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Structured process improvement for construction enterprises (SPICE) level 3: Establishing a management infrastructure to facilitate process improvement at an organisational level: Industry report

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Structured Process Improvement for Construction Enterprises (SPICE) Level 3: Establishing a Management Infrastructure to Facilitate Process Improvement at an Organisational Level

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Structured Process Improvement for Construction Enterprises (SPICE) Level 3: Establishing Management Infrastructure to Facilitate Process Improvement at an Organisational Level

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FOREWORD

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THE AIMS OF THIS HANDBOOK

This handbook introduces the second iteration of SPICE research project was aimed at developing and validating the Level 3 key processes within the SPICE model. SPICE (Structured Process Improvement for Construction Enterprises) is a step-by-step process improvement framework for construction enterprises. The objective of Level 3 key processes is for establishing a management infrastructure to facilitate process improvement at an organisational level.

Who should read this?

This handbook has been written specifically for both senior managers and project managers in construction organisations, who are increasingly faced with challenges of innovation and continuous process improvement.

What can SPICE Level 3 achieve?

The SPICE Level 3 can help construction organisations to:

- increase their awareness of processes that would enhance organisational capability to explore and exploit organisational competencies by sharing good practices across projects;
- identify improvement areas that need organisational attention and efforts;
- prioritise activities to achieve continuous improvement; and
- facilitate discussions on process improvement throughout the organisation so that people can share contexts beyond their immediate project or functional boundaries.

EXECUTIVE SUMMARY

Structured Process Improvement for Construction Enterprises (SPICE) provides a method to continuously improve business processes. 'SPICE' is a continuous process improvement model developed through a DETR funded project (1998-2000). The model proposed a structured approach to help construction organisations improve their management processes in a structured manner. Building upon the first iteration of SPICE project [refer to 'Introduction to SPICE' published by Construct IT (2000)] that presented a robust instrument to assess process maturity at an individual project level (see Section 1 for review of the SPICE model and its underlying concepts); this second iteration of SPICE, funded by EPSRC, has investigated key issues in process improvement at an organisational level (called Level 3).

In order to achieve Level 3, organisations need to build an effective management infrastructure to support organisational learning and change processes. Several key issues pertinent to building and developing a management infrastructure for process improvement are highlighted:

- Process improvement at an organisational level requires far greater efforts than the sum of individual project level process improvement;
- Implementing organisational level process improvement is not just a linear mapping exercise, nor transmitting process information through ICT tools;
- Organisational level process improvement should be driven by business strategy, which enables managers and employees alike to identify and prioritise critical issues;
- The success of organisational level process improvement hinges on the individual and organisational capabilities to create, transfer and exploit knowledge to the organisation's advantage;
- Organisational level process improvement requires developing and integrating internal and external knowledge-base across all levels of the organisation and across its supply chain; and
- Interaction between technology, people, and processes are key to successfully building and developing an enabling environment for good practice sharing.

As a result of empirical development and testing as well as literature review and synthesis, we present four key processes (process definition, process customisation, process training, and process improvement resourcing) that are deemed critical to building an organisational management infrastructure to facilitate process improvement through good practice sharing.

Although this handbook describes the background of SPICE and its Level 3 in a detailed manner, it is not sufficient for some construction organisations to actually implement SPICE Level 3. Findings from the case studies conducted so far indicate that few construction organisations are able to achieve SPICE Level 3. If your organisation would like to find out whether you can stand up to the challenges of SPICE Level 3, or need more information on SPICE Level 3 research, please contact the research team at Salford Centre for Research and Innovation (SCRI, scri@salford.ac.uk).

ORGANISATION OF THE HANDBOOK

This handbook describes the latest iteration of the SPICE model (2002-2003), a step-wise approach to process improvement that has been developed specifically for the construction industry. However, before examining the latest developments in SPICE, in particular its focus on providing process improvement capability at an organisational level, we provide a broader overview of the SPICE model and its underlying concepts as well as a summary of key findings from the first iteration of the SPICE model. Early work in SPICE focused on the development of process improvement capability at an individual project level. The first section is specifically designed to be read by those unfamiliar with the SPICE approach. It begins with a short history of the development of the SPICE model during the last five years.

Following an overview of the SPICE model and its concepts, we present a state-of-the-art literature review and synthesis of organisation-wide process improvement. The literature review and synthesis draws upon a wide range of theories including knowledge management and organisational learning. By setting the backdrop of the process improvement at an organisational level, we suggest four key processes at SPICE Level 3. Then, we illustrate how they can help to improve construction processes at an organisational level rather than at a project level. Along this line, we present five process enablers that, if well managed, would ensure that the key processes are successfully implemented: commitment, ability, activity, evaluation, and verification. The purpose of process enablers is to ensure that organisational process improvement efforts are well aligned to the business needs and systemically integrated to deliver real benefits in return of investments made in process improvement.

Next, we present real-life case study examples and finally conclude that process improvement at an organisational level is a long and winding road for construction organisations and requires painstaking efforts to nurture an enabling context for good practice sharing across projects.

SECTION 1: SPICE CONCEPTS

A History of the SPICE Model

Development of the SPICE 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). Egan also emphasised the need to look at experiences in other industries. Accordingly, a consortium of academics (University of Salford) and industrialists (AMEC Construction, BAA, Cruickshank and Seward, Oxford Software Engineering) was set up to undertake a two year investigation funded by the UK's Department of the Environment, Transport and the Regions (DETR). It aimed to develop a process improvement model for the construction industry based on an approach widely adopted in the software engineering industry, which is called CMM[®].

Early research focused on improving processes at an individual project level. The first iteration was published in 2000 and generated considerable interest from major industrialists. This led to further research being commissioned in 2002, this time focusing on process improvement across the construction organisation. The research was funded by the EPSRC and undertaken at the University of Salford's SCRI. BAA, Balfour Beatty, Raynesway Construction Southern, and Oxford Software Engineering provided industrial support for the project.

The SPICE model has also been adapted for use in the Facilities Management (FM) sector. The first iteration of the SPICE FM model was published by Construct IT in 2001. In addition to tailoring the model to the needs of the FM sector, this research also examined the relationship between process improvement and strategy. It proposed integrating the SPICE approach with a strategic management tool such as the Balanced Scorecard.

Why was SPICE developed?

In the last two centuries, the construction industry has approached its work from a functional point of view. In turn, this has meant functional project structures, as shown in Figure 1. In this type of structure, each discipline involved in a project carries out its own activities without much thought for how it fits into the activities of other disciplines. There can be a communication wall between the various professions and organisations on the project, and an adversarial culture predominates. In this type of structure, the focus on the customer becomes clouded, and many issues related to the whole life cycle of the built product are undermined.

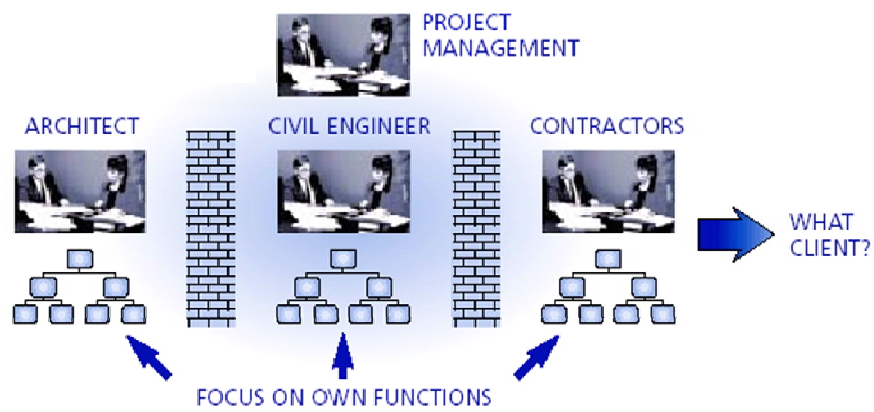


Figure 1: Functional project teams

Improving construction processes

In order to improve productivity, the construction industry has set itself the target of moving away from functional thinking and towards the production-based philosophy found in manufacturing industry. Most people agree that improvements in construction processes are a means to achieving this goal. This was also emphasised by the Egan (1998) and Latham (1994) reports.

The aim is to move towards a focus on the process, or “process thinking”, and process-based organisations. In other words, managers in construction need to shift thinking from traditional functional or task-oriented structures to focusing on the processes and how these processes interface with the client. As shown in Figure 2, the process focus reduces the communication barriers between the various disciplines are reduced, and there is a strong focus on the project and the customer.

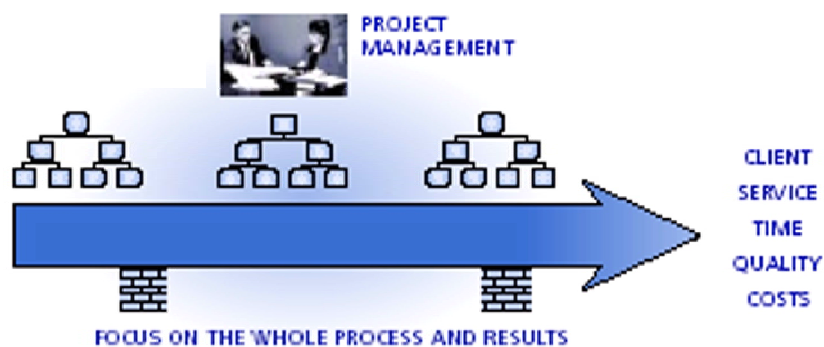


Figure 2: Process-based project

Concentrating on the processes involved in a project or business processes at an organisational level can help to align the behaviour and activities of the participating teams towards a common goal. It makes the various teams' behaviour more consistent and uniform, which in turn improves their capability and leads to better results and improved supply chain relationships. Without this focus and alignment towards common goals, the activities of the different team members could start to contradict each other, thus damaging the effectiveness of the team as a whole.

Due to fast changes in the market place and clients' increasing expectations, task oriented or functional thinking has become outdated. Many managers in construction now believe in process thinking. But belief in itself is not enough, and the problem has been how they should implement this thinking in actuality.

Many organisations in the construction industry have a culture that is focused on the product they provide. In such a culture, people are naturally inclined to emphasise issues that are tangible. They expect the outcome of any activity to be in some way tangible, visible or measurable. In such organisations, people are likely to resist activities that do not contribute to short-term tangible results. Managers often view process-related work as a low priority activity, which could be deferred until there is a slack time for "non-critical" activities.

On the other hand, process-focused organisations consider tangible results to be one aspect of the total business picture. In these organisations, documenting and recording processes is considered to be a tool that facilitates process participation, not an objective in itself. The objective is that the process should be accepted and used consistently. The process is seen as a disciplined way of conducting business. A positive attitude towards process thinking is therefore vital.

Organisations need to find the right balance between focusing on the product and focusing on the process and whole life cycles. The industry needs user-friendly tools and techniques to implement and achieve this balance. SPICE is being developed as one of those tools.

Transferring good practices

Project-based industries have much to gain from instigating a learning culture, in particular the ability to capture and transfer good practices from project-to-project. Yet studies suggest construction, in common with other project-based industries, may be least open to such philosophies. Despite the interest and effort exerted by many leading construction companies into managing knowledge and instigating a learning culture, there is little evidence that the expected improvements in business processes have arisen. Many practitioners and researchers have acknowledged the limitations of current approaches to managing the information and knowledge in relation to and arising from projects (Rezgui, 1998):

- Much construction knowledge, of necessity, resides in the minds of the individuals working in the construction domain.
- The intent behind the decisions is often not recorded or documented. It requires complex processes to track and record thousands of ad-hoc messages, phone calls, memos and conversations that comprise much project related information.
- People responsible for collecting and archiving project data may not necessarily understand the specific needs of actors who will use it, such as the actors involved in the maintenance of the building.
- The data are usually not managed while they are created but instead are captured and archived at the end of the construction stage. People who have knowledge about the project are likely to have left for another project by this time – their input is not captured.

- Lessons learned are not made explicit and remain tacit. It is difficult to reflect on practices executed in a project-based organisation, let alone compiling and disseminating useful knowledge to other projects.
- Many companies maintain historical reports of their projects. Since people always move from company to another, it is difficult to reach the original authors who understand the hidden meaning of historical project data. These historical project data should include a rich representation of data context so that they can be used with the minimum of data consultation.

Process Concepts

What is a process?

There are many definitions of a process. The term is interpreted differently by different people depending on the sector, function, and market in which they are operating. Table 1 gives three examples. Each emphasises different aspects.

Table 1: Definitions of Process

Source	Definition
The Concise Oxford Dictionary	Course of action, proceeding, esp. series of operations in manufacturing, printing, photography, etc.
SEI CMM® (Capability Maturity Model)	A process is a sequence of steps performed for a given purpose. More simply stated, process is what you do. The process integrates people, tools and procedures together.
Harrington (1991)	Any activity or group of activities that takes an input, adds value to it and provides output to an internal or external customer. Processes use an organisation's resources to provide definitive results.

Characteristics of a Process

Rather than discuss the exact definition of a process, it is easier to discuss its essential features. Ould (1995) lists these to be as follows:

- A process involves activity. People or equipment do things.
- A process also generally involves more than one person or piece of equipment. A process is about groups, it concerns collaborative activity.
- A process has a goal. It is intended to achieve something and produce some results.

These features have implications.

- (i) Since a process must be shared among groups, it needs to be defined.
- (ii) The definition and knowledge of the process must be passed to those who will perform it. Hence there is a requirement for process learning. The knowledge of the process should drive and align the behaviour and activities of those who perform it.
- (iii) The process leads to process results, which are the results of performing the process. This is shown in Figure 3.



Figure 3: Aspects of a process

Process vs. Function

"Functions", such as Architecture or Quantity Surveying are not processes. Functions are parts of a construction project team or organisation. They are vertical structures and have responsibilities, staff and resources. Conversely, processes cut across organisational structures. For example the Architect function can be viewed as part of the process "defining client requirements", and also part of the process "managing project life cycle". An organisation's structure and functions can hinder efficient operation of processes. The relationship between process and function is complex. In a re-engineering context these relationships must be explored so that they result in the efficient performance of processes.

Process Institutionalisation

A process determines the way we act, interact and react. The activities and tasks we perform to achieve a certain goal form the process for achieving that goal. A disciplined process will result in ordered and consistent patterns of behaviour, whether by individuals or by groups of people following a common process. The process defines how we act, interact or react in certain situations, or it defines the activities needed to fulfil a certain task. We have a process for "going to work", a process for "designing a foundation", a process for "paying sub-contractors", and so on.

In organisations, processes involve groups and teams of people. To achieve a process discipline shared by the whole organisation, the process needs to be established or "institutionalised" in the organisation. Without organisation-wide established processes, every individual would follow his or her own way of performing a task. Attempts to adhere to a common process are likely to be ad-hoc or even chaotic. This could lead to conflict and stress on projects.

On the other hand, in organisations where common processes are institutionalised, employees perform the process painlessly, smoothly and in harmony with each other. The process itself becomes invisible or "transparent", because it simply becomes the natural way of performing business activities.

Core, Support and Management Processes

Business processes can be divided into three broad types: (i) core processes; (ii) support processes; (iii) management processes. This is shown in Figure 4.

Core processes concentrate on satisfying clients. They directly add value to the product in a way that clients understand. These processes respond to the needs of the client and generate client satisfaction.

Support processes concentrate on satisfying “customers” within the organisation. They might add value indirectly by supporting a core business process, or they might add value to the business directly by providing a suitable environment. Management processes concern themselves with managing the core and the support processes.

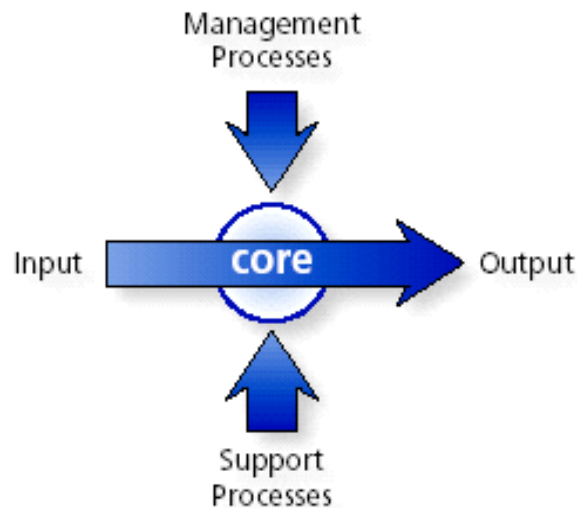


Figure 4: Types of processes

SPICE is primarily concerned with management processes. The underlying philosophy is that if the management processes are well performed, they will have an impact on the performance of the core processes. SPICE does not prescribe how organisations should perform core processes. Instead, it focuses on creating a management infrastructure, which allows members of staff to perform their core processes successfully.

Process Thinking in the Construction Industry

The construction industry features many complex processes, and the supply chain adds a further layer of complexity. Construction is also a mature industry, with strong inherited cultures and working traditions. This means it has the advantage of well-understood practices that have evolved over a long period. The disadvantage of this can be that it is difficult to manage and implement change.

As early as the 1970s, the industry understood the value of improving its processes. The RIBA plan of work was one of the first industry documents to advocate process thinking. More recently, the success of the Generic Design and Construction Process Protocol (GDCPP) research (<http://pp2.dct.salford.ac.uk>), and the increased use of process mapping techniques within the industry, indicate a growth in awareness of process.

Process Myths and Facts

Based on this understanding of processes, Zahran (1998) lists a number of interesting process myths and realities which prevail in most organisations. Some of these myths are suited to construction organisations and are listed below:

“We have a set of standard documents that specify the steps of construction management. We think we have a process.”

Wrong! A standard document on its own, without being trained and enforced, is no more than “shelfware”. It could do harm rather than good. It gives the false impression to management that there is a process in place. A document is a dead object. It only comes to life when it turns into knowledge in people’s brains and memories. It only becomes effective when such knowledge drives people’s behaviour.

“We already train our staff in the process. We automatically assume that they practise what they have learned. We think we do not have to monitor their activities or put enforcement procedures in place. We trust our staff.”

Wrong! This is “wishful thinking”. An effective process environment is designed to work effectively and endure throughout generations of staff. Without follow up, people tend to revert to their old habitual ways of performing activities. Why should they change? People can attend many training events but still act as if they had received no training. Without enforcement, you can not guarantee that everyone in the team will follow the process.

“We have a senior management sponsor who believes in the value of the process improvement effort. We do not have to justify our investment and effort in process improvement.”

Wrong! Unless the business benefits of the process improvement are continuously monitored, measured and made visible, management sponsorship could be lost. The process improvement effort could be stopped at the first business crisis. Business benefits attributed to process discipline should be uncovered and publicised.

“We have the process defined, documented, trained and enforced. The process is stable, and it should remain effective without any change.”

Wrong! The process will only be effective if it is aligned with the business goals. If the business goals change, the process goals must be realigned. A stable process does not necessarily mean that the process is effective. The process should reflect the latest changes in business, techniques and methods. It should be continuously realigned to reflect any changes in the business goals.

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. For example;

- Hughes Aircraft reported a 5:1 return on investment
- Raytheon achieved a 7.7:1 return on investment and 2:1 productivity gains.
- Analysis of the IT Industry shows an average of 35% productivity improvements and a 39% reduction in post-delivery defects.

SPICE has borrowed many basic concepts from CMM® and developed them into a construction specific model. SPICE is intended to address processes related to product development within construction companies. It is relevant to processes associated with tendering, design and construction. However, it does not cover many of the other processes relevant to construction companies, such as finance or marketing. 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. In the long term this benefits the whole company.

Process Capability

Over the past decade, a number of management thinkers (Ghoshal and Bartlett, 1995; 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. In contrast, process performance is backward looking and consists of the results achieved after completion of the process, thus providing historic data on the project.

When a process is stable, its results will have predictable means and be within predictable ranges about the means. Requirements or specifications typically represent the voice of the client. When the variability within a process falls within the limits required by the customer, the process conforms to customer requirements. When a process is stable and conforming to requirements it is termed capable. The concept of capability thus depends on both the stability of the process and its ability to conform to customer requirements.

Process Maturity

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.

Process maturity is the extent to which an organisation is able to define, manage, measure and control a specific process. Having 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.

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.

Mature Organisations

On the other hand, 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.

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.

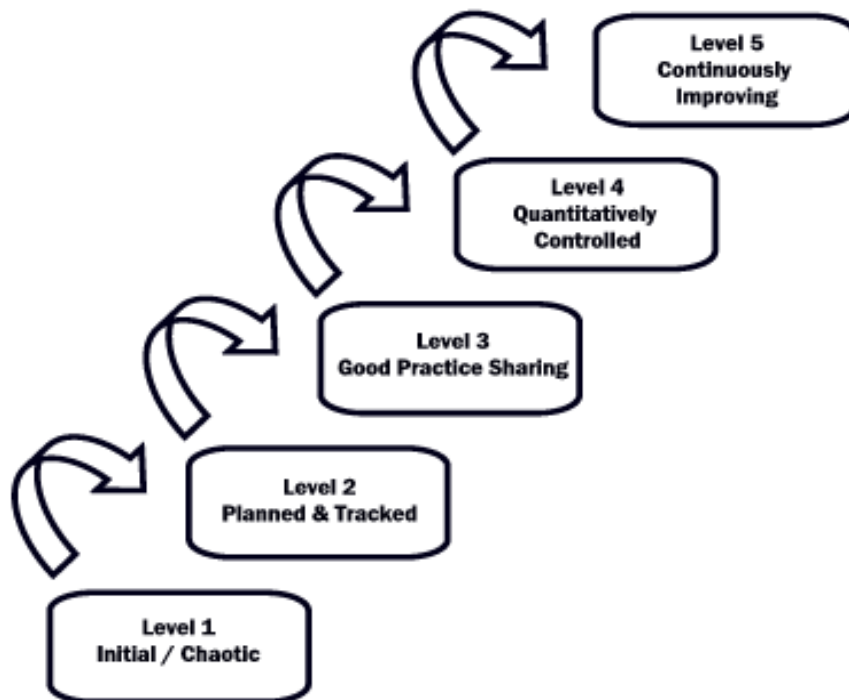


Figure 5: Five Levels of the SPICE model

Level 1 – Initial/Chaotic

Level 1 is the basic entry Level to the model. This Level has no key processes. An organisation at Level 1 can be large or small. Irrespective of its size, it 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. This results in 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.

Key Processes

Each SPICE Level, with the exception of Level 1, includes key processes that identify where an organisation must focus to improve processes. When an organisation collectively performs the activities defined by process areas, it can achieve goals considered important for enhancing process capability.

Early research into SPICE focused on Level 2 of the model. When published in 2000, the first iteration of the SPICE model defined eight key processes at Level 2, the aim being to stabilise and improve processes at a project level.

The Level 2 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 detailed description of each key process, refer to the glossary). For an organisation to achieve Level 2 of maturity, all projects must perform all these key processes adequately. This forms the basis for progression to Level 3.

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 possess 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.

Key Practices

Each key process is expressed in terms of key practices that describe the infrastructure and activities that are required to support and continuously improve a process. Each key practice supports one of the process enablers.

The key practices are not prescriptive in suggesting “how” the goals must be achieved; instead the practices describe “what” is to be done.

SECTION 2: CHALLENGES OF ORGANISATIONAL LEVEL PROCESS IMPROVEMENT IN CONSTRUCTION

Process improvement beyond individual projects

As construction projects often have a temporary 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 and 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 of all employees. However, achieving benefits of process improvement through sharing good practices requires painstaking and resource-intensive processes. The most difficult but critical issue to fostering an appropriate organisational climate to promote organisation-wide good practice and knowledge sharing is perhaps sharing contexts and visions among both individuals and projects. Creating and sharing contexts and organisational vision entails alignment of interests of employees and empower them to take proactive roles of improving processes. This will be particularly challenging to those who are accustomed to traditional command-and-control management styles often adopting bureaucratic and hierarchical organisational structures.

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.

Organisational context

A Level 3 organisation builds on the achievements of Level 2. At this Level the organisation has the capability to capture and share knowledge across projects, on an organisational scale. A Level 3 organisation focuses on creating a process improvement infrastructure, which captures and shares good practices across the organisation.

But, implementing organisational level process improvement to construction is not a linear mapping exercise. Studies show that transfer of innovation across countries (and industries) cannot take place in their original packaging. The core idea of an innovation must be abstracted and then recreated in a form, which fits local conditions. Construction is no exception. Some argue that a significant amount of work is required at the receiving end of innovation, especially in adopting the appropriate organisational forms. This has certainly been the case in SPICE Level 3.

In order to improve overall organisational level process improvements, construction organisations need to set themselves objectives to move away from functional thinking and towards the production-based process philosophy. The aim is to move towards a focus on the processes, or “process thinking”, and process based organisations. Concentrating on the processes involved in a business can help to align the behaviour and activities of the participating teams towards a common goal. It makes the various teams’ behaviour more consistent and uniform, which in turn should improve capability and lead to better results and improvement in supply chain relationships.

One way of creating and developing knowledge sharing infrastructure is achieved through the creation of “Process Improvement Teams (PITs)”, who collaborate with project teams to capture and institutionalise good practices. PITs facilitate the creation of organisation wide process libraries, which act as process standards (good practices). Project teams use these standards to define and tailor their unique project processes. Employees in any part of the organisation can easily refer to these standard processes. Experience from the software industry provides guidelines on what life at a Level 3 organisation is. Some characteristics of a Level 3 organisation are there is: (i) a pro-active client management; (ii) an effective defect tracking system, which drives product management; (iii) there is an organisation focus on “getting it right”.

Strategy and process improvement

Strategy is derived from the organisation's vision and implies a purpose for which a direction is set over the long-term. It requires leadership and an understanding of the broader context in which organisation is in operation. Although this link between strategy and process improvement is not specifically examined in SPICE Level 3, the previous experience of the research team with the SPICE model within the Facilities Management sector (called SPICE FM, refer to <http://www.scpm.salford.ac.uk/SPICEFM>) suggests that it is important to realise that the organisational process improvement function cannot exist in strategic isolation. By linking the SPICE model and strategic tools (e.g. Balanced Scorecard), the organisation will be able to more effectively exploit its entire knowledge base to best support the process improvement initiatives.

Over ninety per cent of organisations have not effectively aligned their strategy at all levels of the organisation (Fortune Magazine, 1997). The result represents an organisation that is not operating at maximum efficiency, typically leading to less than optimal performance as well as missed opportunities. Therefore, process improvement initiatives in general should attempt to address a key management issue: that organisations often fail to turn strategy into action.

The objective of any process improvement initiative should be to motivate all managers and employees to implement successfully the organisation's strategy. Those organisations that can translate their strategy into their process improvement "actions" are far better able to execute their strategy because they can communicate their objectives and their targets. This communication focuses managers and employees on the critical drivers, enabling them to align investments, initiatives, and actions with accomplishing strategic goals.

Technology context

Recent developments in information and communication technologies (ICT) present tremendous opportunities for firms to impart information efficiently and timely. Many ICT tools, which can be usefully exploited in the context of process improvement, are being developed and now widely available in the marketplace. Systems vendors are providing not only generic but also firm-specific solutions for process improvement, e.g. knowledge management tools, which could meet idiosyncratic requirements of the organisation.

Popular applications of ICT technologies in the process improvement arena include those process-mapping tools and workflow management as well as those that can assist knowledge capturing, storing, retrieving, and disseminating (such as, document management tools, corporate yellow pages, database, best practice repositories, etc). In addition, there are many supporting tools that may be utilised to enhance the improvement activities. For example, organisational development tools (knowledge mapping, computer-based training or on-line training) or communication tools (groupware, email, chat rooms, video conferencing, teleconferencing, bulletin boards, etc). These tools can help people get access to up-to-date and relevant information within and across organisations. As these technologies provide more efficient and effective means to document and distribute information on processes, process improvement can be greatly assisted by using them. However, over-reliance on ICT technologies in process improvement can be ironically detrimental to other aspects of process improvement.

Despite their potential benefits, there are some limitations of utilising ICT tools in the context of sharing knowledge and good practices for process improvement. For example,

- a) Although ICT tools provide efficient and effective means for capturing and disseminating information, they still do not substitute human interactions (e.g. face-to-face meetings or co-location) that are required to build interpersonal relationships;
- b) Knowledge is highly situational and context-specific, which means good practices write-ups may not present sufficient 'nuance' of implementing good practice in a different context;
- c) Without sufficient training to the people who would actually use the ICT tools, however sophisticated or advance the tools can be, benefits would not be obtained automatically. It is all too often misused and, consequently, people suffer from 'information overload' as they receive far too much information than they can digest or sift relevant ones;
- d) Building centralised process repositories and making people blindly adhere to the standard processes might be counterproductive and can stifle innovation; and
- e) Technologies are complementing rather than replacing knowledge and experiences of employees. If employees do not perceive themselves as part of the change process leading to uncertainty and anxiety, it is highly likely that the initiative will be met with 'resistance'.

Knowledge context

Process improvement at an organisational level requires individual and organisational capability to create, transfer and exploit knowledge and lessons learnt. Increasingly the role of knowledge in modern businesses is acknowledged as a key to creating sustainable competitive advantage in construction as well as other industries. It is suggested that knowledge has tacit and explicit dimensions (Nonaka and Takeuchi, 1995). Tacit knowledge is highly personal and difficult to articulate, such as insights and intuition. In contrast, explicit knowledge can be codified in the form of manuals and specifications. It is often argued that the majority of knowledge in construction is of tacit nature. For example, whereas knowledge on certain straightforward and linear processes (e.g. material handling or installing light fixtures on the wall) can be abstracted and articulated easily, certain experiences and skills gained over time in highly complex and non-linear processes (such as design or decision making processes) may be difficult to articulate and thus the majority of knowledge remain as tacit.

In this regard, it is necessary to introduce two distinct but complementary schools of thought in how the utility of knowledge can be enacted: 'cultural' vs 'technical' approaches. These approaches are discussed here to illuminate how they can be related to process improvement. The technical approach is to achieve economy of scale by codifying what individuals or groups know or have learnt and help employees get easy access to the knowledge. It often (but not necessarily always) advocates using advanced ICT technologies to spread 'good practices' or 'lessons learnt' rapidly throughout the organisation. The cultural approach is essentially people-oriented and aims to integrate individual and group knowledge in order to solve idiosyncratic or non-routine problems. However, this dichotomy may be misleading, as often is the case, not only because they can benefit from each other but also because not one solution can be effectively and efficiently applied to every situation.

When an organisation attempts to leverage collective knowledge and what has been learnt by experience, the context of knowledge transfer concerns several questions such as whether the organisation can benefit mostly by spreading repeatable and proven solutions or whether it is more appropriate to build a system to devise solutions so that unique or non-routine problems can be effectively dealt with. Equally important issue is how it can be shared and integrated with various existing organisational systems. The following table compares technical vs cultural approaches to managing knowledge in processes.

Table 2: Technical vs Cultural Approaches to Managing Knowledge

	Technical	Cultural
<i>Key Process</i>	Verify and communicate	Share contexts through dialogues
<i>Problem Contexts</i>	Similar	Idiosyncratic
<i>Common Mechanisms</i>	Codifying good practices, skill-based training, and building databases	Face-to-face meetings and collocation of key personnel
<i>Driver</i>	Efficiency	Effectiveness and innovation
<i>Process Application</i>	Routine processes	Non-routine processes
<i>Outputs</i>	Repeatable solutions	Unique solutions

SECTION 3: SPICE LEVEL 3 PROCESS MATURITY

Aim of SPICE Level 3

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.

A journey from Level 1 and Level 2 to Level 3

The first iteration of the SPICE project has investigated how Level 1 organisations can achieve Level 2. At Level 1, processes are planned and executed in an ad hoc manner. In order to progress to Level 2, organisations have to establish policies and procedures for managing the major project-based processes. Key processes at Level 2 include, for example, brief and scope of work management, project planning, project change management, health and safety management, risk management, and project team co-ordination. A Level 2 organisation has established an infrastructure for managing project-based processes in a systemic manner, which allows organisations to repeat successful project execution.

A Level 3 organisation builds on the development of Level 2. 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, 1995; Zahran, 1998). Figure 6 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.

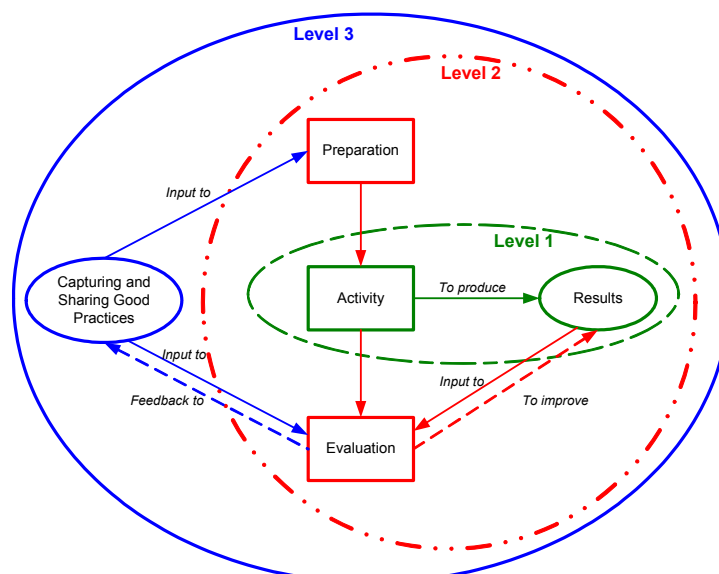


Figure 6. Transition from Level 1 and Level 2 to Level 3 [Source: Modified from Construct IT (2000)]

Experience from the software industry shows that, at Level 3, an organisation might create and utilise 'Process Improvement Teams (PITs)' or facilitators who collaborate with project teams to capture and institutionalise good practices (Construct IT, 2000). However, we do not suggest that establishing PITs is *the* only means to achieve organisation-wide good practice sharing. Solutions will vary depending on the existing technology, skills, competencies, internal and external networks, and culture of the organisation. Therefore, we recommend that organisations devise and establish means of achieving SPICE Level 3 that is not only desirable from a technological perspective, but also feasible from an organisation's cultural viewpoint.

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.

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. The key processes are derived through an iterative research process between literature review and case studies and finally categorised under the following four headings: 'process definition', 'process customisation', 'process training', and 'process improvement resourcing'. Each key process is defined and explained below.

Process definition

Establishing and developing organisation-wide good practice processes.

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. Successful 'process definition' will depend on to which extent process information is made accessible and relevant to users. This will lay a foundation for further cumulative developments that could yield benefits to the organisation as a whole. In construction, organisation-wide good practice processes need to consider a range of projects in which the business units or company are involved and their diversity and idiosyncratic project characteristics. As a consequence, it would be necessary to contextualise good practice processes in light of users' perspective so that they can be more easily understood.

Process customisation

Tailoring good practice processes to meet the specific needs of individual construction projects.

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). In this respect, successful process customisation will occur when various stakeholders' perspectives are taken into account. In construction, this may entail, among others, early involvement of key suppliers, clients and facility managers at an early stage of the given project so that more informed decisions can be made. Integration of various stakeholders at a project level and strategic dialogues with key collaborators at a business level will foster knowledge sharing and trust building which are essential to develop organisational process capability.

Process training

Providing appropriate learning and development opportunities for all levels of employees.

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. Appropriate learning mechanisms, both informal and formal, need to be devised and used for developing employees' competencies and capabilities. In this regard, this key process goes beyond typical conventional skill-based training programmes. The challenge to construction organisations would be to find innovative ways to develop individuals and groups and eventually transform the organisation.

Process improvement resourcing

Providing appropriate resources and support to foster process improvement and organisational change.

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. It might also entail supporting change agents, such as "process champions" and "process owners", or establishing "process improvement team" for the improvement initiatives to sustain. Successful process improvement resourcing will be dependent on whether all levels of employees share the necessity for active search for good practices and subsequent change processes. Thus, empowerment of all employees is critical for process improvement. Clear goals, measures, and outcomes of improvement initiatives need to be agreed upon and communicated so that a sense of achievement can be shared throughout the organisation.

SPICE process enablers

SPICE differentiates between incomplete processes and disciplined processes. 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 possess such features as detailed in the SPICE process enablers. Thus, all key processes in each Level are tested against these common process enablers.

Commitment

Involves an organisation taking action to ensure that the process is established and will sustain.

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

Describes the conditions that must exist before a process can be implemented competently.

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

Describes the activities, roles, responsibilities, measures and procedures necessary to implement processes.

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

Evaluation

Involves internal process evaluation and reviews to help manage and improve processes.

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

Considers whether the practice is implemented in compliance with procedures and guidelines.

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.

SPICE Level 3 assessment scheme

Following Figure 7 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').

When we ask senior managers in construction firms whether they are implementing these key processes within their organisations, the responses we usually get are 'Yes, we do'. However, as we argue in previous section on 'Process Enablers', there are incomplete processes and disciplined processes. Thus, 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 8.

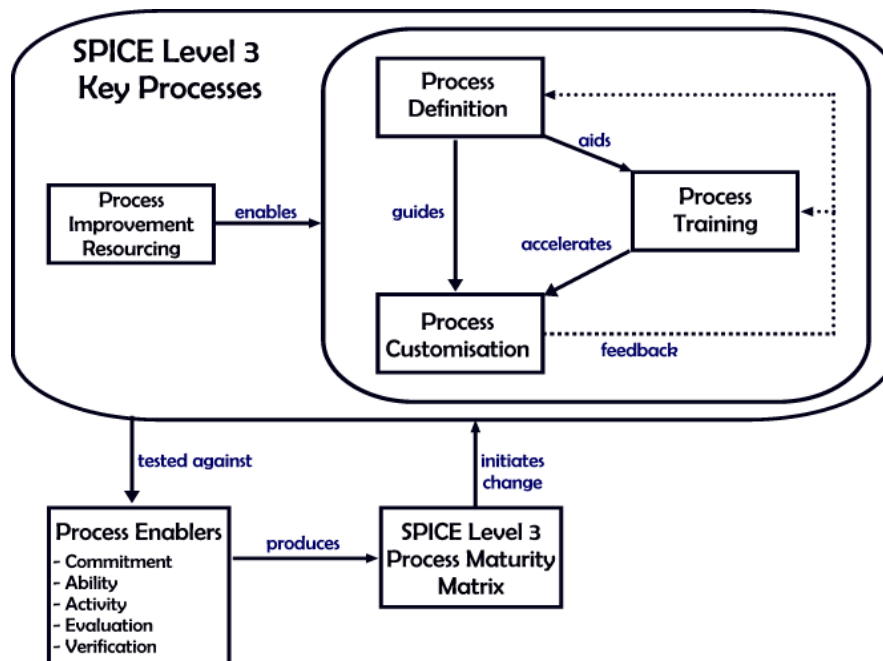


Figure 7. A schematic diagram illustrating how Level 3 Key Processes are linked to each other and how they are positioned within SPICE Level 3

	Process Definition	Process Training	Process Customisation	Process Improvement Resourcing
Commitment	Satisfied	Satisfied	Areas for further improvement	Satisfied
Ability	Areas for further improvement	Satisfied	Satisfied	Satisfied
Activity	Satisfied	Satisfied	Satisfied	Areas for further improvement
Evaluation	Satisfied	Areas for further improvement	Satisfied	Areas for further improvement
Verification	Satisfied	Areas for further improvement	Areas for further improvement	Areas for further improvement

Satisfied
 Areas for further improvement

Figure 8. A sample SPICE Level 3 process maturity matrix

SECTION 4: CASE STUDIES

To date SPICE has investigated Level 2 and Level 3 construction processes. The latest iteration of SPICE research has specifically examined the applicability of Level 3 processes on two companies.

Findings from the case studies indicate that the SPICE methodology and instrument designed for Level 3 can provide an accurate, precise and balanced view of construction organisations' process maturity. All the case study firms participated in the assessments have agreed with the SPICE Level 3 findings, and accepted that they reflected the current state of their organisational process maturity. The results provided a significant insight into organisations' process capability and an opportunity to openly discuss areas for further improvement. In this section, we discuss these two 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. For more detailed description for an assessment process, please refer to the next Section. Below describes the assessment process in a concise manner in order to set backgrounds for case study examples.

Assessment process

1. Initially, the SPICE Level 3 team briefed senior management and obtained their commitment to the SPICE Level 3 assessment.
2. Next, 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. Then, SPICE Level 3 team followed this with a short document review to further understand current practices within the organisation's context.
4. Later, 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. Based on the above data collection, the SPICE Level 3 team analysed and constructed detailed findings, highlighting 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.

Case study 1

Case study 1 was conducted to assess organisational process maturity with PROROAD (a pseudonym), a private limited company that was established in 1996 and has expanded rapidly to become a leading UK infrastructure support services provider. It is a subsidiary of a major international engineering, construction and services group. The company works predominantly for the Highways Agency and Local Authorities. Its central office is located in Hampshire, England, with a network of local offices and depots located in each region. PROROAD's 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. The study focused on one of PROROAD's teams in Southwest England, employed as a term contractor by the UK Highways Agency to undertake maintenance and small contract work on road and motorway infrastructure.

The scope of assessment for Case Study 1 included two site teams and 24 participants involved in the assessment. Data collection was done in three stages. The first stage of the semi-structured interviews involved eight senior and middle managerial personnel attached to A site (a pseudonym). Each interview lasted for between 45 minutes and one hour. The second phase of data collection was undertaken in a workshop setting with nine practitioners attached to A site and lasted approximately for two hours. The third phase of data collection was also in a workshop setting with seven supervisory level staff from B site (a pseudonym) and lasted around one hour and a half. The assessment revealed good practices and areas for further improvements in the company.

Examples of good practices

PROROAD 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 to PROROAD appears to be a lack of visibility within process improvement activities. Although PROROAD 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 PROROAD 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.

Case study 2

The second case study was conducted with INNOSKY (a pseudonym). It was incorporated in 1985 and one of the global airport operators. INNOSKY manages all commercial facilities at its airports including shops, catering outlets, foreign currency exchange, car hire and car parks. The company's capital investment philosophy is 'value for money'. Based on this philosophy, INNOSKY strives to revolutionise the way major construction projects are managed: building airport facilities more efficiently and at a lower cost, without compromising on safety and environment. Using their framework agreements, INNOSKY aimed to assimilate its suppliers into specialised teams, integrating all major project participants regardless of which company they are working for. By so doing, it was to facilitate transfer of knowledge from project to project.

The study focused on an integrated team at Airport A (a pseudonym). The project team tried to provide temporary and permanent solutions for separating arriving and departing passengers in accordance with the recent DTLR requirements. Corporate critical success factors identified for managing projects included, for example, minimum duplication of design, maximum efficiency of delivery, and clear accountability. The scope of assessment for this second case study was limited to a single integrated project team, which consisted of not only INNOSKY's employees but also members from Designer and Supplier organisations. Data collection for this case study was done in two stages. Five senior and middle managerial personnel from INNOSKY participated in the first phase of interviews. Each interview lasted for around one hour. The interviews were conducted in a semi-structured format based on a case study protocol devised to ask relevant questions to managerial processes to improve processes at an organisational level and factors that might impact their effectiveness. The second phase of interviews involved eight project members from Designer and Supplier organisations. The interviews were also conducted in a semi-structured format and each lasted for around 45 minutes.

Examples of good practices

INNOSKY recognised that, in order to achieve 'value for money', it was essential to adopt process approaches and revolutionary means to improve processes. The company has established its own dedicated 'PIT'. 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 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.

INNOSKY 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 used 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 INNOSKY was relatively adept at facilitating learning at a management level, the absence of clear mechanisms to capture knowledge and experience at operatives' level meant that 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. Actions resulting from learning activities were not always visible to middle/lower managerial personnel and operatives, among who some felt isolated from the improvement initiatives and felt 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 INNOSKY's 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 lack of collective 'sense making' to share contexts and goals of process improvement.

SECTION 5: GUIDELINES FOR ASSESSMENT & IMPROVEMENT PLANNING

The SPICE Assessment Scheme is an assessment and improvement method for measuring a project or organisation's process maturity. Having achieved Level 2 process maturity, a project or organisation can assess its capability to achieve Level 3 process maturity. The findings of SPICE Assessment Scheme will highlight strengths and areas for improvement in an organisation's processes, providing a basis for implementing changes. It can assist in diagnosing a project or organisation's capability towards process improvement, and subsequently prioritising and initiating improvement efforts.

The assessment and improvement process can be categorised into four broad stages:

Preparation

During this stage, organisations: (i) obtain support, (ii) define the objectives of the assessment; and (iii) plan the activities.

Assessment

This stage is for collecting data. The assessment team collects and records information about the project and organisation via questionnaires, interviews, document reviews, and any other means wherever necessary.

Findings

This stage documents and interprets the assessment findings. The assessment team presents and discusses the findings with the organisation's staff, who then propose improvement suggestions.

Improvement planning

During this stage, the managers involved in the assessment prioritise improvement efforts and develop the support structure in the organisation that will be needed to initiate improvement efforts.

The activities and typical time scales for each of the four assessment stages are summarised in Figure 9. More details on assessment and improvement planning activities can be found in the Handbook, titled 'Introduction to SPICE' (Construct IT Centre of Excellence, 2000).

	On Site	Off Site	Approximate Timescales ¹
Preparation	Secure organisational support		On-going
	Meeting to determine assessment scope		2 hours
		Develop assessment plan	2 days
Assessment	Assessment briefing and questionnaire		1 hour
		Analysis of questionnaire results	1 day
	Semi-structured interviews		60 minutes each
Findings	Document review		1-2 days
		Information analysis and prepare draft findings	2 days
	Dissemination and discussion		2-3 hours
Improvement Planning	Prioritise and assess improvements		2 hours
	Improvement planning workshop		2 hours
	Implement improvements		On-going

Figure 9. SPICE assessment process [Source: Modified from Construct IT Centre of Excellence (2000: p. 30)]

¹The approximate time scales given for each activity of the assessment and improvement process are based on experiences gained during the SPICE case studies. The figures are indicative only and actual time scales will vary depending upon the size of the project / organisation being assessed and the objectives / scope of the assessment.

SECTION 6: SUMMARY

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, with over four case studies at Level 2 (see the previous publication, 'Introduction to SPICE') and two case studies at Level 3 demonstrating the applicability and value of the SPICE approach. 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. We have highlighted several such issues pertinent to organisational level process improvement beyond individual project process improvement. Amongst others, strategy, organisation, knowledge, technology, and cultural aspects are explored based on the literature review. Taking into account of these issues, 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 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.

APPENDIX: EXTRACT FROM THE SPICE LEVEL 3 QUESTIONNAIRE

This appendix contains an extract from the SPICE Level 3 process maturity questionnaire. The questionnaire can be used as part of an assessment of a project or organisation against the SPICE framework. A cross-section of staff from the organisation completes the questionnaire, providing a balanced view on how the organisation stands in terms of process maturity. The responses highlight areas for further investigation through subsequent semi-structured interviews and document review. The following extract from the questionnaire refers to one of the Level 3 key processes, 'Process Training'.

Process Training

Process training is to ensure that the individuals and groups possess and acquire appropriate and relevant knowledge and skills to fulfil current and future processes competently. It entails identifying the gaps of individual, group and organisational competencies and addressing the identified needs successfully. This might include formal (as well as informal) training, mentoring, developing networks of people within and between similar disciplines.

		Never	Rarely	Sometimes	Usually	Always	Does not apply	Don't Know
1	Is there senior management commitment to planning and allocating appropriate resources for developing individual, group, and organisational competencies to implement processes successfully? Comments:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Are the specific needs and requirements of learning and development of personnel determined prior to delivery of formal and informal training programmes? Comments:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	Does your organisation follow a written organisational policy to meet its learning and development needs in enhancing the skills and competencies to perform individual and group roles in implementing processes? Comments:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	Are adequate resources provided to implement the organisation's learning and development programmes (funding, personnel, and appropriate training facilities, etc.)? Comments:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	Are there systems to ensure that individuals and groups understand the current and future requirements of knowledge and skills required by the project and organisation? Comments:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	Do managers and employees participate in reviewing and evaluating effectiveness and efficacy of process training programmes? Comments:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	Are the activities for managing process training programmes subjected to QA or other verification? Comments:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

GLOSSARY

<i>Ability</i>	One of the five 'process enablers' in the SPICE model. Ability to perform considers whether adequate resourcing, appropriate organisational structure, training, and means to motivate people are provided to carry out a process.
<i>Activities</i>	One of the five 'process enablers' in the SPICE model. Activities to perform considers whether plans and procedures are developed and in place for implementing a given process and whether performance is monitored.
<i>Brief & Scope of Work Management</i>	One of the SPICE Level 2 key processes. Brief & Scope of Work Management establishes a common understanding between the client and the project team, concerning the specific requirements for the construction project. This forms the basis for estimating, planning and tracking the construction project's activities. Whenever the brief is changed, the affected drawings, portions of work, programmes and activities are identified and after agreement revised to remain consistent with the updated brief.
<i>Commitment</i>	One of the five 'process enablers' in the SPICE model. Commitment to perform considers whether the organisation will ensure that the process is established and will endure.
<i>Evaluation</i>	One of the five 'process enablers' in the SPICE model. Evaluation considers whether processes are evaluated on a periodic basis.
<i>Health & Safety Management</i>	One of the SPICE Level 2 'key processes'. Health & Safety Management ensures compliance with all current health and safety legislation in relation to design, construction, and facilities management. Health and safety risks are identified, assessed and action is taken to eliminate or minimise the probability of occurrence.
<i>Key Processes</i>	Related activities that when performed collectively achieve a set of common goals considers important for establishing process maturity. The key processes are the principal building blocks of the SPICE framework that help to determine the process capability of an organisation. Each maturity level is comprised of relevant key processes.
<i>Process</i>	The means by which people, procedures, methods, equipment, and tools are integrated to produce a desired result.
<i>Process Customisation</i>	One of the SPICE Level 3 key processes. Process Customisation is concerned with sharing a common understanding of good practice processes across the organisation. It is to guide each individual and team to tailoring

organisation-wide good practice processes into more project-specific processes considering idiosyncratic project circumstances.

Process Definition

One of the SPICE Level 3 key processes. Process Definition refers to establishing and developing a well-defined set of organisation-wide good practice processes. A well-defined process includes standard descriptions and models for performing the task at hand, mechanisms to verify that the work has been done correctly (such as peer reviews) and completion criteria that provide a good insight into progress. It is to ensure that lessons learnt and good practices at a project level are continuously and periodically captured.

Process Improvement Resourcing

One of the SPICE Level 3 key processes. Process Improvement Resourcing ensures that appropriate resources, time and support are allocated to foster process improvement and organisational change. Clear goals, measures, and outcomes of improvement initiatives need to be agreed upon and communicated so that a sense of achievement can be shared throughout the organisation.

Process Training

One of the SPICE Level 3 key processes. Process Training is to accelerate an organisational transformational process via providing appropriate learning and development opportunities for all levels of employees. It ensures that gaps and needs for individual, group, and organisational competencies are met appropriately. It is to establish appropriate learning mechanisms, both informal and formal, for developing employees' capabilities to carry out processes competently.

Project Change Management

One of the SPICE Level 2 key processes. Project Change Management tracks and controls revisions to the project by ensuring the traceability of all changes made, assessing, and controlling the impact of any changes (e.g. assessing impact on programme, cost, and the effect on other activities) and informing all relevant members of the project team regarding the changes.

Process Enablers

Five preconditions that each key process is tested against to assess whether a project or organisation has capabilities to implement processes competently.

Project Tracking & Monitoring

One of the SPICE Level 2 key processes. Project Tracking & Monitoring ensures that there is an awareness of actual progress so that management can take corrective actions when the project's performance deviates significantly from the plans.

Project Planning

One of the SPICE Level 2 key processes. Project Planning establishes realistic plans and programmes of work for all activities during the project. These plans are in accordance with the requirements outlined in the project brief. Project planning

involves developing estimates for the work to be performed. (e.g., budgets, programmes, procurement, safety resourcing etc.).

Project Team Co-ordination

One of the SPICE Level 2 key processes. Project Team Co-ordination draws on the experience of the other organisations and disciplines in order to effectively meet project requirements. Those processes that would benefit from the involvement of other disciplines are identified in time for effective collaboration. Representatives from those organisations and disciplines are nominated, and agendas and schedules of collaboration agreed.

Risk Management

One of the SPICE Level 2 key processes. Risk Management identifies, assesses, monitors and mitigates risks. The objective is to eliminate the risk, lower the probability of the risk occurring, or limit the extent of the resulting damage.

Subcontract Management

One of the SPICE Level 2 key processes. Subcontract Management involves selecting a suitable subcontractor, establishing commitments, and tracking and reviewing their performance and results.

Verification

One of the five 'process enablers' in the SPICE model. Verifying implementation considers whether compliance with procedure is determined.

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