APM /INCOSEUK Systems Thinking SIG

Systems Thinking for Portfolio, Programme and Project Managers

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1. Who Is This Guidance For?

This white paper provides an introduction to systems thinking, its approach and methods. It considers its application to portfolio, programme and project management, the potential benefits realisable and key aspects for its application. It is intended for portfolio, programme, and project managers, change managers, business managers and sponsors who define, operate and transition programmes and projects in their organisations.

2. Why Is Systems Thinking Important?

System thinking provides a framework to address complex, uncertain and/or inter-connected problems which do not have simple solutions. Its application can improve portfolio, programme and project success rates and reduce delays and budget over-runs. In summary, systems thinking:

- Enables users to understand both what is going on to create a problem, its environment and why the system behaves as it does. Dynamic complexity and emergent behaviour are easier to understand when component relationships and cause and effect cycles are made visible, including the human aspects. This helps develop a clear understanding of what the problem is and why it is a problem.
- Enables effective solutions to be defined and implementation strategies established, together with clear objectives for their realisation. By revealing assumptions and making them explicit, risks can also be more comprehensively identified, assessed and managed.
- Enables understanding of how the proposed solution fits into the broader environment so that any unintended consequences can be addressed before implementation.
- Facilitates contribution and buy-in from stakeholders to identify the problem and the proposed solution(s), as a working understanding of systems thinking can be taught relatively quickly. For example:
  - drawing causal loop diagrams helps teams develop a shared understanding of the problem and their place in it (and possible contribution to it), without apportioning blame;
  - for broader audiences, the diagrams used by the systems thinking approach can be very effective for communicating both problems and proposed solutions.
- Enables complex dynamic problems, characterised by non-linearity and component interdependencies to be addressed. The traditional top-down 'divide-and-conquer' approach is often unsuccessful for these types of problem as it is neither clear where the 'top' is nor how the problem should be 'divided'. Systems thinking enables these types of problem to be addressed holistically to identify the key leverage points.

Application of systems thinking has proved beneficial.

- In the private sector, applying systems thinking enabled an organisation to lower their costs from the highest in their industry and increase revenues by assessing its product lines and streamlining supply chain costs[Ref a]. Systems thinking also enabled a 30,000 person software company to improve its new product launch success by moving from a culture of 'who is to blame for this' to one of 'how are we all contributing to the problem' [Ref b].
- In the public sector, applying systems thinking enabled three local councils to reduce average end-to-end service delivery times by more than half while reducing costs by at least ten percent and delivering better services [Ref c]. In addition, tangible knock-on benefits were provided to related public sector departments.

3. What Is Systems Thinking?

Systems thinking recognises that the world is made up of interconnected, often hierarchically organised, technical and social entities, which produce behaviours that cannot be predicted by analysing the behaviours of their parts or sums. Two definitions of systems thinking are useful: the first defines its purpose and the second defines it operationally:

- *'Systems thinking is a discipline for seeing wholes rather than parts, for seeing patterns of change rather than static snapshots, and for understanding the subtle inter-connectedness that gives … systems their unique character'* [Ref d].
- Systems thinking uses approaches, tools and methods to help explore and map dynamic complexity:
  - *Approaches* to think about and frame dynamically complex problems and their solutions.
  - *Diagrams and other tools* to visualise and understand dynamic complexity.
  - A *vocabulary* with which to express understanding of dynamic complexity.
  - *Method(s)* to coherently apply the approaches and tools.

Application of systems thinking requires a conceptual move from considering the individual components that make up a system to considering the structure of the system, its interconnections and the interactions between its components and its environment. Systems thinking does not replace traditional top-down thinking, but can complement it to enable problems that are intractable using a top-down approach to be addressed successfully.

Traditional and Systems Thinking Approaches

Traditionally, solutions are defined and developed using the approach of top-down functional decomposition where the primary purpose/function of the solution is defined and agreed, with all further definition flowing from this. Decomposition continues until buildable components are identified. These components are then built and integrated at increasing levels until the whole solution is obtained. This approach works well for problems with a single agreed cause or where there is no pre-existing solution that the new solution must operate within.

However, there is an increasing need to address problems where there is no agreement on the boundary for the solution, or where the dynamic complexity of the environment within which the solution will operate must be taken into account. The holistic approach provided by systems thinking is needed. The key is to fully consider issues and their contexts by applying the principles below.

- **Understand the bigger picture** by identifying the patterns and trends generated as system inputs, outputs and the environment change over time. Analyse external events together with the internal responses to these events. This enables the problem to be framed in terms of patterns of behaviour over time rather than focusing on particular events.
- **Recognise that a system's structure generates its behaviour:** appreciate that the context of relationships must be understood and identify the (often circular) cause and effect relationships rather than focusing on details to understand something. Appreciate that the internal actors managing policies and system operation are responsible for system behaviour rather than assuming that a system's behaviour is driven by external forces.
- **Make assumptions explicit and test them:** recognise that all models are working hypotheses with limited applicability rather than seeking to prove models[1] by validating them with existing data or perfect new measured data. While things cannot always be measured, they can always be quantified.
- **Change perspective to increase understanding:** regard causality as both uncertain and on-going, with feedback influencing causes, and causes driving each other rather than viewing causality as running only one way, with causes being independent.
- **Appreciate that mental models define current reality and expected futures:** Mental models are the framework of beliefs, assumptions and attitudes used to interpret situations and are often regarded as the 'truth'. Appreciate that mental models are perceptions and are often flawed or incomplete, and that making decisions based on an incorrect mental model is likely to generate unwelcome consequences.

1 Noting the quote from statistician George Box: "All models are wrong, but some are useful."

Systems Thinking Tools

Systems thinking uses various diagrammatic and visualisation tools to support the approaches described above. Development of the diagrams should involve individuals working in the part(s) of the organisation(s) covered, with these individuals either being part of the project team or through workshops. Joint development of the diagrams facilitates the processes. Frequently used diagram types are described below. It is not an exhaustive list and where others provide insight, they should be used. Examples are given at the end of the paper.

- **Fishbone diagrams**: variation of the standard fishbone/Ishikawa diagram to structure thoughts and distinguish hard (at the top of the diagram) and soft (at the bottom of the diagram) variables that affect the problem of interest. An example is given in Figure 3.
- **Context diagrams**: enables definition of the system in its environment. Checklists (e.g. PESTLE: political, economic, social, technological, legal, environment) can be used to identify the influence of relevant factors and captured to come to a shared understanding of the problem. An example is given in Figure 4. A variation is the Rich Picture, defined as part of Soft Systems Methodology (SSM) [Ref e].
- **Actor maps**: depict the key organisations and roles that make them up and are affected by the system (many, if not all, of whom are likely to be stakeholders in the solution). An example is given in Figure 5. An extension is the policy structure diagram, which focuses on how an organisation weights factors at various decision points (and the roles in the organisation that define these weights).
- **Concept maps**: represent knowledge concepts of a topic, starting with the main concept and breaking this down to show its sub-topics. The relationships between these are articulated on the links (e.g. 'causes', 'contributes to'). An example is given in Figure 6.
- **Trend maps:** depict the trends influencing the system. Trend maps should be developed using the knowledge of people familiar with the system and its context. A trend map over time is useful to visualise important activities, changes and other events to identify contextual factors (e.g. social, economic, and political). An example is given in Figure 7. A variation on the trend map is the cumulative sum (CUSUM) chart from the total quality management (TQM) world that can be used to monitor a process based on averaging samples at a given time.
- **Causal loop diagrams:** represent the causal relationships between system elements and identify reinforcing and balancing processes (positive and negative feedback). An example is given in Figure 8. In addition, common situations are addressed by the 'system archetype' causal loop diagrams (see [Ref d] for details).

Systems Thinking Method

The application of systems thinking comprises the three main generic steps described below (note: these are derived in combination from the Soft Systems Methodology [Ref e] and The Fifth Discipline [Ref f] methods).

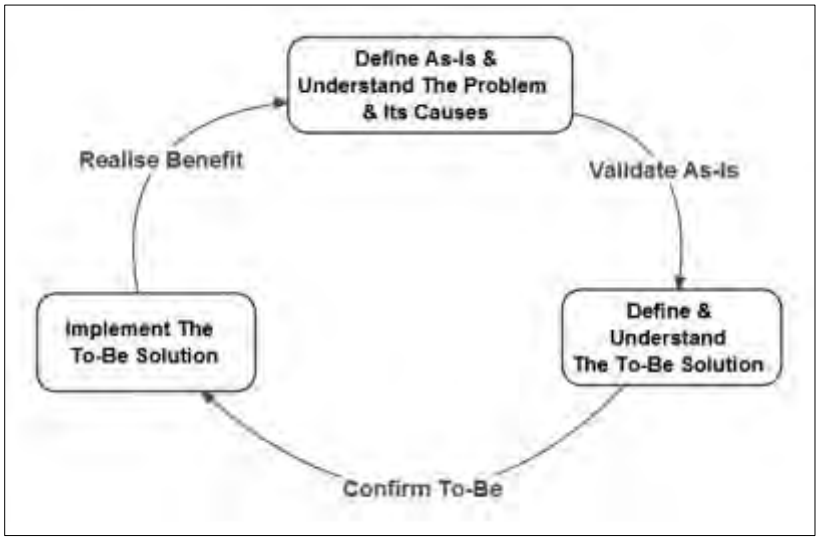

Figure 1: Generic Systems Thinking Process

Application of systems thinking typically comprises the steps below. The main diagram tools listed are an initial suggestion based on the systems thinking tools described above. As stated previously, other tools should be used where they can provide insight into the situation or problem.

1. **Define the As-Is to understand the problem and its causes.**
   - Main activities:
     - Describe and understand the bigger picture and define the system boundary.
     - Identify and describe cause and effect relationships between system elements and the environment.
     - Make assumptions explicit and test these assumptions.
     - Develop a conceptual model of the problem and test this on the causes of the problem.
     - Resist the urge to come to quick conclusions: consider issues fully.
     - Change perspectives to increase understanding.
     - Iterate as necessary.
   - Thinking:
     - Identify, describe and understand patterns of behaviour over time.
     - Identify and consider the actors (internal and external) responsible for behaviours and together with the policy environment(s) that they operate in.
     - Understand the context(s) of behaviours, actors, policies and relationships identified.
   - Core Tools: fishbone diagrams, context diagrams, actor maps, trend maps, causal loop diagrams, checklists (e.g. PESTLE or SSM CATWOE: customers, actors, transformation process, worldview, owners, environmental constraints).
2. **Define and understand the To-Be to re-design the system to resolve the problem(s) addressed.**
   - Main activities:
     - Construct and test hypotheses for solutions to the problem.
     - Define the To-Be that addresses the problem. (This may suggest whether a portfolio, programme or project is required. The formal definition of this is done under the next step).
     - Develop the conceptual model of the new system.
     - Make assumptions explicit and test these assumptions.
     - Resist the urge to come to quick conclusions: consider issues fully.
     - Change perspectives to increase understanding.
     - Iterate as necessary.
   - Thinking:
     - Identify, describe and understand causality and understand how behaviour(s) are generated.
     - Identify and describe the feedback (reinforcing and balancing) that influences causes and causes that affect each other.
     - Consider how suitable data to enable measurement can be gathered, although it may not be quantified.
   - Core tools: context diagrams, concept maps, actor maps, trend maps, causal loop diagrams.
3. **Implement the To-Be Solution.**
   - Main activities:
     - Compare the As-Is and To-Be conceptual models to define the changes required.
     - Define the changes (are both desirable and feasible) that will be implemented by the portfolio, programme or project that will be established to implement the solution.
     - Define the portfolio, programme or project to implement the changes (this includes development of appropriate documentation as required by the organisation: e.g. Blueprint, Project Definition).
     - Implement the changes by implementing the portfolio, programme or project.
     - Communicate the changes being implemented.
     - Transition the solution into operation.
   - Thinking: Recognise that all models are working hypotheses with limited applicability.
   - Core Tools: fishbone diagrams, context diagrams, concept maps, actor maps, trend maps, causal loop diagrams. Portfolio, programme and project documentation associated with the organisation(s) involved.

4. How Can Systems Thinking Help Portfolio, Programme and Project Management?

Systems thinking can help portfolios, programmes and projects as described below.

High Level Application

Application of systems thinking at a high level enables all involved to pull back from specific details and understand the bigger picture that the portfolio, programme or project is intended to address. In summary, application of systems thinking helps portfolios, programme or projects to:

- Address complex problems that traditional top-down decomposition is not well suited to tackle:
  - Systems thinking enables development of an holistic view of the problem and its context to understand how the constituent parts fit together and interact.
  - Systems thinking enables identification of decomposable, near-decomposable and dependent elements and leverage points to better inform scoping of the portfolio, programme or project.
- Enable identification and definition of the right portfolio, programme and/or project:
  - The holistic understanding of the problem and its context given by systems thinking enables the full problem scope and the associated portfolio, programme or project to be defined and documented. This enables a clearer business case to be developed and increases credibility to management.
  - The greater stakeholder engagement that system thinking facilitates, both before and during the life of the portfolio, programme or project, leads to a better shared understanding of the problem, the real requirements and the right solution. It also helps increase commitment from stakeholders.
- Support doing the portfolio, programme and/or project right:
  - Better planning and reporting of multi-disciplinary work anticipates problems and copes with complexity, leading to more accurate statements of the portfolio, programme or project status.
  - Improved risk management by enabling more comprehensive risk planning and mitigation activities, resulting in improved confidence in the forecast final schedule and cost.
  - Improved portfolio/programme/project governance by better identification of stakeholders and their viewpoints. This enables their roles and responsibilities to be better identified in the context of the problem and its proposed solution.
  - Improved benefits management as a result of better structured project outputs, programme outcomes and maintaining an appropriate governance structure as the programme/project proceeds.
- Maximise portfolio/programme/project outcomes and outputs and minimise unintended consequences:
  - The holistic view provided by systems thinking helps to better identify, mitigate or avoid any unintended consequences of solutions proposed.
  - Systems thinking facilitates alignment of the interests and participation of diverse teams, specialisms and interest groups to ensure that of all activities are covered, with no missed requirements or features. This enables a more successful solution development, transition, acceptance and handover.

Application To Portfolio, Programme and Project Management Processes

Application of systems thinking at management process level can improve the management of portfolios, programmes and projects. Potential application of systems thinking to these management processes are:

- Portfolio, programme or project approach and life cycle definition: As-Is and To-Be systems thinking activities and analysis informs the selection of the project life-cycle (e.g. Waterfall, Agile, Staged, Phased), and the definition of the organisation required to manage the portfolio/programme/project.
- Phase/stage/sprint scope and requirements: the analysis and life cycle selection helps define coherent phase/stage/sprint requirements. The context diagrams, concept maps, actor maps and causal loop diagrams developed during the As-Is and To-Be activities are useful.
- Risk management: systems thinking identifies interconnections between portfolio, programme and project components, stakeholders, the environment and other risks. Concept maps, actor maps and causal loop diagrams from the As-Is and To-Be activities are useful (including the assumptions made explicit).
- Governance: the better understanding systems thinking provides of the impact of the solution on existing elements helps identify the governance approach and participation that should be used. The context diagrams, concept maps and actor maps developed during the As-Is and To-Be activities are useful.

- Stakeholder management: systems thinking helps identify the stakeholders (and the nature of their stakes) that impact on and will be impacted by the solution implementation. Fishbone diagrams, context diagrams, concept maps and actor maps developed during the As-Is and To-Be activities are useful.
- Dependency management: identification of dependencies is inherent in the systems thinking approach. However, they need to be applied across the portfolio, programme or project to give full benefit. The context diagrams and causal loop diagrams developed during To-Be definition are useful.
- Transition approach: The analysis undertaken during the As-Is and To-Be activities informs definition of the transition approach; not least because the people who will receive the outcomes or outputs from the programme or project should have been represented during these stages.
- Organisational learning: assessment of what went well and what needs improving (and why) in both undertaking and managing portfolio, programme or project activities. Applied correctly, this can improve organisational capability and productivity significantly by continuously reinforcing the good and improving the not so good. This was one of the initial drivers for the development of the systems thinking principles.

Benefits of Portfolio, Programme and Project Level Application

Application of systems thinking to improve portfolio, programme and project management consists of application of the topics described above. However, here are specific areas where systems thinking can give benefit:

- The *APM Body of Knowledge* [Ref f] definition of portfolio management is *'Portfolio management is the selection, prioritisation and control of an* organisation's *projects and programmes in line with its strategic objectives and capacity to deliver. The goal is to balance change initiatives and business-as-usual while optimising return on investment*'. Portfolio level application of systems thinking helps:
  - Ensure that the portfolio strategy and the programmes and projects that make up the portfolio are aligned with the organisational situations and problems that the portfolio is intended to address, and remain aligned following portfolio progress, events and changes in the environment.
  - Define, document and communicate the relationships between portfolio programmes and projects.
  - Identify, document and communicate dependencies between programmes and projects in the portfolio that support or potentially hinder each other, and should be identified as risks/opportunities.
  - Coherently plan the transition of outputs from portfolio programmes and projects to stakeholders.
  - Assess the impact of changes to programmes or projects on the portfolio as a whole and its objectives.
  - Assess the impact of potential new programmes or projects on the portfolio and its objectives.
  - Identify and prioritise further objectives that the portfolio should address, but currently does not.
  - Provide a coherent basis against which to periodically review portfolio strategy and objectives. This is particularly important for organisations that operate in changing environments.
- The *APM Body of Knowledge* definition of programme management is *'Programme management is the coordinated management of projects and change management activities to achieve beneficial change*'. Programme level application of systems thinking helps:
  - Develop and maintain a coherent understanding of the benefits that are to be achieved by programme outcomes and their realisation that is resilient to changes in the environment.
  - Define, document and communicate the scope of the programme and its dependencies, including the potential impacts of the complexities in the environment within which the programme will operate.
  - Identify, document and communicate dependencies between projects that support or potentially hinder each other within the programme and identify these as risks/opportunities.
  - Assess and plan for the impact(s) on stakeholders from the programme; both during the programme and when programme outcomes are delivered. This is particularly important if there is significant organisational change associated with the programme as systems thinking can support successful realisation of this change.
  - Assist in the development of effective communication mechanisms and communication content to stakeholders based in the better understanding of their differing perspectives given by systems thinking.
  - Assess the impact of potential new projects on the programme.

- The *APM Body of Knowledge* definition of project management is *'Project management is the application of processes, methods, knowledge, skills and experience to achieve the project objectives*'. Project level application of systems thinking helps:
  - Define project scope by clarifying objectives and the project approach should stakeholders have different views on what the objectives of the project should be or the approach the project should take.
  - Assess and plan for the impact(s) on stakeholders from the project; both during the project and when project outputs are delivered. This is particularly relevant where there is a significant organisational change aspect associated to achieving the objective(s) of the project.
  - Assess and diagnose 'failing' projects to identify how they went wrong. Typical causes are:
    - Insufficient commitment from project sponsors.
    - Cultural issues.
    - Unclear scope and/or requirements.
    - Poor planning, lack of formal project management processes or inexperienced team members.
    - Unclear roles of team members including that of the project manager.
    - Inadequate communication.

5. What are the Key Aspects For Successful Application Of Systems Thinking?

Key aspects for successful application of systems thinking are:

- Moving from thinking in terms of cause and effect for individual causes to considering the interactions between system elements and their environment. This often requires broadening the definition of the system to include the people and policies that operate on, and are impacted by, the system. For example, an organisation may consider profitability as dependent on a number of elements independently (e.g. product quality, leadership competitors), when in fact, each is both driven by and impacts the others.
- Appreciating that dynamically complex problems cannot be understood from a single perspective and different viewpoints and contexts are necessary to properly understand them. Clearly, if a problem is not properly or fully understood, it unlikely that an effective solution will be identified and implemented.
- Appreciating that the Events seen as outputs from systems are the 'tip of an iceberg' of a deeper structure. The systems thinking 'Iceberg' is given in Figure 2 [Ref d].

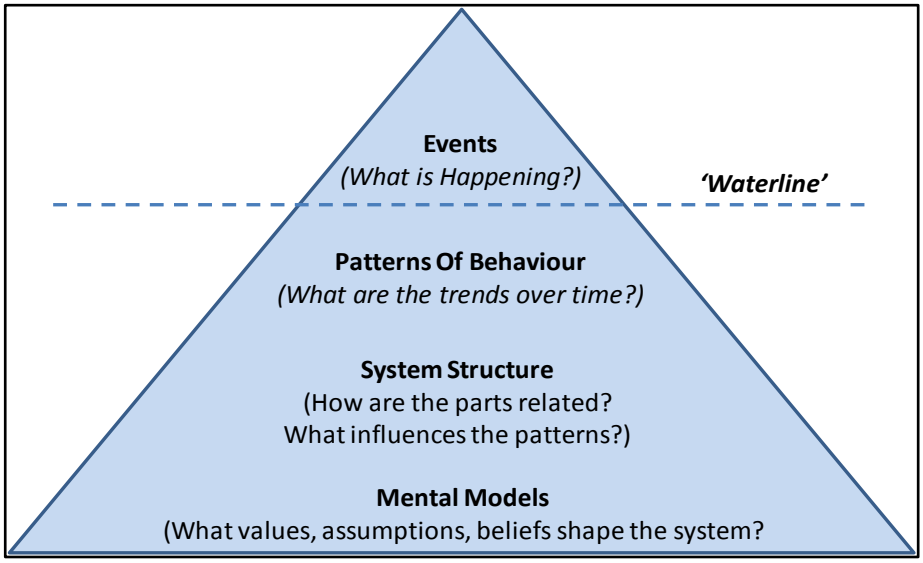

Figure 2: Systems Thinking 'Iceberg'

  - **Events:** the Events level is the level at which we experience the world and experience the symptoms of problems. While some problems observed as events can be addressed directly, not all problems can be solved by treating the symptom(s) and a deeper analysis is needed.
  - **Patterns of behaviour:** looking below the Events level often identifies patterns of behaviour. This enables Events to be forecast and hypotheses for their causes developed and tested.

- **System Structure:** consideration of System Structure (including the broader environment within which the system operates) identifies the causes of the pattern(s) observed.
- **Mental Models:** (sub-conscious) mental models are the attitudes, values and beliefs that cause structures to function as they do. As Senge [Ref d] points out "*The deepest insight comes when they realise that their problems and their hopes for improvement are inextricably tied to how they think.*"

- Thinking should focus on what is required for an *effective* solution as opposed to an *efficient* solution for both the solution to the problem and the management of its development. Clearly, efficiency is important, but consideration of its effectiveness should come first. Consideration of effectiveness should be in terms of the recipients of the outputs from the system.
- Apply the systems thinking principles:
  - Resist the urge to come to quick conclusions and consider issues fully.
  - Understand the bigger picture.
  - Identify the inter-dependent/circular nature of complex cause and effect relationships.
  - Observe how elements change over time, generating patterns and trends.
  - Change perspectives to increase understanding.
  - Consider how mental models affect the current view of reality and the expected future(s).
  - Recognise that a system's structure generates its behaviour.
  - Make assumptions explicit and test them.
- Systems thinking complements other skills staff have rather than being a discipline in its own right. Realising a systems thinking capability in an organisation cannot be bought-in from outside, but must be developed by staff at all levels. As a manager in the systems thinking applications described in [Ref g] "*Systems thinking is only truly learned by doing, by action learning: it is only by doing that managers can unlearn, can find out for themselves where their current beliefs about the design and management of work are flawed, in order to put into place something that works systematically better, and can systemically be further improved.*" A typical approach to develop systems thinking capability uses the following steps:
  - As with all major organisational change activities, senior management support is vital.
  - Mobilise a small team of staff who collectively undertake the end-to-end activities to which systems thinking is to be applied. This team should be lead by a manager who believes systems thinking can give significant benefit, but may not be a systems thinking practitioner. The team will diagnose the problem and design and implement the changes identified by the systems thinking application. The members of this team need to be freed-up from their day-to-day responsibilities and given the scope and time to experiment with different approaches.
  - Teach the team the principles and practice of systems thinking. A working knowledge can be taught relatively quickly and be provided by an external consultant if necessary. This consultant should be available for a further period of time to provide systems thinking guidance and support as requested by the team. Using the team to collectively understand the problem and jointly develop the solution enables broad participation to improve the As-Is and To-Be analysis, improve job satisfaction for the people involved and gain their buy-in to the need for change and to the solution developed.
  - The team should establish a set of principles to drive solution definition development. These principles should relate to what an effective solution looks like for the 'customer' of the solution rather than simply an efficient one for the organisation using or providing this solution. Facilitation and advice from an external consultant can be useful for this.
  - Develop and implement the solution. Although this may be undertaken by others, the team should be available to clarify and resolve any issues with the interpretation or implementation of the solution.
  - Transition the solution into operation. This gives the organisation an initial systems thinking capability.
  - To expand the systems thinking, a 'roll-in' approach can be used whereby the initial team rolls-in further staff into the application of systems thinking as they apply it elsewhere in the organisation.

6. Conclusion

System thinking provides a framework to address problems that cannot be easily tackled using a traditional top-down decomposition approach. These problems are usually complex, interconnected and/or uncertain.

Systems thinking addresses complex problems by providing a framework for seeing wholes, comprising

- approaches to think about and frame dynamically complex problems;
- diagramming, visualisation and other tools to explore, map and understand dynamic complexity;
- method(s) to coherently apply the approaches and tools.

Systems thinking can be applied at portfolio, programme or project levels, across the whole life cycle to

- identify and understand the correct problem to be addressed;
- establish the correct solution and implementation strategy that minimises unintended consequences;
- guide the operation and organisational learning of the delivery organisation as it changes over the life cycle.
- improve buy-in from stakeholders during problem definition and solution implementation.

The key aspects for successful application of Systems Thinking are to

- move from a view of the world that considers only causes and effects between components to consider systems in terms of their elements, structures, environment and the interactions between these;
- appreciate that complex problems cannot be understood from a single perspective and context and different viewpoints and contexts are necessary to properly understand the problem;
- apply systems thinking principles without jumping to quick conclusions: understand the bigger picture, recognise that a system's structure generates its behaviour, make assumptions explicit and test them and change perspective to increase understanding;
- recognise that a working knowledge of systems thinking can be taught quickly to enable broad participation from people across organisations;
- recognise that systems thinking is only truly learned and an organisational capability established by doing.

The main benefits from applying systems thinking are

- solutions to complex problems that traditional top-down decomposition is not well suited to tackle;
- identification of the right portfolio, programme or project to address the problem;
- support to doing the portfolio, programme or project right;
- maximised portfolio, programme and project outcomes, including better identification, avoidance or mitigation of unintended consequences;
- reduced portfolio, programme and project delays and cost over-runs;
- improved organisational learning for current and future projects.

References

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[e] Checkland, P. (1981). *Systems thinking, systems practice*. Chichester, NY: Wiley.

[f] APM (2012), *APM Body Of Knowledge Sixth Edition*, APM.

[g] Seddon J and Caulkin S 2007 *Systems thinking, lean production and action learning* in Action Learning Research and Practice Vol 4 No.1 April 2007, special issue: 'Lean Thinking and Action Learning.'

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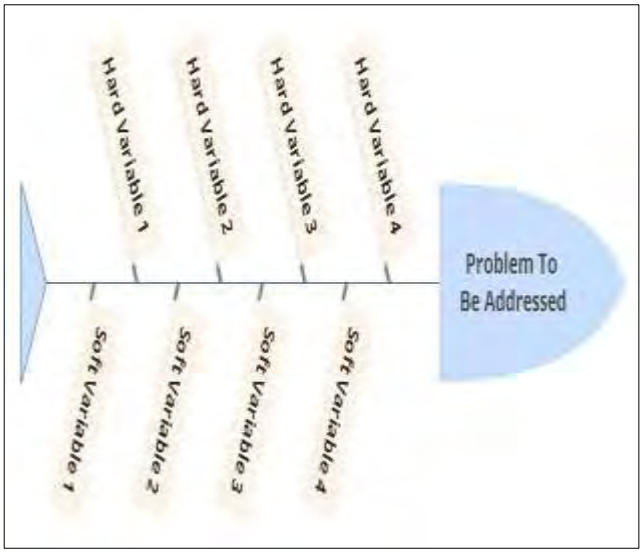

Figure 3: Example Fishbone Diagram

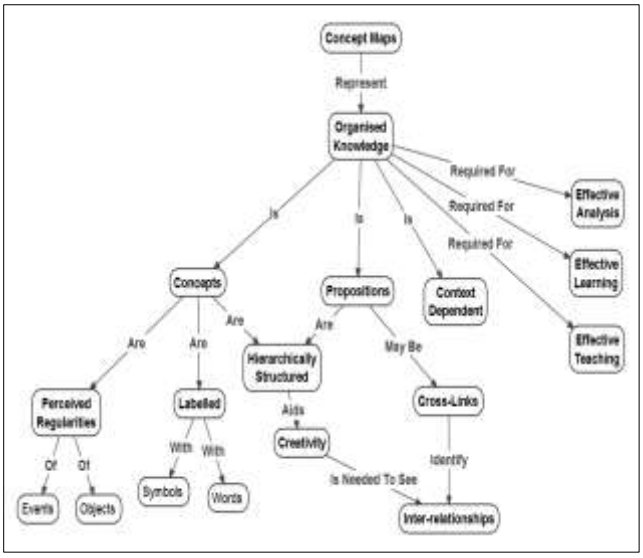

Figure 6: Example Concept Map

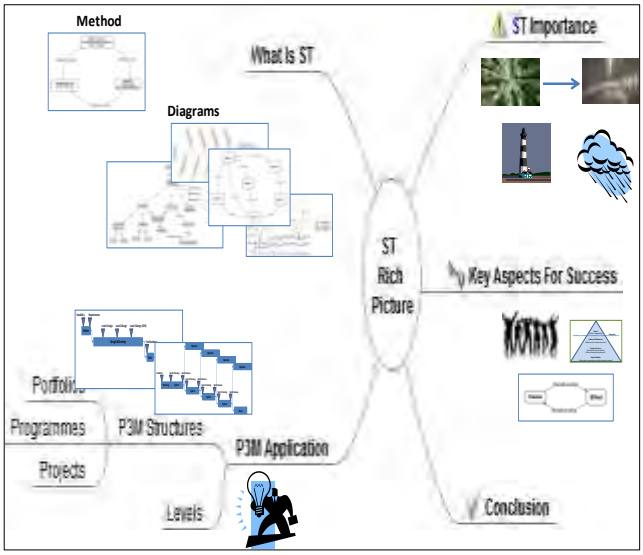

Figure 4: Example Context Diagram

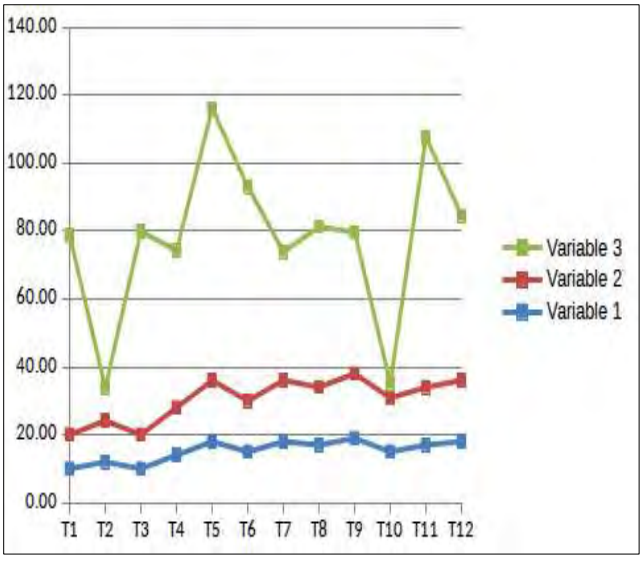

Figure 7: Example Trend Map

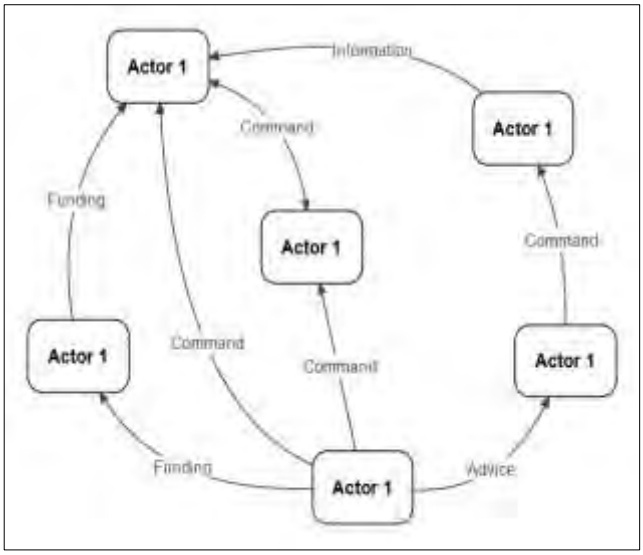

Figure 5: Example Actor Map

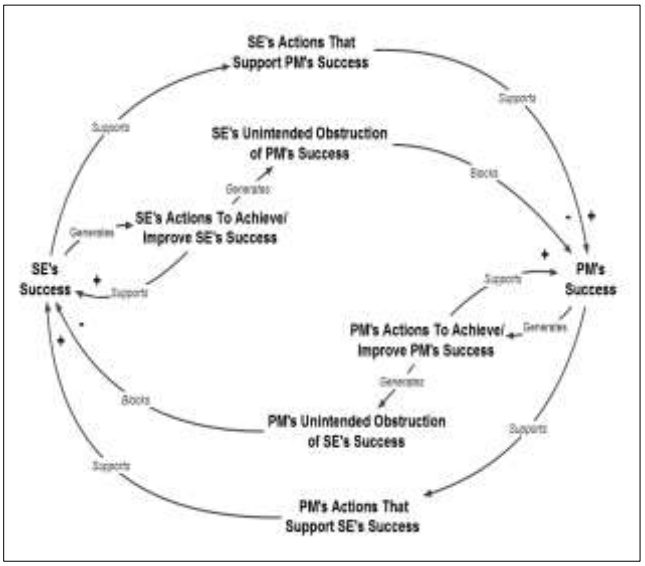

Figure 8: Example Causal Loop Diagram