SPICE 3: FACILITATING ORGANISATIONAL PROCESS IMPROVEMENT THROUGH GOOD PRACTICE SHARING

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ABSTRACT: This paper describes the latest iteration of the SPICE research. SPICE 3 explains the process maturity framework to address the level III of the SPICE model. Building upon the developments of level II, SPICE 3 advocates establishment of a process improvement infrastructure to facilitate good practice sharing in construction organisations. To achieve SPICE level III process maturity, organisations should posses four key processes and five process enablers. The model developed helped the case study organisations to identify their process strengths and also areas requiring improvement.

Keywords - SPICE, SPICE 3, Process Improvement, Good Practice Sharing

1. INTRODUCTION

Development of the SPICE (Structured Process Improvement of Construction Enterprises) model began in 1998, in response to calls from the industry's critics. Egan and Latham both highlighted the need for construction organisations to focus on and improve their processes (Egan, 1998; Latham, 1994). This paper presents the latest iteration of the SPICE research, named SPICE 3, which developed the SPICE level 3 process maturity framework. The project was conducted at the EPSRC funded Salford Centre for Research and Innovation (SCRI) in the built and human environment, of The University of Salford. Following a brief description of the background to the project, the paper will discuss the relevant aspects of the organisational context within which the proposed process improvement model operates. The components of the SPICE level III process improvement model is then be presented. The paper also presents the outcomes of the industry based case studies conducted as part of the project.

2. THE SPICE APPROACH TO IMPROVING CONSTRUCTION PROCESSES

The SPICE model has been developed using experiences gained in the IT sector for step-by-step process improvement. SPICE specifically draws on the Capability Maturity Model® (CMM®) that was developed for the United States Department of Defence (DoD). The DoD, which is a major software purchaser, had faced problems of poor quality software, missed schedules, and high costs. In 1991, they approached the Software Engineering Institute (SEI) at Carnegie Mellon University and asked them to produce a model to help assess their software suppliers. The SEI developed the CMM® framework to continuously measure, evolve and improve processes. The CMM® rapidly gained acceptance in the IT sector, and organisations that have successfully implemented CMM® have reported significant benefits.

SPICE has borrowed many basic concepts from CMM® and developed them into a construction specific model. SPICE is intended to address the improvement of management processes within construction organisation with emphasis processes associated with tendering, design and construction. The experience of using CMM® shows that organisation can create a general culture of process improvement by initially emphasising the core processes of product development.

2.1 Process capability and maturity

Over the past decade, a number of management thinkers (Ghoshal and Bartlett, 1994; Quinn Patton, 1998) have begun to stress the unique factors that can provide an organisation with a source of competitive advantage, that distinguish it from competitor organisations and that explain why it does certain things well. They apply terms such as core competence or corporate competence. Instead of competence being viewed solely as the property of an individual, it becomes a social and collective phenomenon embedded in an organisation's processes, systems, relationships and routines. In the view of these thinkers, organisational capabilities are far more decisive in securing competitive advantage than the ability to manage physical assets or produce isolated moments of strategic brilliance. One reason cited is that it is easier for a competitor to copy a strategic decision than to duplicate a fine tuned highly effective day-to-day business process (Sayles, 1994).

SPICE directly addresses the issue of capability by identifying the current process capability of organisations. Process capability is a forward-looking view of an organisation's operational processes (Paulk et al., 1995; Zahran, 1998). It predicts the outcome of a process before that process has taken place. When a process is stable, its results will have predictable means and be within predictable ranges about the means.

Process maturity is the extent to which an organisation is able to define, manage, measure and control a specific process. Higher process maturity implies that an organisation has potential to improve its capability, and indicates the richness of its processes. Process maturity also suggests that processes will be applied consistently in projects throughout the organisation. The SPICE model helps organisations understand their level of process capability, in terms of their process maturity. In general, mature organisations have a high level of process capability, while immature organisations have a low Level.

2.2 Immature vs Mature Organisations

SPICE differentiates between mature and immature organisations. In an immature organisation, construction processes are generally improvised by employees and project managers during the project. Even if a particular construction process has been specified, it is not rigorously followed or enforced. The immature organisation is forced to react to events, and managers are usually focused on fire fighting. In an immature organisation, there is no method for judging the quality of the product or for solving product or process problems. Quality assurance is often suspended or eliminated when projects fall behind schedule. In an immature organisation, it is difficult to predict the quality of the product. Activities intended to enhance quality, such as project reviews, are often given insufficient attention. Quality assurance checks and documentation are often left until project completion, where defects are identified as snags. At this point, the problems are often more costly to rectify and lead to conflict within the project team. However, even in undisciplined and immature organisations, individual projects sometimes produce excellent results. When such projects succeed, it is

generally thanks to the efforts of a highly dedicated team or individual, rather than systematic and proven methods.

A mature construction organisation has an organisation-wide ability to manage design, construction and maintenance activities. The processes are communicated accurately to existing staff and new employees, and activities are carried out according to planned processes. The processes fit each situation well and are consistent with the way the work gets done. Roles and responsibilities are clear throughout the project and across the organisation. In mature organisations, managers monitor the quality of the product as well as client satisfaction. There is an objective basis for judging product quality and analysing problems with the product and process. The organisational culture includes time for reflection. In general, disciplined processes are consistently followed because all the participants understand the value of doing so, and the infrastructure exists to support the processes. In a mature organisation, construction processes are well understood, usually thanks to practice, enforcement, documentation and training. After implementation, the processes are continually monitored and improved by their users. It is important to note that the actual performance of the project may not reflect the full process capability of the organisation. In some cases, the environment and outside factors can constrain the capability of the project. External constraints which can influence process capability include economic recessions, new supply chain relationships, and acquisitions and mergers. Mature organisations, such as those at Levels 2 and 3 of the SPICE framework, are able to adapt to these external factors.

2.3 Stepwise Improvements in Organisational Maturity

The SPICE model promotes continuous process improvement based on many small, evolutionary steps. It divides these evolutionary steps into five maturity Levels, which lay successive foundations for continuous process improvement. These maturity Levels form a scale for measuring the capability of a construction organisation's individual processes, and its overall process capability. Each Level of maturity consists of a set of key processes. When an organisation is successfully applying each key process, it can stabilise an important part of the construction process and make it predictable. The five Levels provide guidelines on how to prioritise efforts at process improvement.

The SPICE model is shown in Figure 5. For each Level, the model specifies a number of "key processes". By following the steps in the model, an organisation can achieve effective and continuous improvement based on evolutionary steps. An organisation can only be at one Level of the model at any one time. If an organisation is at Level 1, but implements some of the key processes of Level 3 or 4, it is still considered a Level 1 organisation. This is because each Level lays successive foundations for the next. The model shows that the organisation has little to gain by addressing issues at a higher Level if all the key processes at the current Level have not been implemented.

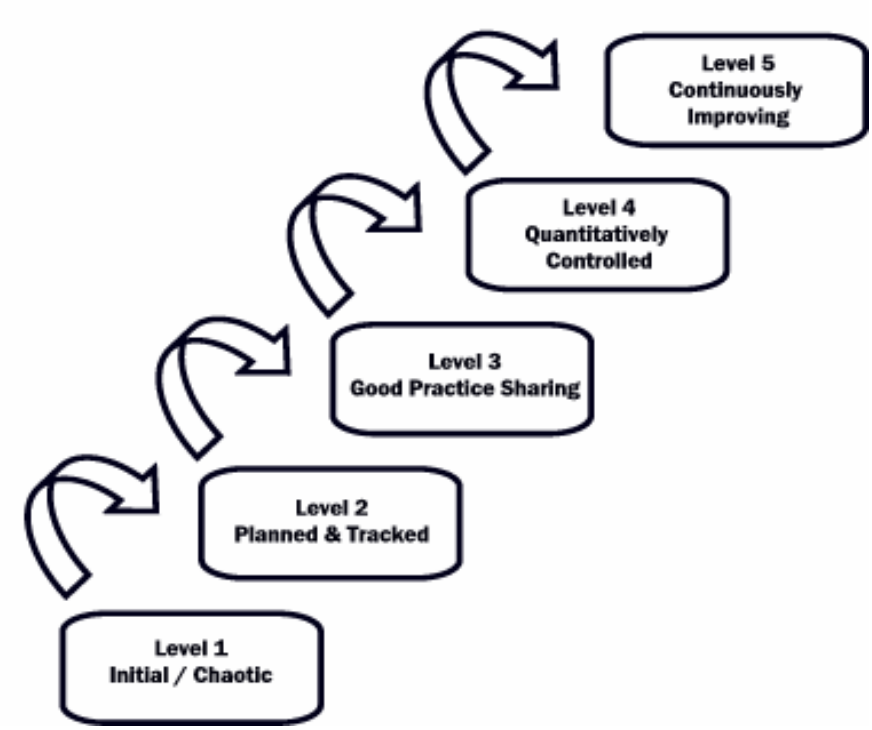

Fig. 1. Five Levels of the SPICE model

Level 1 – Initial/Chaotic

Level 1 is the basic entry Level to the model. At this level an organisation has little focus on process, and project visibility and predictability are poor. Good project practices are local, and are not repeated or "institutionalised" across the company. Ineffective planning and co-ordination undermine good practices. Organisations make commitments that staff or the supply chain cannot meet, which can lead to a series of crises. During a crisis, projects typically abandon planned procedures; instead, individuals do whatever activities it takes to get the job done, with little regard for the effects on other people. In construction, time and cost schedules are often under tight control. Hence the crisis often leads to compromises on quality. At Level 1, the success of a project depends entirely on having an exceptional manager and a competent team. When these managers leave, their stabilising influences leave with them. The construction process capability of a Level 1 organisation is unpredictable, because the process is constantly changed or modified as the work progresses. Performance depends on the capabilities of the individuals, rather than that of the organisation.

Level 2 – Planned and Tracked

At this Level, there is a degree of project predictability. A Level 2 organisation has established policies and procedures for managing the major project-based processes. This allows organisations to repeat the successful practices of earlier projects. Effective process planning is introduced before a project starts. During the project execution, activities are evaluated and improved. An effective process can be described as one that is practised, documented, enforced, trained, evaluated and able to improve.

At Level 2, organisations make realistic commitments to clients and the supply chain, based on the results obtained from previous projects and on the requirements of the current project. Managers track quality and functionality on site as well as time and costs. Problems in meeting commitments are identified as they arise. The integrity of the project's brief and requirements are maintained throughout the project. Standards are defined and organisations ensure that they are faithfully followed. Organisations work with sub-contractors to establish strong relationships.

At this stage, processes for good project management are planned, tracked and enforced on every project. Each project within the organisation is predictable. However, the management processes across the different projects may differ. Each team devises and enforces their processes.

Level 3 – Good Practice Sharing

A well-defined process includes standard descriptions and models for performing the work, mechanisms to verify that the work has been done correctly (such as peer reviews) and completion criteria, that provide a good insight into progress. In other words, there is organisational visibility of projects. Because the process is well defined, management has good insight into progress. Quality and functionality of all projects are well tracked.

Level 3 is where an organisation develops the capability to capture and share good practices, across the organisation rather than on a localised basis. SPICE model advocates that an organisation does not have the capability to capture and share good practices, until it reaches Level 3. Attempts to do so will be risky and are likely to prove unsuccessful.

The processes for all activities are documented and integrated into the organization. All projects use an approved, tailored version of the organization's standard process. Consequently, organizations develop the capability to capture and share good practices.

Level 4 – Quantitatively Controlled

The process discipline established throughout the organization at Level 3 lays the foundations for objective measurement of the product and processes at Level 4. Consequently, projects are able to reduce variations in process performance, so that they fall within acceptable boundaries. Meaningful variations can be distinguished from random variations. The risks involved in moving up the learning curve - as a result of taking on new categories of projects, or new procurement and supply chain arrangements - can be managed.

The organisation will have a programme that measures productivity and quality for important construction process activities across all projects. This programme forms an objective basis for measuring the product, the process, the degree of customer satisfaction, and the level of harmony across the supply chain.

At this Level, organisations have the capability to set quality goals for (i) the product, (ii) the process, and (iii) the supply chain relationships. Productivity and quality are measured for important construction process activities across all projects as part of an organisational measurement program. This forms an objective basis for measuring the product, the process, and the degree of customer satisfaction.

Level 5 – Continuously Improving

The expectation is that at Level 5, the entire supply chain is focused on continuous process improvement. Level 5 organisations can identify weaknesses and strengthen processes before any problems emerge, and can do so in a collaborative manner. Data on the effectiveness of the processes is used to perform cost benefit analysis of any new technologies and proposed changes in the organisation's processes. This increased level of understanding allows organisations to consider large-scale changes to their processes. Innovations that exploit good practice in business management are identified and adopted throughout the organisation.

Project teams across the supply chain analyse defects to determine their causes. Construction processes are evaluated to prevent known types of defects from recurring, and lessons learned are communicated to other projects.

By Level 5, an organization can use the data on the effectiveness of processes to identify strengths and weaknesses in a pro-active manner. This enables the organization to continuously improve its processes.

2.4 Key Processes

Each SPICE Level, with the exception of Level 1, includes key processes that identify where an organisation must focus to improve processes. SPICE level II key processes are brief and scope of work management, project planning, project tracking and monitoring, subcontract management, project change management, health and safety management, risk management, and project team coordination For an organisation to achieve Level II of maturity, all projects must perform all these key processes adequately. This forms the basis for progression to Level 3.

2.5 Process Enablers

SPICE differentiates between incomplete processes and disciplined processes, listing a number of key management features for a complete and coherent process. Process enablers focus on results that can be expected from a key process. This is a forward-looking approach, which indicates process capability before a process takes place. They provide critical features that a key process must posses in order to yield successful results. Ensuring that all the process enablers are in place, improves the performance and predictability of key processes. Process enablers are common across all the key processes. Section 3 will discuss process enablers in more detail.

3. SPICE LEVEL III PROCESS MATURITY FRAMEWORK

3.1 Process Improvement beyond individual projects : the organisational level

As construction projects often have a limited life span, with a multi-organisational environment to undertake unique and novel products, it is extremely difficult when they attempt to improve processes by leveraging knowledge and lessons learnt from, within, and between projects, to the organisation. In order to successfully deliver a unique, novel, and transient project, it would be beneficial if the project team can make decisions and make adjustments on processes at a local level. However, if too strong an emphasis is placed on defining processes at each project, process improvement at an organisational level would

suffer. It could lead to improvising processes each time, thus re-inventing the wheel each time. Process improvement beyond individual projects is thus a logical and necessary step forward to improve organisational performance by capturing good practices and leveraging expertise oall employees.

In order to develop rich and substantial organisational process capability, one should go beyond a boundary of a firm. As the construction industry is highly fragmented, it is essential to integrate the knowledge of various project stakeholders across both upstream and downstream value chains. As these stakeholders have different interests and competencies in processes, it is necessary to prevent opportunistic and adversarial behaviours from impeding collective learning and change. In this context, it is called for more proactive integration efforts among construction supply chain. This may be achieved through strong leadership to create a collaborative climate by forming strategic networks in the construction communities for fostering reciprocal knowledge and good practice sharing.

A SPICE Level 3 organisation builds upon the achievements of Level 2. At this level an organisation has the capability of capturing and sharing good practices on an organisational scale. The aim of SPICE Level 3 is defined as establishing management infrastructure to facilitate process improvement at an organisational scale. At this Level, the organisation has the capability to capture and share good practices and knowledge across projects, at an organisational scale. A Level 3 organisation focuses on creating a process improvement infrastructure for capturing and sharing good practices across the whole organisation (Paulk et al, 1995; Zahran, 1998). Figure 2 illustrates how Level 3 differs from the previous Levels as to process execution and improvement. Project teams use these good practices and tailor them to define their unique project processes. Employees in any part of the organisation can easily refer to its well-defined set of good practice processes.

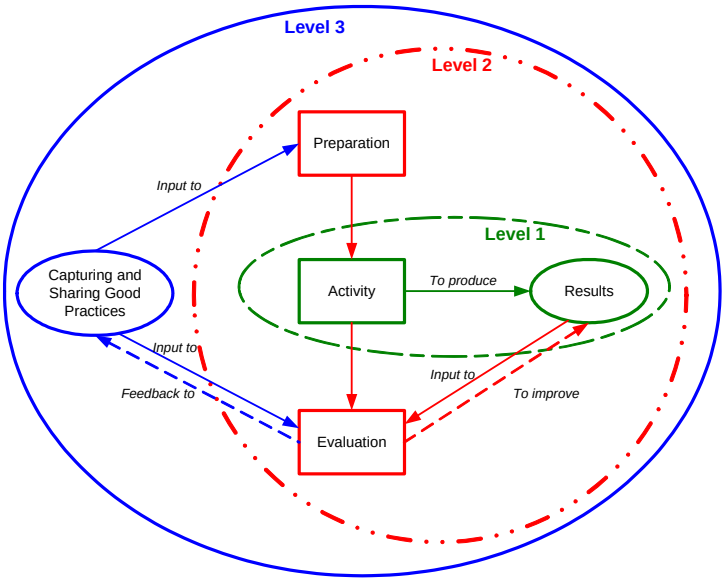

Fig. 2 . Transition from Level 1 and Level 2 to Level 3[Source: Modified from Construct IT (2000)]

In order to demonstrate a Level 3 maturity level, organisations need to show organisational process capability that they can integrate and institutionalise learning from individuals and projects, which can be subsequently used at an organisational scale. SPICE Level 3 process maturity assessment can highlight strengths and weaknesses of organisational process capability, and lays a foundation for openly discussing and thereby building consensus on

organisation specific strategies to bridge the gap between a current state and a desirable and feasible state.

3.2 SPICE Level 3 key processes

Although establishing an organisational infrastructure for process improvement at an organisational scale entails a diverse array of factors and processes, the SPICE Level 3 team has attempted to untangle complexity involved in organisation-wide process improvement and to present a concise set of key processes that have most direct and important bearings on implementing and achieving Level 3 process maturity. Each key process is defined and explained below.

Process definition

This key process is to establish and develop a well-defined set of organisation-wide good practice processes. Building upon from the achievements and lessons learnt from Level 2, this key process is to ensure that lessons learnt and good practices at a project Level are continuously and periodically captured.

Process customisation

This key process is aimed at achieving the implementation aspect of the common understanding of good practice processes across the organisation. Based on the organisation-wide good practice processes, each team will use them as guidelines (rather than rigid procedures) for developing more project-specific processes considering specific project characteristics (e.g. procurement route, supply chain, location, project team structure, project strategy, and resource requirements).

Process training

This key process is to ensure that the individuals and groups possess appropriate and relevant knowledge and skills required not only to fulfil processes at hand but also to absorb new knowledge necessary to develop further organisational competencies. It entails identifying the current and future gaps of individual, group and organisational competencies and addressing the identified needs successfully.

Process improvement resourcing

This key process refers to providing required organisational resources and time for facilitating process improvement and subsequent organisational change. Detailed requirements and solutions for ‘process improvement resourcing’ will vary depending on each organisation or team’s circumstances and internal climate; however, process improvement initiatives will benefit from senior management sponsorship, which will ensure that resources are directed to critical areas and at an appropriate level.

3.3 SPICE process enablers

SPICE identifies five process enablers that are prerequisite for a process to be complete and coherent. This is a forward-looking approach, which indicates process capability before a process takes place. They suggest that, in order for a process to yield successful results, it must posses such features as detailed in the SPICE process enablers. Thus, all key processes in each Level are tested against these common process enablers.

Commitment

Typically, this means establishing policies that are shared by the whole organisation. Some processes need sponsors or leaders in the organisation. Commitment ensures that leadership positions are created and filled, and that the relevant organisational policy statements exist.

Ability

It normally means having adequate resources (physical and/or virtual) and time, an appropriate organisational structure, and formal/informal training in place. It is also necessary to have appropriate mechanisms to enlist collaboration and involvement of employees.

Activity

They typically involve establishing plans and procedures, performing the work, tracking it, and taking corrective action as necessary.

Evaluation

During the early stages of maturity, this will mean efforts by the team to improve existing processes. The focus here is on the project team's internal improvements.

Verification

Adopting such verification checks as a process enabler emphasises the need for independent quality assurance. The focus is on external verification of processes. This enabler can be usefully utilised as a learning point that it helps organisations identify possible root causes of their success/failure and devise feasible solutions.

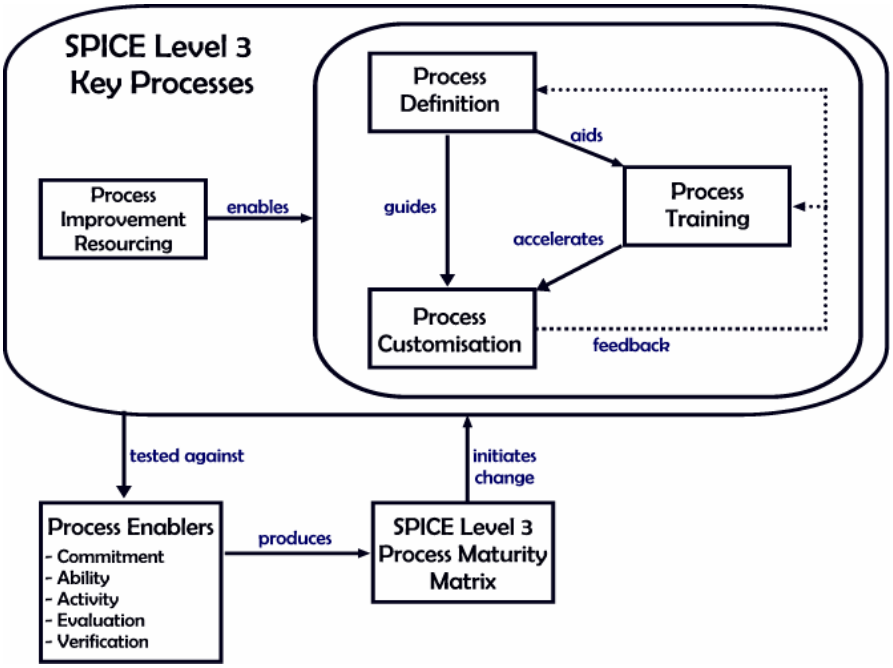

Fig. 3. A schematic diagram illustrating how Level 3 Key Processes are linked to each other and how they are positioned within SPICE Level 3

Figure 3 shows a schematic diagram to illustrate how these Level 3 key processes are linked to each other and to process enablers within the SPICE Level 3 assessment scheme. The SPICE model argues that, at Level 3, key processes should be integrated and interact with each other. For example, establishing and developing organisation-wide good practice processes ('Process Definition') will aid the organisation to prioritise issues pertinent to employee learning and development ('Process Training'). The established and developed organisational good practice processes will help the organisation have common understanding of the processes and their contexts so that they can tailor those good practice processes to meet the specific needs of individual construction project ('Process Customisation'). The tailoring process will be also accelerated along with the increased competency and skill levels of employees through process training. The activities within these three key processes will be sustained and enabled when there are appropriate organisational resources and supports to foster process improvement and organisational change ('Process Improvement Resourcing').

In order to satisfy the process maturity level advocated by SPICE Level 3, the key processes need to be backed up by the process enablers that are key features of disciplined processes: commitment, ability, activity, evaluation, and verification. Once the SPICE Level 3 key processes are tested against these five process enablers, the SPICE Level 3 process maturity matrix can be produced to help organisations identify gaps and initiate organisational change. The process maturity matrix shows graphically the strengths of the organisation in terms of process capability and which areas need to be further improved. A sample process maturity matrix is shown in Figure 4.

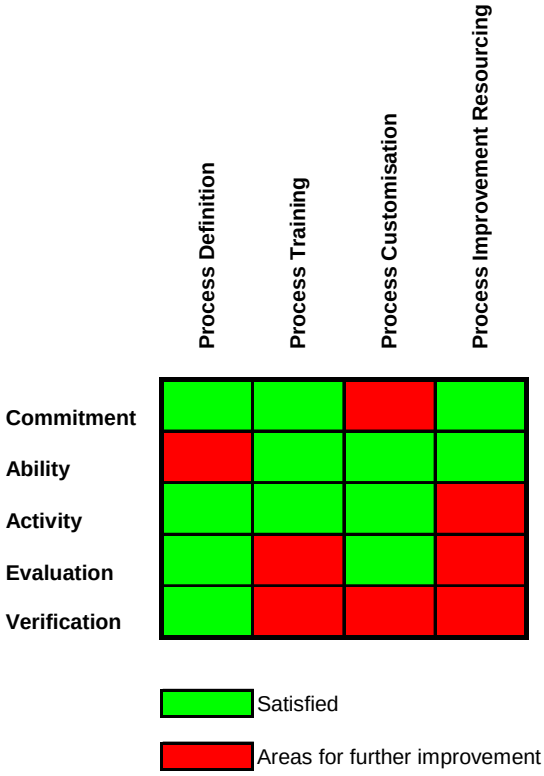

Fig. 4. A sample SPICE Level 3 process maturity matrix

4. CASE STUDIES

In order to ensure SPICE Level 3 key processes are relevant and applicable to construction organisations, the research team undertook field works in real world settings. The research was conducted in close collaboration with two construction industry partners. A similar approach was taken in both case studies. In each case, the organisation was assessed against Level 3 of the SPICE framework. Described below are the main stages of the case studies.

1. SPICE Level 3 team briefed senior management and obtained their commitment to the SPICE Level 3 assessment.
2. Senior managers who are directly or indirectly involved in organisation-wide process improvement were invited to discuss key issues and concerns within their organisation. At this stage, discussions are open-ended in order to understand how they perceive their capability to share good practices at an organisational level and what mechanisms are used to facilitate the process.
3. A document review followed, to further understand current practices within the organisation's context.
4. Potential interviewees were identified and their participation in the assessment was confirmed. At this stage, the assessment focused on senior and middle management, as well as those staff members either responsible for or directly affected by the SPICE Level 3 key processes being assessed. The participants attended a short briefing at which they were explained about what the assessment was for and how the findings would be used. Semi-structured interviews were used to examine current practices from middle managers' perspective and workshops were adopted to investigate a viewpoint of supervisory staff.

5. Data collected were analysed, highlighting the strengths and areas for further improvement. The findings were summarised into a project process capability matrix.
6. A detailed feedback report was presented to key participants of each organisation, and their agreement was sought on findings.

4.1 Case study A

The case study organisation is a major UK infrastructure provider working predominantly for the Highways Agency and Local Authorities. The commitment to process improvement is culminated in three areas: continuous improvement through training; capitalising on innovative technology; and partnering arrangements with its clients, business colleagues, subcontractors and suppliers.

Strengths

The organisation has a relatively short history of using process approach towards managing and improving site processes. The company aspired to have a high degree of strategic knowledge sharing and transfer good practices across their dispersed sites. Some of the practices identified during the case study seemed to have established a good foundation for nurturing process improvement. The organisation has established a 'Process Improvement Team' and process owners were assigned to their respective process.

Overall process maps were developed with collaboration with process owners. Standard procedures, manuals, forms, etc. were codified and stored in the computer systems. There was a high level of team-centred culture fostering knowledge sharing among members within the same team. The organisation promoted a proactive approach to integrate key project participants in order to deliver better value to the Client and achieve better bottom line results. Suggestion schemes and best practice dissemination workshops were in operation to encourage employees to take initiatives on process improvement. Attempts were made at mapping processes with downstream suppliers, who were evaluated periodically against various key performance indicators for encouraging continuous improvement.

Areas for further improvement

The major challenge appears to be a lack of visibility within process improvement activities. Although the organisation has established systems and assigned a dedicated process improvement team (PIT) to codify and store knowledge in the form of standards, documents, procedures, and rules, their existing systems were neither sophisticated enough nor user-friendly. It appears that it has placed too much emphasis on capturing good practices and documenting them in the form of standards and procedures. It has not yet developed a shared understanding, among different levels of hierarchy, of how the organisation will improve processes and what would be potential benefits.

Even though a set of well-defined processes was being developed, there was little evidence that it was used as a learning tool. Evaluation of processes was sporadic and has not led to further improvements. Consequently, process owners or possible contributors to process improvement did not offer much more collaboration with the PIT than they could probably afford. Concerns were also raised that blindly enforcing processes recorded in the procedure document actually demoralised those who actually were implementing the process. There was an indication that relatively less attention had been paid to training people in comparison to building IT systems to store standard forms and procedures, etc.

4.2 Case study B

The second case study was conducted with one of UK's largest global airport operators, which manages all commercial facilities at its airports including shops, catering outlets, foreign currency exchange, car hire and car parks.

Strengths

The organisation has recognised that in order to achieve 'value for money', it is essential to adopt process approaches centred on products and revolutionary means to improve processes. The company has established its own dedicated team for process improvement that provides generic solutions for products and coordinates with local teams to tailor those solutions. Then, local teams are responsible for developing the generic solutions to fit the specific local circumstances and providing feedback to the process improvement team for further improvement on the solutions.

The integrated project team strived to integrate supply chain and utilise their expertise in an early project stage. This was enabled through a special contract type embracing the spirit of partnering. There were a significant number of learning mechanisms and supporting technology infrastructure (e.g. virtual learning, document management systems, mechanisms to facilitate and record lessons learnt during the project, open discussions on improvement) already in place. Process guidelines were well-established and key stages, processes, and milestones of project were clearly defined, whilst documented processes were executed with appropriate flexibility to accommodate local circumstances and contingencies. There were also strong organisational drives for sustainability and value management.

The senior and middle managerial personnel shared that the importance and value of process management activities. The project team used generic high level and strategic, rather than operational level and detailed process maps. The process maps were not followed blindly, but were flexible and descriptive rather than normative. An emphasis was placed on objectives, inputs and outputs of each process, which is in turn linked up with previous, concurrent, or subsequent processes or sub-processes. The process maps included responsibility matrix for each process – who are responsible, accountable, to consult, or to be informed – which illustrated that the organisation's process maps were used as a platform for dialogues rather than a basis for auditing.

Areas for further improvement

However, this case also revealed that not all project team members in the integrated team shared the same vision for the project. Even though the organisation is relatively adept at facilitating learning at a management level, the absence of clear mechanisms to capture knowledge and experience at operatives' level meant that the lower echelon of the integrated project team became reactive to any change or development within the organisation. Despite the perceived value of post mortem project reviews, in actuality, reviews were taking place in an ad hoc manner. Comments were also made that actions resulting from learning activities were not always visible to middle/lower managerial personnel and operatives. Some felt that they were isolated from the improvement initiatives, whereas others felt that they were suffering from 'initiative fatigue'. Strategies and expectation of training to support learning and improvement initiatives were not also clear. Consequently, some corporate systems, e.g. electronic document management system and training programmes, were being under-utilised.

The most challenging task to the integrated project team appears to be generating consensus among the project team members on the vision and objectives of the project.

Although, by and large, the organisation was successful and supportive at experimenting new ideas, the results were not quickly institutionalised across projects. Therefore, efforts on process improvement were isolated and practitioners felt that the organisation was operating numerous dispersed knowledge silos. There appears to be a lack of collective 'sense making' processes to share contexts and goals of process improvement.

5. CONCLUSION

Construction organisations are increasingly challenged to improve performance. SPICE is developed in response to this call to aid construction organisations to improve process capability in a structured manner. SPICE is an on-going research and development project. So far, SPICE has investigated up to Level 3 of the five-level model. SPICE 3, the latest iteration of SPICE research has specifically examined key processes and relevant issues to establishing a management infrastructure for process improvement at an organisational level.

Process improvement at an organisational level is a multi-faceted problem, and involves a range of stakeholders. Taking into account many organisational process management aspects, we identified four key processes at Level 3 that have important bearings on efforts to establish and develop an organisational management infrastructure for process improvement. The four key processes are: process definition, process training, process customisation, and process improvement resourcing. In addition, in order to achieve SPICE level 3 maturity level, we argued that these four key processes need to satisfy five process enablers: commitment, ability, activity, evaluation, and verification.

Throughout our case studies, we recognised that the SPICE process capability assessment involves proactive participation of managers and employees alike, capturing improvement opportunities from all levels of the business. Implementing the SPICE model can help construction organisations identify strengths and weaknesses, and prioritise areas for improvement. In conclusion, we would like to emphasise that the SPICE model should not be followed blindly in a prescriptive manner, but rather the benefits of using the model will be establishing a frame of reference for facilitating discussion across all levels of employees. As each organisation has different strategic orientation, market position, technology invested, organisational culture, competencies and skills, the use of the SPICE model, in general, and SPICE Level 3, in particular, requires incorporating such organisational specific aspects.

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