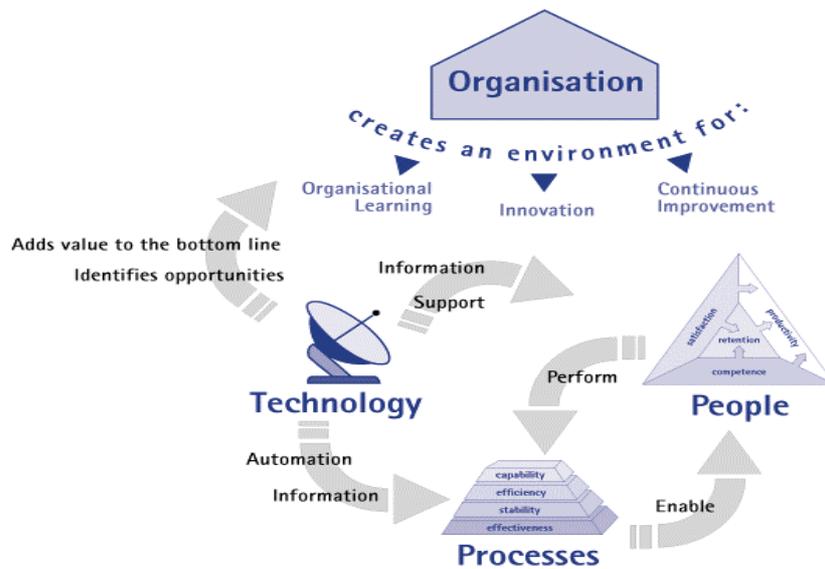


Figure 2 - Infrastructure & Innovation Perspective Framework - ESI
Balanced IT Scorecard

organisations fail to give more than lip service to the adage “*people are our most valuable asset*”. This is especially true in software intensive organisations where it is people, not machines, who perform the processes that will convert ideas into tangible products and services that support the achievement of the organisation’s financial goals.

Although we initially contemplated defining a separate set of goals, drivers and indicators for *technology* issues, we found that technological considerations are embedded in each of the other three areas. We believe that by focusing the integration of technology into the social and business (hence operational) fabric of the organisation we can come closer to bridging, and perhaps closing altogether, the traditional gap between IT and business.

Since the terms “goal, driver and indicator” appear frequently in this paper and within the context of a Balanced IT Scorecard, figure 3 describes the purpose of each of these elements and is useful for providing a common understanding of these terms as a basis for comprehending the concepts to be discussed.

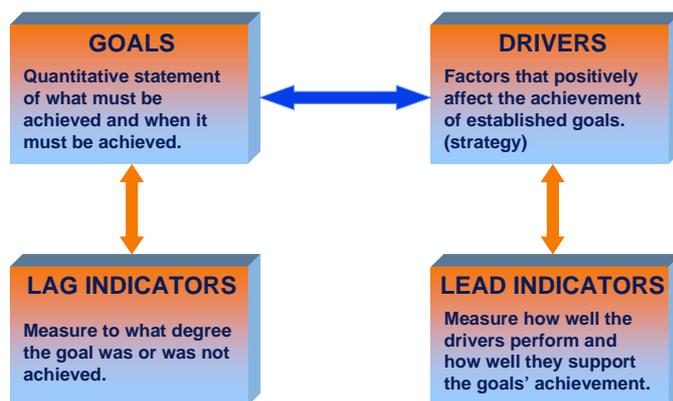


Figure 3 - Elements of a Balanced IT Scorecard
Perspective

During the rest of this paper we will provide more detailed information on the goals, drivers and indicators for people, process and organisational issues. While this is not a comprehensive list of all factors that *could* be considered, we focus on

those that we have found as increasingly significant in setting up and quantitatively managing a sustainable software process improvement programme.

2. FOCUSING ON YOUR RAW MATERIAL – IT’S A PEOPLE ISSUE

It’s no secret that for many years the manufacturing industry has placed a high level of emphasis on supply chain management as a key driver for increasing profits. While there are many variables that must be considered as a part of effective supply chain management, undoubtedly managing the quality of the raw material provided by one’s suppliers and the quality of the internal processes that will convert the raw material into products are key to creating and sustaining a profitable enterprise. Part of this practice has been transferred to the software industry in the form of Software Process Improvement (SPI). We strive to continuously improve our development processes, yet we often forget about the importance of the raw material that these processes must convert to produce better, faster and cheaper software.

Software development is probably one of the most knowledge intensive industries, so how does a software intensive organisation manage the quality of its raw material when the raw material itself is embedded in the knowledge of its staff? Research, experience and even common sense all tell us that there is a direct relationship between the quality of our products, the processes that produce them and the people that perform those processes. In spite of this, why is common sense so uncommon when managing people during the course of a SPI programme (or any improvement initiative for that matter)?

The Infrastructure & Innovation perspective of ESI’s Balanced IT Scorecard (BITS) aims to provide software intensive organisations with a framework for managing the foundation of a robust SPI programme, not just process and technical issues. As you have figured out by now, the people in your organisation are an integral part of that foundation. Many organisations focus directly on increasing employee productivity because it can be linked directly to reduced development costs and cycle times. However, productivity increases are more a result of focusing on more basic human needs: *People want to feel that they know what they are doing and be happy doing it where they are doing it.* The diagram above tells us that focusing on employee satisfaction and competence will have the highest impact on our capacity to retain high-quality professionals and increase overall staff productivity. In the BASE III project we have developed a set of quantitative indicators for managing a series of performance drivers aimed at increasing both the satisfaction and competence of an organisation’s personnel.

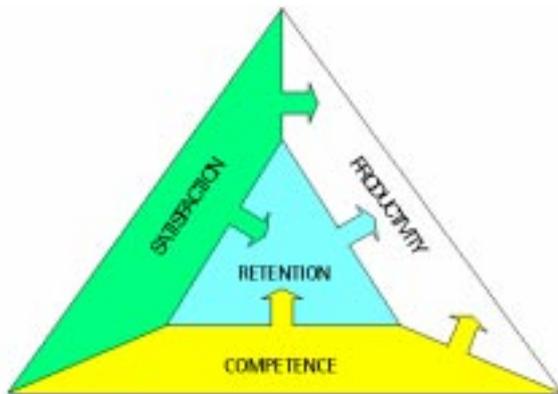


Figure 4 - People Issues

EMPLOYEE SATISFACTION: The objective of this goal is to create a motivating environment for everyone in the organisation in order to have employees satisfied with their job and with the organisation they are working in. As evidenced by the drivers, there is much more to creating a satisfying software engineering culture that will attract and retain high-calibre professionals than money. In his article “*No Silver Lassoes*” [2], Bill Curtis states that “Becoming an ‘employer of choice’

conjures up images of spacious offices, lavish training budgets and expensive benefits. Yet people primarily motivated by self-development and pride in technical work are less impressed by pampered environments than by a software culture that encourages and rewards professionalism.”

The indicators for both the goal and the drivers related to employee satisfaction will help us answer questions such as:

- 👉 How do employees feel about their work?
- 👉 What does the organisation do to create a motivating environment for its employees?

EMPLOYEE COMPETENCE: The objective of this goal is to continuously enhance employee capabilities in order to ensure that the workforce can successfully perform assigned responsibilities and that the strategic competencies for the organisation to meet current and future business needs are being covered. The indicators for both the goal and the drivers related to employee competence will help us answer questions such as:

- 👉 What are the core strategic competencies required for the business?
- 👉 At what rate are the core competencies currently covered?
- 👉 Are needed capabilities being developed?

In their book “*Peopleware*” [3], software industry gurus Tom DeMarco and Tim Lister comment “The final outcome of any effort is more a function of *who* does the work than of *how* the work is done”. By taking care of the personal and professional needs of your employees, the source of the precious raw material that will develop your products and services, you will be provided with readily available opportunities to avoid organisational entropy and boost your organisation’s financial performance.

When using the BITS for managing SPI programmes, we use the elements identified in the Generic Model as a starting point for identifying potential strategies (groups of drivers) as well as indicators for monitoring those strategies. In the case of setting a goal based on Employee Competence (just as with any goal included in the BITS Generic Model), organisations can select an individual or set of drivers from those listed above as their strategy. Based on this strategy, both lag and lead indicators are selected for monitoring goal achievement and driver performance. It should be noted that although a specific goal may include more than 10 potential drivers, it is not practical to attempt to address each of the drivers at the same time. The very thought of doing so would generate unrealistic expectations throughout the organisation and, as such, jeopardise the credibility and probability of success of the improvement initiative.



Figure 5 - Factors affecting Employee Satisfaction



Figure 6 - Factors affecting Employee Competence

Based on the elements of the Infrastructure & Innovation perspective of the BITS, a strategy for increasing employee competence could be through addressing the *Team Building & Cohesion* and *Coaching* drivers (figure 7).

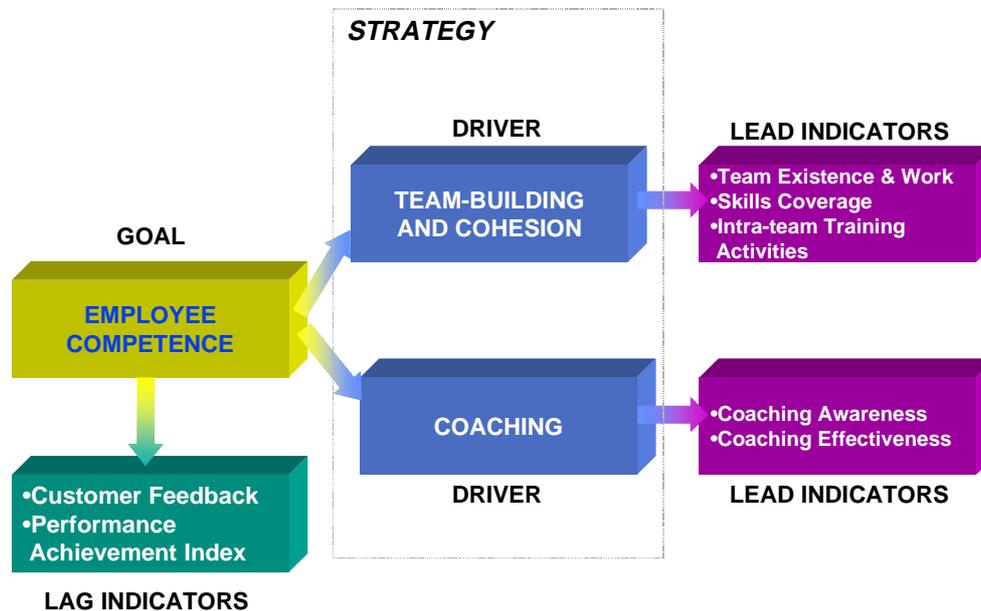


Figure 7 - Potential drivers and indicators for increasing employee competence

This strategy focuses on identifying situations in which teaming can improve performance by establishing the appropriate team for the project in a manner in which the individual skills and knowledge of each team member are complimentary to the others and team members are formally encouraged to learn from each other. As well, the organisation will focus on using the experience of the most senior people in the organisation to provide guidance and support to the most junior people for the development of knowledge and skills that improve their performance.

Both the goal and the drivers have associated indicators for monitoring their success and effectiveness. In the case of the *Coaching* driver, it is monitored through two indicators: *Coaching Awareness* and *Coaching Effectiveness*. The *Coaching Awareness* indicator provides information on how many members of senior staff are involved in coaching activities and the frequency at which the coaches interact with individuals and the team. As a result, the *Coaching Effectiveness* indicator tracks the number of improvement suggestions that are submitted and implemented as a result of the coaching activities.

3. IN SEARCH OF PROCESS EXCELLENCE?

One may ask, “Why focus on *process* improvement when what we really need to do is improve our *products*? After all, we sell products to our customers, not processes.” Improvements in the software process result in measurable improvements in the software product, hence “software process improvement” implies software process AND product improvement.

The focus on the software process has resulted from a growing recognition that the traditional product focus of organisational improvement efforts has not

generally had the desired results. Many management and support activities are required to produce effective software organisations. Inadequate project management, for example, is often the cause of cost and schedule problems. Similarly, weaknesses in configuration management, quality assurance, inspection practices or testing generally result in unsatisfactory product quality. Typically, software development projects have neither the time nor the resources to address such issues and additional processes and thus a broader process improvement focus is required.

With this in mind, we must be careful not to confuse process excellence with living in a process utopia. Our goals for process improvement are more related to business requirements than to capability/maturity levels as defined in CMM or SPICE. The illustration in figure 8 highlights the necessity to first focus on getting the process to produce the desired outputs. Once this is

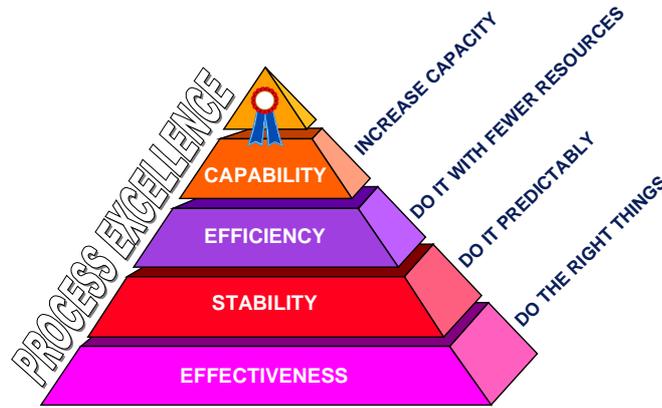


Figure 8 - Process Improvement Issues

achieved our aim is to get the process under control, increasing not only the predictability of process performance but also quantitatively identifying areas where process efficiency can be improved. By doing this, we can achieve higher levels of process productivity and enhance process capacity. Our definition for these four goals and their related drivers is as follows:

PROCESS EFFECTIVENESS: Effectiveness of a process is the ability ‘to do the right things’. Process effectiveness implies that the activities being performed in the process are adequate to produce the desired results. These activities could include good practices of software management or development, as suggested in models like SPICE and SW-CMM. For organisations that operate with processes, these are commonly defined in terms of the objectives of the process, the required inputs and the expected characteristics the outputs must fulfil. The application of the process is then effective if the output produced matches what the process was required to provide. The main parameter for a successful development is meeting customer expectations. The indicators for both the goal and the drivers related to process effectiveness will help us answer questions such as:

- ☞ Are the right processes implemented in order to address anticipated project risks, issues and constraints?
- ☞ Are the processes properly defined and documented?
- ☞ Are there control mechanisms in place to verify process effectiveness?
- ☞ Which factors have the highest impact on process capability and efficiency?
- ☞ Is the process producing what we want / need it to produce?



Figure 9 - Drivers of Process Effectiveness

PROCESS STABILITY: The objective of this goal is to perform a process in a predictable manner, reducing variation from common causes. Process Stability is central to organisations' ability to produce products according to plan and to improve processes in order to produce better and more competitive products. The use of statistical techniques allows organisations to avoid out-of-control situations belonging to constant systems, where "predictability" is the key word. The indicators for both the goal and the drivers related to process stability will help us answer questions such as:

- ☞ Does the process behave in a predictable way?
- ☞ What is causing performance variation?
- ☞ Is the process supported such that it will be stable if operated according to the definition?
- ☞ Which techniques and tools does the process use?



Figure 10 - Drivers of Process Stability

PROCESS EFFICIENCY: Process efficiency is the degree to which the process obtains the required outcomes with minimum consumption of resources. The objective of this goal is to continuously reduce the amount of resources consumed by the process once it obtains the required outcomes (process effectiveness). The indicators for both the goal and the drivers related to process efficiency will help us answer questions such as:

- ☞ What resources is the process consuming?
- ☞ How is the amount of resources consumed by the process varying along the time?
- ☞ Is the process continuously consuming fewer resources?



Figure 11 - Drivers of Process Efficiency

PROCESS CAPABILITY: Process capability is defined as the inherent ability of a process to produce predictable results in a predictable manner. A capable software process is characterised by maturity, where this term implies that software process capability must be known. This goal relies on the assumption that improving the maturity of a process as the ISO 15504, CMM, BOOTSTRAP and other software process assessment models suggest, drives to the improvement of the capability of the process. For instance, the ISO 15504 (*Software Process Improvement and Capability dEtermination*) model proposes six levels of maturity, from "Incomplete" to "Optimising", where each level characterises the level of understanding and control that a process is being carried out. The indicators for both the goal and the drivers related to process efficiency will help us answer questions such as:

- ☞ Have we institutionalised an infrastructure and a corporate culture that supports business-oriented methods, practices and procedures in order to achieve SPI goals?
- ☞ Is our commitment to improvement constant over time?
- ☞ How do we compare to other organisations?



Figure 12 - Drivers of Process Capability

4. CREATING THE RIGHT ORGANISATIONAL CLIMATE

While it may seem as common sense, the ability/willingness of an organisation to create an environment that is conducive to long term financial health is often overlooked and/or underrated. Focusing on people and process infrastructure issues may generate short-term gains in terms of satisfaction and productivity, however, if an organisation fails to create and reinforce an adequate climate for long-term, sustainable growth, commitment at all levels will dissipate until the organisation reverts to the “old way” of doing things.

Caputo [1] identifies several cultural assumptions that highly influence the organisation’s ability to conduct long-term software process improvement programmes that will have a positive impact on organisational business goals and strategies:

- ☞ *Engineering discipline is required to build quality into products of large size and complexity.*
- ☞ *One person can’t track all the details, and error detection is more probable when the work is examined by more than one person.*
- ☞ *Our success is dependent on other groups and customers.*
- ☞ *Process makes a difference in the quality of the activities and the quality of the products.*
- ☞ *The organisation uses Process Definition to transmit the culture’s quality values.*
- ☞ *The projects use Process Definition to incorporate the culture’s quality values.*
- ☞ *Surviving in a business world that is constantly changing requires constant adaptation and learning.*

As illustrated in figure 13, our focus on organisational culture issues is directed at creating and maintaining a climate for:

- ☞ Innovation
- ☞ Continuous Improvement
- ☞ Organisational Learning

The drivers and indicators selected for these goals are



Figure 13 - Organisational Climate Issues

focused on the effectiveness and adequacy of the actions taken by the organisation when addressing these issues. The results of dealing with such issues, while they may appear as “soft” or intangible, can be directly related, in a quantifiable manner, to improvements in the other two areas of the Infrastructure & Innovation perspective as well as the other three perspectives of the Balanced IT Scorecard.

INNOVATION: By focusing on creating and maintaining a climate for innovation the organisation establishes the foundation for identifying, evaluating, managing and realising new business opportunities in the form of new processes, products and/or services. The indicators for both the goal and the drivers related to innovation will help us answer questions such as:

- ☞ How well do we manage Innovation Capital?
- ☞ How well do we convert organisational learning capability into new knowledge?
- ☞ Is our project portfolio balanced from a risk management viewpoint?
- ☞ Do we have a satisfactory return from the R&D activity?
- ☞ What is the rate of innovation?

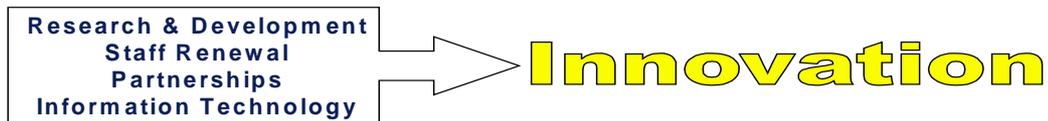


Figure 14 - Drivers of Creating an Innovative Climate

CONTINUOUS IMPROVEMENT: By focusing on creating and maintaining a climate for continuous improvement the organisation establishes a systematic framework for achieving incremental and breakthrough improvements resulting in *more* effective and efficient processes that produce products and services for the industry. The indicators for both the goal and the drivers related to continuous improvement will help us answer questions such as:

- ☞ How do we actively and publicly reward improvement?
- ☞ Are we taking a systematic approach to continuous improvement and, if so, does the approach fit our needs?
- ☞ How often do we conduct formal and informal assessments?
- ☞ Has our organisation been publicly recognised for its improvement through formalised channels/certification schemes (Baldrige, EFQM, SPICE, CMM, ISO 9000, etc.)?



Figure 15 - Drivers of Creating a Climate for Continuous Improvement

ORGANISATIONAL LEARNING: By focusing on creating and maintaining a climate for organisational learning the organisation increases capability to retain and capitalise on the knowledge gained through continuous improvement and innovation. The indicators for both the goal and the drivers related to organisational learning will help us answer questions such as:

- 👉 How effective are we at retaining and capitalising on our knowledge?
- 👉 What mechanisms do we use to validate this?
- 👉 How well do we manage Human Capital?
- 👉 Is the complexity of our key processes conducive to rapid change based on market requirements?



Figure 16 - Drivers of Creating a Climate for Organisational Learning

5. CONCLUSIONS

Increasing organisational process capability is not a question of jumping directly from level one to level five (CMM or SPICE). Although often perceived as such, it is imperative that organisational personnel refrain from viewing process improvement as a one-time investment. The marketplace is constantly changing which means that organisational requirements must change to meet the needs of the market. For most sectors, and indeed for software intensive organisations, this requires a high level of organisational agility to respond to these changes. Agility simply defines the organisation's capability to manage the rate of change and the direction of change based on market requirements. For software intensive organisations, continuous software process improvement facilitates that agility and, as such, it is much more than just a short-term need – it is a prerequisite for long-term success and consequently it must be viewed as a way of life.

On its own, the Infrastructure and Innovation perspective guides organisations in setting up the foundation of a sustainable process improvement programme. When used within the framework of the Balanced IT Scorecard organisations are presented with a powerful, quantitative tool for:

- ☞ Identifying process improvements that will have a positive impact on business objectives.
- ☞ Establishing a baseline of current process performance.
- ☞ Planning improvement actions and setting improvement targets.
- ☞ Assessing performance to evaluate the improvement (or failure to improve) as compared with the initial baseline.
- ☞ Evaluating the applicability of the improvement actions and results for widespread institutionalisation.

REFERENCES

- [1] CAPUTO, K., *CMM Implementation Guide: Choreographing Software Process Improvement*, Addison-Wesley Longman, Inc., 1998
- [2] CURTIS, B., *No Silver Lassoos*, American Programmer, Volume 11, No. 1, January 1998
- [3] DEMARCO, T. & LISTER, T., *Peopleware: Productive Projects and Teams*, Dorset House, 1987
- [4] KAPLAN, R.S. & NORTON, D.P., *Translating Strategy Into Action – The Balanced Scorecard*, Harvard Business School Press, 1996
- [5] REO, D.A., QUINTANO, N. & BUGLIONE, L., *Balanced IT Scorecard Generic Model Version 2.0*, European Software Institute, 1999
- [6] REO, D.A., QUINTANO, N. & IBAÑEZ, M., *ESI Balanced IT Scorecard Process Perspective V 1.1*, European Software Institute, ESI-1999-TR-016, 1999