

A Model to Measure Organizational Readiness for Software Process Improvement

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Abstract: This paper presents a model that can be used to measure the readiness of an organization to engage in a software process improvement (SPI) program. This model focuses on the main stakeholders of an SPI program, which include the “Sponsor”, the “Change Agent”, and the “Organization” directly affected by the improvements. The model identifies the drivers that motivate the SPI main stakeholders and assigns metrics to these drivers so that it is possible to evaluate the readiness of the whole organization to start and maintain an SPI program. The model presented augments the concepts of “Change Management” from the Software Engineering Institute by incorporating the experiences of ABB in implementing SPI programs in its business units during the past decade. The paper presents as well an example on how this model has been used to track the evolution of SPI in an ABB organization.

1 INTRODUCTION

Like any software development project, implementing a software process improvement (SPI) initiative in an organization presents risks that must be identified and managed to ensure the highest likelihood of success. One common risk in SPI initiatives revolves around how ready an organization is to accept and embrace the changes that an SPI initiative brings. When an organization is used to carry out their productive activities in a certain way, members of the organization have difficulty to make changes in the way they work (Massey et al, 1998). Change occurs when any part of the organizational system is modified or replaced. Change means replacing what is established in favour of something new. In a software process improvement activity, old and established development practices are replaced by improved, streamlined, and more efficient practices and processes. Even if the new practices and processes selected for adoption enhance the organization’s operations, there is always a tendency for the organization to resist the change. Organizational change readiness refers to the capacity that an organization possesses to respond to new challenges in its operational environment. This paper presents a model that can be used to quantify this risk and

measure the mitigation progress being made during the course of the SPI effort.

2 SOFTWARE PROCESS IMPROVEMENT (SPI)

SPI refers to the use of improved software development practices in an organization to improve the quality of products, increase customer satisfaction, reduce development costs, increase employee’s job fulfilment, and enhance delivery times. SPI activities are typically conducted using software development process frameworks and standards such as CMMI-DEV, ISO/IEC, SWEBOK, and others. When conducting SPI initiatives, two important factors need to be considered. The first factor involves the technical issues related with the process frameworks used in the SPI initiative. Second, it is important to consider those human and organizational factors that impact the change and occur due to natural human resistance to change (Lopez and Garay 2012).

Early research in the SPI field was primarily focused on the technical, procedural, quality and instrumental aspects and models (Ferreira and Wazlawick, 2011). More recent research in the SPI has recognized the importance of both the technical

and organizational and human/management aspects of the software process improvement activity (Khokhar et al., 2010). Muller et al. (2010) assert that not considering the organizational aspect of a software process improvement initiative leads to a failure in the initiative.

3 ORGANIZATIONAL CHANGE READINESS

Organizational change readiness refers to the capability that an organization exhibits at a particular point in time to adopt a new behaviour and respond to new challenges in its operational environment. Software process improvement is viewed as a “change” activity within an organization because SPI inevitably bring a change in processes, procedures, policies, methods, and sometimes even tools.

The Software Engineering Institute (SEI) and Debou (2009) have defined a change matrix that identifies the necessary elements for change and how the lack of these elements results in frustrated and ineffective efforts, as shown in Figure 1. Necessary elements for change, and hence for the implementation of a successful SPI program include: (a) *vision* on where we want the organization to be with the proposed SPI program; (b) *skills* in the organization necessary to achieve the improvements; (c) *incentives* and *dis-incentives* provided by senior management to the organization to change its behaviour; (d) *resources* needed to successfully conduct the SPI activity; (e) an *action plan* that guides the SPI program activities. Figure 1 shows that the lack of *vision* in an SPI program causes confusion in the organization. The lack of *skills* necessary to conduct the SPI activities causes anxiety in the organization. The lack of *incentives* or *dis-incentives* to members of the organization affected by the SPI activities cause a delay in the SPI program. The lack of adequate *resources* (tools, time, people, etc.) causes great frustration in an organization trying to implement a successful SPI program. And finally, the lack of an *action plan* causes false starts and disorientation in the SPI program.

When an organization is faced with a severe change prospect such as a major SPI program, people in the organization may suffer from similar reactions as the stages of loss and grief which include denial and isolation, anger, bargaining, depression, and acceptance (Kubler-Ross, 1969).

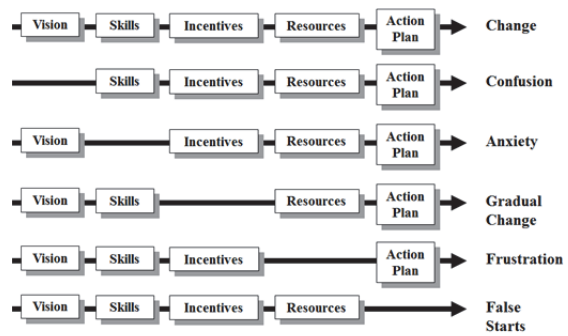


Figure 1: Organizational Change Matrix.

In an SPI program is important to recognize that people will embrace changes differently. The advocates see the changes that the SPI program brings as a “good thing” and will support the initiative. The apathetic do not care initially about the initiative until they see how it affects them. The incubators have thought about trying new things, so the SPI initiative may have some appeal to them. And the resisters have concerns about the SPI initiative and make things difficult for the implementation of the changes through overt or covert resistance.

4 READINESS ASSESSMENT MODEL

Kautz (2000), Maturro and Saavedra (2012), and the Software Engineering Institute (2014) identify four components essential to change management in an organization. The first component evaluated is the *organizational readiness* that refers to the load an organization has at a particular point in time with respect to management issues, change initiatives, and operational and legal issues taking place. The second component evaluated refers to the *sponsor’s commitment and readiness* to the SPI activity that is supported by what the sponsor expresses about the SPI initiative, by the sponsor’s inherent characteristics as a leader, and by the visible actions of the sponsor towards the SPI initiative. The third component evaluated is the *change agent (CA) commitment and readiness* to the SPI activity that evaluates what the CA expresses about the SPI initiative, the inherent characteristics of the CA, and the behaviour of the CA towards the SPI initiative. The fourth component evaluated refers to the level of *organizational expertise and experience* that the members in the organization have relative to the SPI initiative (SPI model utilized, appraisal

methodologies, process improvement cycle, etc.). The rEAdiness asSEssment model (EASE) presented in this paper evaluates the four above mentioned components, as shown in Figure 2.

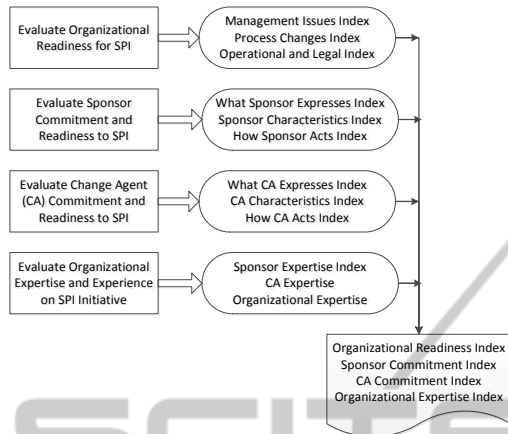


Figure 2: EASE Model.

Sections 4.1 to 4.4 below provide details on the main factors that are individually evaluated. Based on his/her observation, the evaluator gives weights (1-5) to each of the factors and composes an overall index for each component. Section 5, provides an example of the evaluation utilizing a real-world example.

4.1 Organizational Readiness

An SPI initiative will almost certainly increase the stress level in an organization. For this reason is important to evaluate the stress conditions in the organization before starting the SPI initiative. Table 1 shows detailed stress factors that need to be evaluated before an SPI initiative begins and monitored as the SPI program makes progress. It is important to have a sense of whether there are currently other competing initiatives such as introduction of a new technology, or a major construction project, a major litigation, etc. Similarly, it is important to understand the general attitude and experience the organization has towards any change that has occurred in the past.

Each of the elements in Table 1 needs to be evaluated before the SPI initiative starts (typically by the potential SPI project manager, or an assessor) and they need to be continuously evaluated at determined points in time during the SPI project. In the EASE model, an experienced assessor evaluates each sub-element of an element of a component by assigning a weight between 1 and 5. Taking an example from Table 1, under the component

“Organizational Readiness”, the “Process Changes” element has as sub-element the “New customer service program” to which the readiness evaluator gives a weight of 5 if at the time of the evaluation there is an active and engaging customer service program ongoing in the organization. On the other hand, if there is no customer service program, the evaluator assigns a weight of 1 to same sub-element. Once weights w_{ijk} (where i = component i , and j = element j , and k = sub-element k) have been assigned, an overall weight W_{ij} is calculated as $(\sum_{k=1}^n w_{ijk})/n$ to calculate the element index. The overall component index (Evaluate Organizational Readiness for SPI) is a normalized summation value of the weights of each element.

Table 1: Factors of organizational stress.

Management Issues
New senior management
New skills or employee retention
Culture change effort
Performance appraisal
Major reorganization or downsizing
Process Changes
New customer service program
Ongoing quality initiative
New Quality initiative
Productivity improvement project
History on past improvement projects
Operational and Legal
New Technology introduction
Major construction project
Working extra-time
Strike
Major Litigation

4.2 Sponsor Commitment and Readiness to SPI

Members of the software development organization are very perceptive on how the sponsor(s) of the SPI initiative behaves and talks relative to the initiative, as the sponsor’s support is key to the success of the SPI project. Table 2 shows the relevant characteristics that a sponsor should exhibit in a successful SPI initiative. These factors are evaluated in the EASE model to measure the level of commitment that the sponsor has to the SPI initiative.

The sponsor(s) needs to be very careful on how he/she communicates with the rest of the organization about the SPI initiative. The sponsor(s), as the main promoter of SPI, needs to publically

Table 2: Sponsor characteristics for SPI.

What the Sponsor(s) Expresses
Expressed how SPI relates to company strategy
Expressed strong personal commitment to SPI
Communicates clear and understandable message
Communicates the impact to affected individuals
Communicates objectives of SPI to organization
Promotes problem solving attitude
Publically expresses behaviours that must change
Communicates to encourage direct feedback
Observable Sponsor Characteristics
Strong motivation to implement SPI
Believes in the business benefits of SPI
Shows strong support if SPI to direct reports
Demonstrates personal changes aligned with SPI
Demonstrates willingness to pay the price for SPI
Strong and tenacious in pursuing the SPI activities
Invests effort to build support for the CPI effort
Has good relationship with change implementers
Has good relationship with people affected by SPI
Has a good track record in past change initiatives
How Sponsor Acts
Commits the necessary resources to SPI
Establishes incentives to reinforce change
Emphasizes rewards for achieving change
Focuses on reinforcement on direct reports
Emphasizes formal and informal recognition
Links rewards to the achievement of change
Establishes mechanisms for data gathering to monitor progress of change
Makes clear how to report SPI progress
Makes old behaviours difficult to perform
Makes new behaviours easier to perform

promote behaviour modification, needs to have a clear message to the organization, and overall needs to have a clear commitment to the SPI initiative. The sponsor(s) needs to understand the business value that the SPI initiative will bring to the organization. The sponsor(s) needs to demonstrate to his/her direct reports that he/she supports and is willing to pay the price for the initiative. The sponsor(s) needs to have a very good relationship with the change agent. The organization needs to see the sponsor(s) “walk the talk” and align behind the SPI initiative. The sponsor needs to make SPI a priority, commit the necessary resources, and reinforce the change with the appropriate incentives or disincentives. Table 2 shows the main characteristics that a sponsor must exhibit to increase the probability that the SPI initiative succeeds. The sponsor needs to be evaluated in each of these factors before and during the course of the SPI initiative.

4.3 Change Agent Commitment and Readiness to SPI

The change agent(s) is the person(s) that leads the SPI initiative and makes it successful. The change agent needs to work with the sponsor(s) to move forward the SPI initiative smoothly and to report progress.

The change agent typically manages the SPI project, builds support in the organization for SPI, and works closely with the affected people.

The change agent also monitors and tracks the SPI initiative as an internal project in the organization which is at the same level as a development project. The change agent is instrumental in identifying and managing the sources of resistance in the SPI initiative and must respond to the different types of resistance (overt and covert). There are different types of change agents: (a) traditional, who are focused on delivery of SPI results; (b) facilitators, who emphasize transfer of change to stakeholders; (c) and advocates, who are considered to be the true champions of change. Table 3 shows the main characteristics that a change agent must exhibit to increase the probability of his/her success with the SPI initiative. The change agent needs to be evaluated on each of these factors before and during the SPI initiative to increase his/her effectiveness.

4.4 Organizational Expertise

This is the fourth element considered in EASE, and it evaluates the level of technical expertise and competence that the organization has relative to the SPI initiative. The Sponsor, change agent, and the affected organization need to have a competent level of experience and technical expertise in the change management process, in the SPI software framework utilized (i.e. CMMI-DEV, IEEE, SCRUM, XP, SWEBOK, etc.), diagnostics methodology, continuous process improvement, etc. Table 4 provides the specific factors evaluated in terms of organizational expertise.

5 A REAL WORLD CASE

As part of the ABB software process improvement initiative, a business unit that develops software for the power industry implemented a multi-year software process improvement program. An SPI initiative consists of five stages: (a) Initiate; (b) Diagnose; (c) Establish; (d) Act; (e) Leverage.

Table 3: Change agent characteristics for SPI.

What Change Agent Expresses
Believes on the rewards of SPI
Understands the disruption that change will bring
Is committed to the goals of the SPI project
Expresses interest in being responsible for SPI
Is optimistic about the potential SPI results
Expresses confidence in Sponsor's commitment
Believes in a positive personal future through SPI
Expresses enthusiasm about the SPI initiative
Is happy with time and resources available for SPI
Observable Change Agent Characteristics
Has a successful history in the organization
Is viewed as competent in current position
Experience working with different groups
Experience working with all levels of management
Knowledgeable of perspectives/needs of sponsor
Has trust, respect, and credibility with the sponsor
Is viewed as a real asset to the SPI project
Knowledgeable of the perspectives and needs of affected people in SPI initiative
Affected people respect and trust the change agent
Effectively manages resistance to change
Works well with structure of the organization
Understands the organization's culture
Has a working "change" principles
Possesses high level of analytical skills
Understands the value of human and business issues
Has excellent communication skills
Is a team player
Is proactive, sets goals, and achieves them
Enjoys challenge and uncertainty
Feels comfortable working with sponsor
How Change Agent Acts
Has sufficient time to dedicate to the SPI project
Exerts sufficient authority to make changes
Energizes the organization to promote change
Has access to sufficient resources for SPI initiative
Knows when and how to use power and influence
Generates a high level of team work
Has vested personal commitment to the SPI project
Is proactively seeking creative solutions
Is proactively informing sponsor about SPI progress
Has properly planned SPI project

These are the stages of the IDEALSM model developed by the Software Engineering Institute (Software Engineering Institute, 2014; Kautz et al., 2000). During the "Initiate" phase, a foundation is laid for a series of successful improvement efforts in the SPI initiative. It is at this stage where the readiness assessment (utilizing the EASE model) of an organization is conducted. In the "Diagnose" phase, an understanding of the current technologies,

processes and organizational interactions is established and documented to create a baseline for the improvement activity. This information supports the improvement planning and prioritization process, and acts as an indicator to help track and verify the impact of the program's activities. The "Establish" phase determines the foundation for the actions of a specific improvement cycle. The course of action taken is determined by the results of the diagnostic activity. To implement these actions, a software improvement plan is developed to make the appropriate changes (introduce a new technology, develop a new product, make improvements in processes or change the architecture of a product), which draws on the vision established during the "Initiate" phase. During the "Act" phase, the established plan is put into action, and the core work needed to make the specific software process improvements proceeds. Finally, the objective of the "Leverage" phase is to analyze how the improvement cycle has been carried out, to assemble the lessons learned, and to incorporate these lessons learned into the software improvement plan that will be used in the next improvement cycle.

In our example, the SPI initiative of the software development group consisted of IDEAL cycles with one year duration. Readiness assessments using EASE were conducted at the beginning of each cycle and also in the middle of the cycle. Hence, as the SPI initiative was planned for a three year period, six readiness assessments were conducted. The following sections discuss details of the readiness assessments conducted in the SPI initiative for this particular business unit.

Table 4: Organizational expertise relevant to SPI.

Sponsor Expertise/Experience
Experience in change management
Knowledge of SPI technology (CMMI, IEEE...)
Experience in continuous process improvement
Change Agent Expertise/Experience
Knowledge/expertise in change management
Expertise of SPI technology (CMMI, IEEE...)
Experience of SPI technology (CMMI, IEEE...)
Change Agent experience in change management
Experience in continuous process improvement
Organizational Expertise/Experience
Expertise of SPI technology (CMMI, IEEE...)
Experience of SPI technology (CMMI, IEEE...)
Experience on participating in change management
Expertise in continuous process improvement
Experience in continuous process improvement

5.1 Initial Readiness Assessment of an ABB Company using EASE

The ABB business unit in this study develops software for power systems applications and will be identified in the remainder of this paper as ABB MPower. This business unit decided in January of 2003 to start a software process improvement (SPI) initiative and committed to have the initiative running for three years. Hence, the data analysed is aligned with this timeline. The sponsor for the SPI initiative was the site manager. He vocally expressed strong support for the SPI initiative and identified a change agent who was a project leader from the software development organization.

In January of 2003, the authors utilized the EASE model to conduct an initial readiness assessment of the ABB MPower unit. Figure 3 shows the results of the initial evaluation of the sponsor of the SPI initiative in the three dimensions shown in Table 2. As can be observed, in January of 2003, the sponsor seemed to be strong in his characteristics as a sponsor and the way he talked about the SPI initiative. However, the perception of his actions on SPI showed a need for improvement.

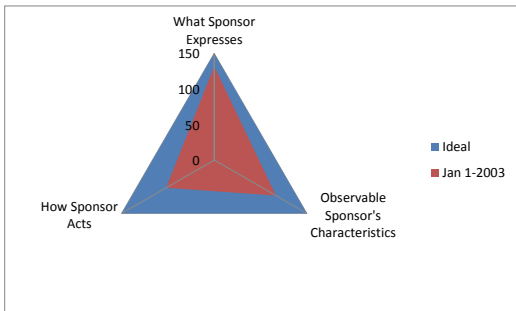


Figure 3: Sponsor evaluation in January of 2003.

Figure 4 shows the evaluation of the change agent in January of 2003. The evaluation shows that the change agent needed to improve in all three dimensions, particularly in how he behaved as a change agent. This became evident because the person selected for this role, at the time, was the leader of the software development group and did not have much change agent experience. He did, however, have a very high level of credibility in the organization and also possessed good change agent qualities.

Figure 4 shows the evaluation in January of 2003 on the organizational situation with respect to SPI. Figure 5 shows that there were no major stress factors due to management issues, but that there were some concerns related to operational issues

such as the introduction of new technologies and people working extra hours. Also, the organization was involved in a major ISO initiative that was nearing completion.

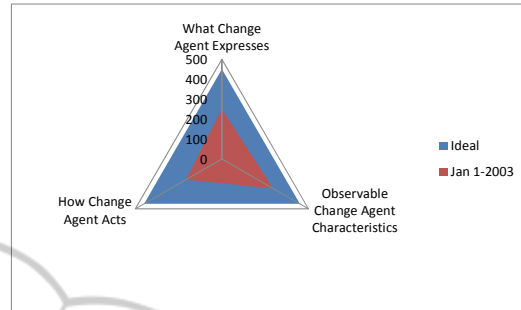


Figure 4: Change agent evaluation in January of 2003.

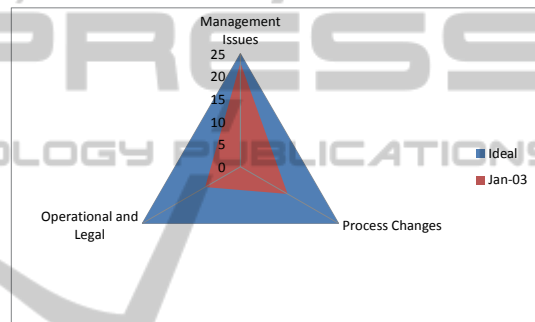


Figure 5: Organization evaluation in January of 2003.

Figure 6 shows the evaluation of the organizational expertise in the SPI initiative. The organization decided to utilize the CMMI-DEV framework for software process improvement. Their decision was not to demonstrate a maturity level, but to use the CMMI-DEV framework to improve their processes. As can be observed in Figure 5, the level of experience and expertise in SPI for the whole organization was very limited. For this reason, the authors worked with the organization to increase their level of expertise in SPI activities.

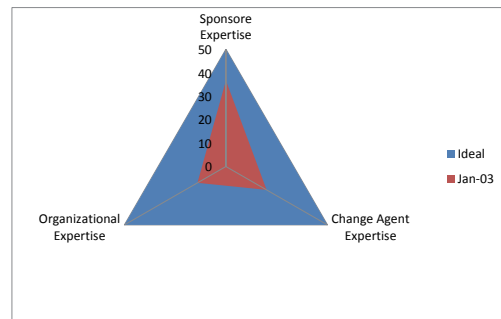


Figure 6: Org expertise evaluation in Jan 2003.

Figure 7 below shows a complete picture of the evaluation of the four elements combined to give the overall assessment picture in January of 2003. From this graph it is evident that the organization was open to the SPI initiative. The sponsor and the change agent needed to improve their level of skills, and the sponsor needed to improve his commitment to the SPI initiative. Moreover, the organization needed to improve its level of expertise in the SPI initiative.

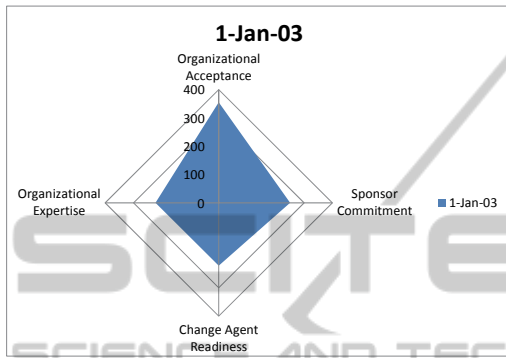


Figure 7: Overall organizational readiness for SPI.

5.2 Progressive Readiness Assessment

Table 5 shows the numeric values of the historical evaluations of the readiness assessments of ABB MVPower from Jan 2003 to Jan 2006.

Table 5: Historical readiness assessment of ABB MVPower from January 2003 to January 2006.

	1-Jan-03	1-Jul-03	1-Jan-04	1-Jul-04	1-Jan-05	1-Jan-06
Organizational Acceptance	355	352	357	345	347	377
Sponsor Commitment	251	178	120	106	286	330
Change Agent Readiness	222	181	174	157	206	260
Organizational Expertise	223	265	299	206	286	354

Figure 8 shows the graphic representation of the weight values shown in Table 5. From the different readiness assessments performed, it is interesting to observe the changes that occurred in the three years of the SPI initiative.

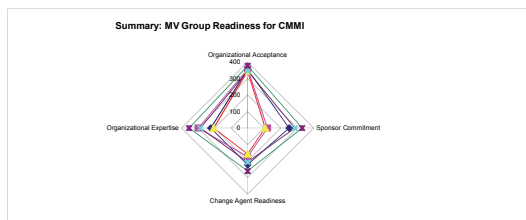


Figure 8: Graphical representation of historical readiness assessment for ABB MVPower.

For example, comparing the assessments from January 2003 and July 2003, a few things can be observed. The organizational readiness remained constant and the organizational expertise in the SPI activities increased. Nevertheless, the sponsor's commitment and the change agent readiness significantly decreased. This trend seemed to continue until July of 2004.

Figures 9 and 10 below show the details on the assessments of the sponsor and the change agent in July 2004. Both figures show a significant decrease in the evaluation of how well the sponsor and change agent expressed support for the SPI activity and also how they acted towards the SPI activity. An interesting point was that the sponsor seemed to change negatively in his own inherent characteristics towards the SPI initiative, while the change agent seemed to acquire skills that made him a better change agent.

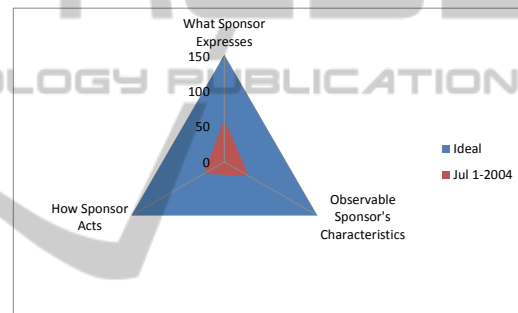


Figure 9: Sponsor evaluation in July of 2004.

The situation in July of 2004 was definitely not good for the SPI initiative, and something had to be done. After deeper analysis, we discovered that there was a breakdown in the communication between the sponsor and the change agent. This then caused a deep mistrust from both towards each other. The sponsor on the one hand felt that the change agent was not delivering the results that he expected from the SPI initiative. On the other hand, the change agent felt that the SPI activity was hampering his position in the organization and that the sponsor was not supporting him and the organization in the SPI initiative. It took a concentrated effort to increase the communication between the sponsor and the change agent so that things began to turn around. As can be observed in Table 5 and Figure 7, there was subsequently, considerable improvement in both the sponsor and the change agent. Also, the organization felt more comfortable and the SPI initiative ended on a positive note. It is important to point out, that a direct result of the SPI initiative was the improvement of the Requirements Engineering

process and this caused a reduction in the cost of poor quality of 10% annually.

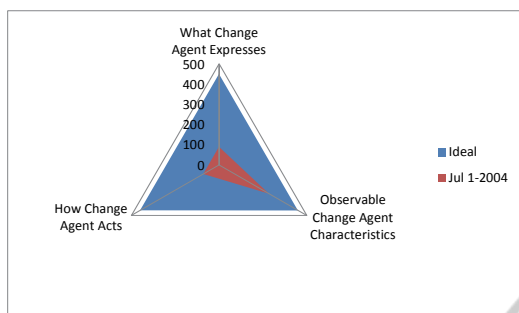


Figure 10: Change agent evaluation in July of 2004.

6 CONCLUSIONS

EASE is a model that quantifies the readiness of an organization to commit to a software process improvement initiative. EASE was developed as part of the ABB software process improvement initiative. Although EASE has been developed specifically for assessing the readiness of an organization to seriously engage in a software process improvement activity, EASE can also be utilized in any other organizational change situation, such as introduction of a new technology, change in organizational structure, change in customer base, introduction of a new product or service, etc. EASE considers four essential elements in the change situation (SPI implementation) and they include the sponsor readiness and commitment, change agent readiness and commitment, organizational readiness, and organizational level of expertise in SPI and the specific model utilized for SPI. The sponsor plays an essential role in exemplifying the new behaviour (walk-the-talk), providing necessary resources, aligning the SPI activity with business goals, providing incentives for the new behaviour, rewarding process improvement, and in general being a proactive supporter of the SPI initiative. The change agent is a multi-disciplinary person that needs to master both the technical and organizational aspects of the SPI initiative, must be highly respected in the organization, must have excellent communication skills, must communicate effectively with the sponsor, and in general needs to have the “fire” for the SPI initiative. The organization on the other hand needs to have a relatively low level of stress with other change initiatives, must have the required level of training and skills for the SPI initiative, needs to see tangible benefits originating from the SPI initiative, and needs to be proactively

involved and committed to the SPI initiative. In the future Fuzzy Logic will be used to evaluate the elements and sub-elements in the EASE model.

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