Competencies for governance of complex systems of systems

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Abstract: Systems of Systems (SoS) require organisational components to have staff with abilities appropriate to the challenges within SoS. Large organisations frequently use competency models as a tool to ensure that their staff have the proper skills to deal with these challenges. Competency models have been used for 40 years to select, train, promote or separate employees. While competency models represent an improvement on their primary predecessor, intelligence tests, weaknesses have been noted in the literature and challenges have been made to improve them. Most improvement efforts have been evolutionary adjustments or insertion of more elements. This research presents a completely new way to create, assess or transform a competency model. This framework can be used to design, assess or transform an existing competency model. This paper represents a significant expansion of a conference paper presented at SOSE 2014 in Adelaide, South Australia in June 2014.

Keywords: system theory; competency model; framework; system of systems; system governance.


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1 Introduction

1.1 Background

Competency models were introduced to improve the tools available for organisation to select, train, promote or separate their workforce. Competency models replaced intelligence tests as the arbiter of a person’s future with the organisation. Two primary methods of developing competency models have been developed. The earliest is the exemplar-highly successful model. In this model, an exemplar for a particular work group is identified, as well as a selection of fully successful members of the same skill set. The core components of the knowledge, skills and abilities of the fully successful and exemplar are identified and used to develop a two level competency model. The second primary method uses a Delphi panel or similar selection of designated experts who are polled on the key characteristics of the position leading to success. Successive rounds of polling and filtering produces a set of knowledge, skills and abilities for a particular job
classification or group. Each primary technique has evolved a variety of variations primarily driven by balancing the cost to benefit and or the perspective of the competency model. Perspective is used to designate the differences between models focused on inputs, outputs or outcomes. In an inputs model, the focus is on identifying the ability of a person to perform a specific individual task or skill. An outputs model focuses on assuring that the person can actually produce or use the particular skill. An outcome model focuses on the business impact of the person’s use of the skill or ability. This later focus grew out of the core competency thinking of Prahalad and Hamel where an organisation is said to have a competency, reflecting the presence of people who can accomplish actions to achieve the desired outcomes.

Both major competency creation methods and their derivatives have been the subject of critique and the literature is filled with challenges to the competency community to improve the models. Parry chose to focus on the lack of leadership oriented elements in competency models, leading to a number of revisions to models to include more factors dealing with leadership. Rothwell and Lindholm issues a broader challenge, aimed at the epistemology of competency models. However, most authors citing Rothwell and Lindholm as a spur to their research chose to extend or modify existing elements of the two major competency model systems. None appear to have re-thought the very underpinning of competency models. This research sought to develop competency models from a new basis, while answering the challenge of Rothwell and Lindholm (1999) to be less backward looking. This research used grounded theory with William Whewell’s discoverer’s induction (1840) to develop a competency model framework from systems theory literature.

1.2 Systems theory

Systems theory has been proposed as unified group of specific propositions which are brought together to aid in understanding systems, thereby invoking improved explanatory power and interpretation with major implications for systems practitioners (Adams et al., 2014). It is exactly this group of propositions that enables thinking and action with respect to systems. The absence of any one specialised field of endeavour titled systems from which systems theory may be derived drives the selection of propositions available for inclusion into a theory of systems come to from a variety of disciplines, thereby making its underlying theoretical basis inherently transdisciplinary. The axiomatic method (Audi, 1999) was used to organise the propositions into seven axioms as follows:

1  The centrality axiom states that central to all systems are two pairs of propositions; emergence and hierarchy and communication and control. The centrality axiom’s propositions describe the system by focusing on
   a  a system’s hierarchy and its demarcation of levels based on emergence
   b  systems control which requires feedback of operational properties through communication of information.

2  The contextual axiom states that system meaning is informed by the circumstances and factors that surround the system. The contextual axiom’s propositions are those which bound the system by providing guidance that enable an investigator to understand the set of external circumstances or factors that enable or constrain a particular system.
3 The goal axiom states that systems achieve specific goals through purposeful behaviour using pathways and means. The goal axiom’s propositions address the pathways and means for implementing systems that are capable of achieving a specific purpose.

4 The operational axiom states that systems must be addressed in situ, where the system is exhibiting purposeful behaviour. The operational axiom’s propositions provide guidance to those that must address the system in situ, where the system is functioning to produce behaviour and performance.

5 The viability axiom states that key parameters in a system must be controlled to ensure continued existence. The viability axiom addresses how to design a system so that changes in the operational environment may be detected and affected to ensure continued existence.

6 The design axiom states that system design is a purposeful imbalance of resources and relationships. Resources and relationships are never in balance because there are never sufficient resources to satisfy all of the relationships in a systems design. The design axiom provides guidance on how a system is planned, instantiated and evolved in a purposive manner.

7 The information axiom states that systems create, possess, transfer and modify information. The information axiom provides understanding of how information affects systems (Adams et al., 2014).

Subordinated to each of the axioms are two to seven propositions that serve to expand the meaning of the axiom. The propositions are not presented to preserve space.

The next section of the paper will review the extant literature related to the development and evolution of competency models. It will introduce systems thinking and research in systems thinking that has implications for improving the key knowledge, skills and abilities of those dealing with systems of systems.

2 Literature review

Many large organisations in government and industry rely on competency models as the basis for the selection, assignment, training, promotion and separation of their personnel. Competency models arose more than 40 years ago in response to the then prevalent use of intelligence tests as the arbiters of personnel decisions. This section reviews their origins, evolution, identification of weaknesses and a potential source for creating them in a totally new method.

2.1 Genesis of competency models and core competencies

Competency models began with a simple set of questions. Those questions led to a chain of inquiry, exploration and development that puts us at today’s state of competency models. The questions that were asked are:

Why should intelligence or aptitude tests have all this power? What justifies the use of such tests in selecting applicants for college entrance or jobs? On what assumptions is the success of the movement based? They deserve careful examination before we go on
rather blindly promoting the use of tests as instruments of power over the lives of many Americans (McClelland, 1973).

With these simple questions and an axiological assertion of improving the lives of many Americans, McClelland launched the concept of competency as the measure to make crucial decisions like hiring and promotion. His recommendation was simple “the best testing is criterion sampling” (McClellan, 1973). He later addressed the difficulty of competence testing, relating it to the experience of intelligence testing. Criterion sampling, in short, involves both theory and practice. It requires real sophistication. Early intelligence testers knew how to do it better than later testers because they had not become so caught up in the ingrown world of ‘intelligence’ tests that simply were validated against each other (McClelland, 1973).

An early effort by McClelland to develop a competency model was with the US Navy. This effort was within the context of improving race relations during the turbulence of the 1970s. McClelland developed a model with eight competencies that would help the Navy improve its race relations. Importantly, McClelland pointed out to the Navy that there were insufficient people with those competencies, but that the competencies were teachable, which he set out to do (Oravis, 1982).

By the early 1980s, the method first developed by McClelland was well established and being replicated on larger scales. McLagan and Bedrick conducted a large scale competency model development for the American Society of Training and Development (ASTD). The study reviewed past research for lists of knowledge, skills, abilities, tasks and outputs that were then rationally clustered into competency areas. Role experts edited, added and deleted competencies, then rated the criticality and level of expertise required of each competency for their assigned roles (McLagan and Bedrick, 1983).

The implications for the long-term strategic advantages implied by a well-developed and executed competency strategy were soon being explored. Lado and Wilson examined both sides of the coin – firms that appeared to execute competency management well and those that appeared to be inhibited by poor competency management (Lado and Wilson, 1994).

The methodology developed by McClelland and described by McLagan and Bedrick was developed as a pragmatic approach, but only weakly connected to an underlying theoretical foundation. Boyatzis and Kolb describe a similar approach, but one specifically tied to experiential learning theory (Boyatzis and Kolb, 1995). While “many of the findings were consistent with the underlying framework, not all of them were…” (Ragothaman et al., 2007).

Concurrent with the development of the perspective of competence as a characteristic of the individual that needed to be identified, trained and used as a basis for promotion, Prahalad and Hamel were espousing the idea of core competencies, that is, organisational strengths that can be leveraged to provide lasting competitive advantage (Prahalad and Hamel, 1990). Prahalad summarised his idea as: “core competency results when firms learn to harmonize multiple technologies” (Prahalad, 1993). Discussing potential confusion with capabilities, he notes that capabilities are required for the organisation to remain in business, but do not confer an advantage against other firms.

### 2.2 Criticism of competency models

Within a short period time, the connection between individuals’ competencies and the core competencies required for strategic advantage elevated the importance of
competency management (Horney and Koonce, 1996). However, the elevated corporate interest in competencies also brought forward increasing numbers of problems with competencies. These included poorly executed competency studies. They were poor for a variety of reasons:
1. focused too narrowly on a specific job title
2. ignoring one of the three cognitive, psychomotor or affective components of learning
3. not including major components of the job
4. not measurable
5. including components that cannot be improved by training and development (Parry, 1996).

Researchers and practitioners alike struggled with the definition of the term competency. Hoffman surveyed the field and described three common definitions:
1. observable performance
2. the standard or quality of the outcome of the person’s performance
3. the underlying attributes of the person.

Rothwell and Lindholm, writing at the same time as Hoffman, were far more aggressive in treating the competency field, issuing several challenges to the community. Beginning with a series of challenging questions and providing definitions of competency, competency model and other important terms, Rothwell and Lindholm rapidly march through a history of competency from McClelland’s groundbreaking work, McLagan’s introduction of competency models as the “focal point for planning, organizing, integrating and improving human resource management systems” (Rothwel and Lindholm, 1999). They note how Boyatzis conceptualised competency identification in a way that goes deeper than observed behaviours that can be reproduced through training. When management style is defined as a set of skills, attributes or characteristics of a manager, the concept refers to a pattern of behaviour that the manager demonstrated and the values that he or she embodies. Boyatzis’ model of managerial competencies is presented as a complex six-level dynamic interaction between the individual performing the job and his or her environment (Rothwel and Lindholm, 1999).

Rothwell and Lindholm describe the three most common methodologies used to create competency models:
1. the borrowed approach
2. the borrowed-and-tailored approach
3. the tailored approach. Rothwell and Lindholm examine the future of competencies and find that they will likely grow in use.

Competencies offer greater explanatory power than job-based approaches. Competency models also address more than what people do and “include the attitudes, feelings and motivation levels of exemplar performers” (Rothwel and Lindholm, 1999). However, they point out three specific challenges:
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1 “the ambiguity of terms and definitions
2 past-oriented competency models
3 issues involving the time-rigour tradeoff” (Rothwel and Lindholm, 1999).

The challenges expressed by Rothwell and Lindholm have been taken up by a number of authors; however, none appear to have questioned the competency model approach from an underlying epistemological perspective. Competency model practice developed in response to weaknesses in the link between intelligence testing practice and job performance (McClellan, 1973); Rothwel and Lindholm, 1999). Competencies do not appear to be founded in theory and have largely evolved in response to gaps in performance (Calhoun et al., 2008; Campbell, 2008, 2006; Rothwel and Lindholm, 1999). Addressing the field of instructional system design, Campbell (2008) noted the existence of a performance gap in competency models due to the evolution of the field to e-learning. Campbell developed a new competency model for the occupation using Delphi techniques and content analysis. Similarly, Calhoun et al. (2008) developed a competency model for masters of public health programme using a modified Delphi technique. Calhoun has a comparatively robust element for systems thinking comprising nine elements in the final competency model. This is one of broadest systems thinking (or systems theory) selection of elements discovered in the literature. However, the model remains the fundamental structure of starting with a list and using experts to refine and order the listed elements.

Many authors seek to use specific cases to expand the inventories of required competencies (Squires et al., 2011; Stedman, 2012; Torres, 2009). Further, many organisations find that their framework does not anticipate future problems and leaves them without the requisite competencies to deal with the emerging problem until it has engulfed the organisation’s leadership and becomes an existential threat. Squires et al. (2011), recall Hollenbeck, Morgan and Silzer’s exchange of a series of letters challenging the value of leadership competency models (Hollenbeck et al., 2006). Invoking work done by Vroom (2000) who reaches all the way back to Tannenbaum and Schmidt (1958) and their seminal discussion of choosing a leadership pattern, Silzer points out some of the strengths and weaknesses of competency models in use. Traditional efforts have focused on the current problems and development of the capability to address those problems (Newhard, 2010; Oravis, 1982; Parry, 1996; Wood, 2009; Xanthos, 2006). Infrequent references couple future problems to the current efforts to improve competency models (Kurz and Bartram, 2008; Hammer et al., 2011; Seiler and Pfister, 2009). Several researchers have addressed the development of an approach using systems theory and its propositions to create a holistic foundation that enables organisations to develop capabilities (although neither uses the word competency) that are not case specific (Espinosa et al., 2007; Anderson, 1999), while others have used components of systems theory to explore approaches to a particular gap (Clark, 2005; Bernard, 2001; Torres, 2009; Stines, 2003). Espinosa et al. invoke numerous systems thinkers, while exploring what they called meta-systemic management. Seeking sufficient requisite variety to manage the turbulence of modern organisations, they propose the use of Beer’s viable system model for organisation design, including management control systems that would, by implication, include competency models (Espinosa et al., 2007).
No competency model was found that was constructed from an independently derived set of axioms and propositions appropriate for the organisational system at hand. Additions to competency models based on a single systems theory principle or small set based on systems theory have been reported. For example, Ronn (2011) focused on complexity as a competency element in leadership development. van der Walt also focused on complexity as a key addition to competency models for leaders (van der Walt, 2010). Shrivastava used the model of open systems to develop a competency model with only three elements focused on “managing interfaces, growth, and contingencies” (Shrivastava, 2008). Stines used a holistic perspective, borrowing “from systems theory and cybernetics (first and second order)” (Stines, 2003).

2.3 An epistemological approach to the problems in competency models

A review of the management theory literature revealed a number of researchers looking at competency models, systems theory and management theory. Prominent is Lari Koskela who has been exploring the stalled pace of innovation in construction management from an epistemological view. He posits that:

“These metaphysical assumptions tend to strongly influence how the subject of the inquiry or action is conceptualized. The thing-oriented view seems to lead to analytical decomposition, the requirement or assumption of certainty and an historical approach. The process-oriented view is related to a holistic orientation, acknowledgement of uncertainty and to a historical and contextual approach. However, an analysis of current conceptualizations and methods shows that it is the thing-oriented view on the world that has dominated the research and practice of production management. The resulting mismatch between the assumed nature and true nature of production has arguably led to major generic failures of production management. As a conclusion, it is contended that the discipline of production management has to seriously address the metaphysical issues confronting both practitioners and scholars.”

(Koskela and Kagioglou, 2005)

Koskela has proposed that management, especially project management, should be re-examined from a flow perspective, vice the substance perspective that has dominated the literature and practice. He traces the problem to two reports funded respectively by the Ford Foundation and the Carnegie Foundation that indicted previous practice and influenced the development of management science and research (Koskela, 2011). Koskela details the influence of these reports and arrives at three conclusions:

First, the 1959 reports on business education have failed, throughout, to give appropriate direction for management research; the outcomes have not passed the test of relevance. Second, in spite of extensive (although somewhat myopic) discussion on irrelevance in the management scholar community from circa 1980 onwards, not much movement towards rectifying the situation can be seen. Thirdly, judging by the way the social science turn in management science happened and at the correctives suggested, it is plausible that the ousting of production from management science in 1959 has been one major contributing factor to irrelevance across managerial sub-disciplines (Koskela, 2011).

Throughout the competency model literature, there is a theme that some key element is missing. This theme drove McClelland to initiate the idea of competency models and Boyatzis, Kolb, Rothwell and others to identify gaps and propose ways to close those
gaps. It is not until we get to Koskela that it becomes clear that the gap may have been at the very dawn of the competency models, when they were created by comparative methods independent of a systems theory or equivalent body of knowledge. The competency models were created by a practical approach to the skills problem and while they clearly represented an improvement from the previous intelligence test models, they ultimately come to barriers that can only be incrementally attacked using the same approaches. To transcend this limitation, a fundamentally different approach is required. Informed by Koskela and Vrijhoef’s (2000) invoking Taylor (1914) and practice in systems theory, the systems theory literature presents itself as a candidate body of literature to use to create a competency model framework with the possibility of achieving that step increase in organisational performance. Combined with the call from Koskela to rethink the discipline of project management from the epistemological perspectives, it seems like an appropriate time to apply systems theory to competency models in the management domain.

The next section of the paper will describe the research that developed a competency model framework based on systems theory, using grounded theory and William Whewell’s discoverer’s induction.

3 Inductive competency model framework building

The competency model literature revealed that the approach of incremental improvement to existing methods and models was unlikely to result in dramatic organisational performance. The abundant literature following Rothwell and Lindholm’s challenge was focused on just such incremental improvement. Koskela and his associates sowed the seed of the idea that a more fundamental change was needed, a new framework for competency models. An examination of the theory building methods led the authors to the use of grounded theory as an appropriate method. Yet, it would leave the authors just shy of the goal and William Whewell’s discoverer’s induction was enlisted to make that least leap to the new framework. This section details that path and the new framework.

3.1 Grounded theory as inductive theory building

Grounded theory was selected as the method to supplement discoverer’s induction. The use of grounded theory brings a rigorous, well-documented method (Corbin and Strauss, 1990) as well as availability of supplemental tools (i.e., software) to aid the researcher. Grounded theory has a number of similarly well-documented weaknesses which were mitigated by the research design.

The data collection strategy is relatively straightforward. Each of the documents listed in Adams et al. (2014) was acquired, generally in an electronic format, verified to be the effective version of the document and maintained as the record copy for the duration of the research. Additional literature was collected based on the above seminal documents, eventually totalling 516 documents. Of these 446 documents were open coded, 70 were not required due to saturation being reached, generating 4,981 data elements at the completion of open coding.

The grounded theory processes are not strictly linear and with an iterative relationship between the steps for data collection and data analysis, using the constant comparative method of grounded theory. As data is analysed and concepts identified and categories
were developed, the research required returning to the data to provide assurance that the emerging theoretical constructs were actually grounded in the data (Corbin and Strauss, 1990).

There were three phases of coding as part of the data analysis. Those three phases are open coding, axial coding and selective coding (Leedy and Ormrod, 2010). Following selective coding, theory development was accomplished. An outline of each of these phases is provided in Table 1:

<table>
<thead>
<tr>
<th>Phase</th>
<th>Activities</th>
</tr>
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<tbody>
<tr>
<td>Open coding</td>
<td>The data are divided into segments and then scrutinised commonalities that reflect categories or themes. Data are examined for properties that characterise each category.</td>
</tr>
<tr>
<td>Axial coding</td>
<td>Interconnections are made among the categories and subcategories.</td>
</tr>
<tr>
<td>Selective coding</td>
<td>The categories in their interrelationships are combined to form a storyline that describes what happens.</td>
</tr>
<tr>
<td>Theory development</td>
<td>A theory, in the form of a verbal statement, visual model, or series of hypotheses is offered to explain the phenomenon in question.</td>
</tr>
</tbody>
</table>

Source: Drawn from Leedy and Ormrod (2010)

3.2 The contribution of discoverer’s induction

The ‘theory development’ phase in Table 5 is where the systems theory is coding explicitly merged with competency model literature using the superinduction of Whewell’s discoverer’s induction. While the coding process is not completely separated from the inductive theory building, that framework theory building was distilled once the coding steps were complete.

<table>
<thead>
<tr>
<th>Proposition or personal capability</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Control was initially defined as “the process by means of which a whole entity retains its identity and/or performance under changing circumstances” (Checkland, 1993). Additionally, control includes the following additional perspective “Management control systems provide information that is intended to be useful to managers in performing their jobs and to assist organizations in developing and maintaining viable patterns of behaviour” (Otley, 1999).</td>
</tr>
<tr>
<td>Equifinality</td>
<td>“If a steady state is reached in an open system, it is independent of the initial conditions and determined only by the system parameters, i.e., rates of reaction and transport” (Adams et al., 2014).</td>
</tr>
<tr>
<td>Purposive behaviour</td>
<td>“Purposeful behaviour is meant to denote that the act or behaviour may be interpreted as directed to the attainment of a goal – i.e., to a final condition in which the behaving object reaches a definite correlation in time or in space with respect to another object or event” (Adams et al., 2014).</td>
</tr>
<tr>
<td>Satisficing</td>
<td>The decision-making process whereby one chooses an option that is, while perhaps not the best, good enough (Adams et al., 2014).</td>
</tr>
</tbody>
</table>
Table 2  Description of proposition or personal capability (continued)

<table>
<thead>
<tr>
<th>Proposition or personal capability</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic equilibrium</td>
<td>For a system to be in a state of equilibrium, all subsystems must be in equilibrium. All subsystems being in a state of equilibrium, the system must be in equilibrium (Adams et al., 2014). The definition is expanded to include Bertalanffy’s conception of an open system that is equilibrium through the exchange of matter and energy (Bertalanffy, 1950).</td>
</tr>
<tr>
<td>Relaxation time</td>
<td>Stability near an equilibrium state, where resistance to disturbance and speed of return to the equilibrium are used to measure the property. The system’s equilibrium state is shorter than the mean time between disturbances (Adams et al., 2014).</td>
</tr>
<tr>
<td>Self-organising</td>
<td>The spontaneous emergence of order out of the local interactions between initially independent components (Adams et al., 2014).</td>
</tr>
<tr>
<td>Feedback</td>
<td>All purposeful behaviour may be considered to require negative feed-back. If a goal is to be attained, some signals from the goal are necessary at some time to direct the behaviour (Adams et al., 2014).</td>
</tr>
<tr>
<td>Requisite variety</td>
<td>Control can be obtained only if the variety of the controller is at least as great as the variety of the situation to be controlled (Adams et al., 2014).</td>
</tr>
<tr>
<td>Performance</td>
<td>Performance is a very value laden term, hard to define. Begin with Lebas and a definition derived from his work Performance is about deploying and managing well the components of the production factors that lead to the time attainment of stated objectives within constraints specific to the activity and support organisations within the boundaries... of the situation (Lebas, 1995). Beer provided insights when he developed his concepts of actuality, capability and potentiality (Beer, 1979). His method of developing three related indices to measure that performance.</td>
</tr>
<tr>
<td>Temporal relationship</td>
<td>Temporal relationship captures the effects of organisation actions over time. This category emerged from the open coding of the literature data set. There are two perspectives depending on the direction the observer is looking. The first, which I call past-now-future, is the resulting picture formed by first looking at the organisation’s past through the lens of today and predicting or estimating what the future will look like based on that past, constrained by the present. Exogenous factors may or may not be included in the determination of the future. The second perspective is called future-now-past. The key difference is that a future picture is created of where the organisation wants to be, then that future is compared to the present to identify the changes and resources required to get to that future and the lessons of the past are included to determine if different actions or paths must be followed. Again, exogenous changes may be included in the depiction of the desired future. The two futures (P-N-F and F-N-P) are likely to be different and those differences would drive actions in and of themselves.</td>
</tr>
<tr>
<td>Leadership</td>
<td>Leadership, like performance is a value laden term. Leadership, like temporal relationships, emerged from the open coding. Numerous definitions exist; none satisfy everyone, or even a majority of people. The researcher chose to use a two part definition to constrain the meaning to the Systems Theory literature data set. The first part comes from Drucker, “management is doing things right, leadership is doing the right things” (Covey and Nathan, 2011). The second part of the definition comes from the idea that leadership is what causes people to successfully work together to reach an enormously difficult goal that would not have been achieved without that leadership being present.</td>
</tr>
</tbody>
</table>
3.3 The new competency model framework

The competency model framework is represented by a three by nine matrix; comprising nine propositions from the description of systems theory along with three emergent personal capability characteristics form the axes of the framework matrix. Those components and their descriptions are contained in Table 2. As noted in Table 2, several of the original propositions have evolved meanings based on the wider literature considered for this research compared to the original work of Adams et al. (2014).

In the next table we present the complete framework. In this representation, the three personal capability characteristics form the horizontal rows and the propositions form the vertical rows [arranged by axiom from Adams et al. (2014)]. Each cell represents an intersection of the respective personal capability characteristics and proposition. The original 30 propositions have been reduced to nine during the selective coding process. The remaining 21 propositions are subsumed within the descriptions of the cell contents. When used to construct a competency model, each cell can be represented individually, or combined with other cells. When used to assess or transform an existing competency model, it is expected that most cells from the competency model framework will be only partially represented in the existing competency model and that various components may be required to verify that the complete concept is represented.

Table 3 Competency model framework

<table>
<thead>
<tr>
<th></th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equifinality</td>
</tr>
<tr>
<td>Temporal relationship</td>
<td>Understands the hidden and delayed system responses that only become visible through time. Uses understanding of time in selecting which of many pathways are more likely to result in reaching the desired organisational goals.</td>
</tr>
<tr>
<td>Leadership</td>
<td>Understands and uses the opportunities presented by multiple paths to the same end state for organisational advantage, while recognising the small changes that can result in dramatically different outcomes. Capable of recognising these small changes in modifying the organisation and its actions to prevent being undone by those seemingly small factors.</td>
</tr>
</tbody>
</table>
### Table 3 Competency model framework (continued)

<table>
<thead>
<tr>
<th>Goal</th>
<th>Equifinality</th>
<th>Purposive behaviour</th>
<th>Satisficing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>Understands how ambiguity will drive many managers to pick a single idea, a</td>
<td>Using skills in formal operations, selects or guides the proper starting point for</td>
<td>Understands that optimised organisations are inflexible, whereas satisficing</td>
</tr>
<tr>
<td>[A-C-P]</td>
<td>single function, or a single solution to the detriment of the organisation.</td>
<td>investigation. Uses knowledge of mental models to overcome flaws including:</td>
<td>enables dynamic boundaries and loose coupling. Knows how to decide and does so</td>
</tr>
<tr>
<td></td>
<td>Is able to deal with that ambiguity both on a personal and organisation level</td>
<td>1. not incorporating individual into the organisation</td>
<td>well.</td>
</tr>
<tr>
<td></td>
<td>to prevent being limited by the choice of one.</td>
<td>2. not representing the hierarchy of control</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. relying on espoused theories vice recognising theories in use.</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4 Competency model framework (cont)

<table>
<thead>
<tr>
<th>Operational</th>
<th>Dynamic equilibrium</th>
<th>Relaxation time</th>
<th>Self-organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporal</td>
<td>Rather than using</td>
<td>Understands system</td>
<td>Understands the value of</td>
</tr>
<tr>
<td>relationship</td>
<td>approaches that define</td>
<td>responses to shocks, how to consider relaxation time</td>
<td>proximity to drive interaction within the</td>
</tr>
<tr>
<td></td>
<td>the processes as successive</td>
<td>when implementing</td>
<td>commonly found nested</td>
</tr>
<tr>
<td></td>
<td>macroscopic equilibrium</td>
<td>change and does not</td>
<td>hierarchical structures.</td>
</tr>
<tr>
<td></td>
<td>states which do not depend</td>
<td>ignore relaxation time</td>
<td>Uses this understanding to</td>
</tr>
<tr>
<td></td>
<td>on time, is able to deal</td>
<td>when considering</td>
<td>drive interactions on</td>
</tr>
<tr>
<td></td>
<td>directly with disorder,</td>
<td>complicated trade-offs in</td>
<td>multiple timescales, in</td>
</tr>
<tr>
<td></td>
<td>instability, nonlinear</td>
<td>resource utilisation.</td>
<td>parallel and series,</td>
</tr>
<tr>
<td></td>
<td>relationships between</td>
<td>Understands and uses</td>
<td>synchronous or</td>
</tr>
<tr>
<td></td>
<td>open systems, evolution</td>
<td>differences in relaxation</td>
<td>asynchronously with the</td>
</tr>
<tr>
<td></td>
<td>and temporal relationships.</td>
<td>times between systems to</td>
<td>goal of establishing the</td>
</tr>
<tr>
<td></td>
<td>Uses approaches that include</td>
<td>the advantage of the</td>
<td>requisite variety for the</td>
</tr>
<tr>
<td></td>
<td>disequilibrium, amplifying</td>
<td>organisation.</td>
<td>organisation to achieve its</td>
</tr>
<tr>
<td></td>
<td>action, recombination and</td>
<td></td>
<td>goals.</td>
</tr>
<tr>
<td></td>
<td>stabilising feedback as</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4  Competency model framework (cont) (continued)

<table>
<thead>
<tr>
<th>Operational</th>
<th>Dynamic equilibrium</th>
<th>Relaxation time</th>
<th>Self-organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>Recognises and takes advantage of crossovers, despite their speed of occurrence and coordinates the organisation getting to a new (and better) basin of stability. Resists the tendency to use averages when specifics are needed to predict future performance.</td>
<td>Knows how to respond to newness and adopt organisation to new assemblies in the face of instability, despite the inherent difficulty of determining relaxation time in a complex system with multiple exogenous sources of change. Able to respond differently over time as the organisation changes and is changed.</td>
<td>Designs the organisation to reduce deficiencies that impair viability, includes redundancy to provide adaptability, all with the minimum specifications to allow the freedom to find the needed paths to organisational goals. Recognises that leadership is affected by followers rather than existing in isolation.</td>
</tr>
</tbody>
</table>

Table 5  Competency model framework (cont)

<table>
<thead>
<tr>
<th>Viability</th>
<th>Centrality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedback</td>
<td>Requisite variety</td>
</tr>
</tbody>
</table>

Temporal relationship

| | Uses feedback lens to enrich the understanding of the situation, while also recognising that feedback can help or hinder by setting boundaries. Self-defeating feedback loops identified and mitigated by improving meaning making. | Understands how requisite variety enables a system to continuously develop as the environment also develops. Able to take advantage of or use the information explosion that results from continuous development. | Understands patterns as well as the world around the organisation and the impact of those patterns on the organisation. Has a deep understanding of the organisation and its environment that enables the use of time and control functions to predict performance, use system understanding to create and revise goals to improve organisation performance. |
### Competencies for governance of complex systems of systems

#### Table 5

<table>
<thead>
<tr>
<th>Viability</th>
<th>Requisite variety</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Leadership</strong>&lt;br&gt;Develops both autopoietic and executive controls to set targets and monitor performance and causes action to close gaps between performance and goals. Uses, improves, expands workforce knowledge to achieve desired organisation results.</td>
<td>Understands requisite variety allows and takes advantage of unexpected use of the system, unexpected behaviours and responding to previously unknown problems to solve. Fosters socio-technical perspective rather than a one-man/one job perspective to enable necessary roles to be filled.</td>
<td>Has the ability to set organisational goals, translate the organisation goals to function goals and constructs to enable hierarchical levels to meet their goals nearly simultaneously. Establishes these goals so as to reduce internal conflicts while dealing with ambiguity and change in the organisation and its environment.</td>
</tr>
<tr>
<td><strong>Performance [A-C-P]</strong>&lt;br&gt;Performance</td>
<td>Enables meaning making to get more strategic thinking, higher levels of collaboration, beneficial feedback, better conflict resolution, better subordinate development. Redefines challenges to get higher performance with designs evolved in response to feedback.</td>
<td>Able to discern the boundary or limit to performance with current system and only expends the resources needed to approach that limit..Seeks out different tools/ideas/skills to jump system to a higher region with expanded limits.</td>
</tr>
</tbody>
</table>

#### 3.4 Case study results

The application of the competency model framework against the extant competency model showed several gaps, with many sections having incomplete coverage. The relatively small number of gaps was somewhat surprising, while the predominance of partial coverage was expected. Only seven of 27 framework elements were assessed as excellent coverage and it should be noted that excellent coverage did not imply 100% coverage. Each of the major themes had a relatively flat distribution. No theme had a truly dominant score. Two of the unsatisfactory grades fell in the same proposition – Relaxation Time. The proposition was covered from the leadership perspective by connecting the concept across three cells of the organisation’s competency model, yet the term was not used (nor expected to be used). Many of the terms from systems theory are not used and the idea of Troncale’s (2009) discynms (disciplinary synonyms) had to be broadly applied in many instances. A summary of the scores is presented in Table 6.
Table 6 Summary of framework scores

<table>
<thead>
<tr>
<th>Grading selection</th>
<th>UN</th>
<th>AD</th>
<th>VG</th>
<th>EX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section: temporal relationship</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Section: leadership</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Section: performance</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Summary</td>
<td>3</td>
<td>9</td>
<td>8</td>
<td>7</td>
</tr>
</tbody>
</table>

The researcher’s sense was that this competency model reflects a fair number of systems theory propositions, but could be made much stronger by the application of the competency model framework in a transformation effort.

4 Summary

The research has produced an original competency model framework based on systems theory and structured induction. This represents a completely new method for the development of competency models. A real-world application of the new competency model framework to an existing competency model indicated gaps within the organisation’s competency model, as well as areas requiring strengthening based on systems theory. This assessment resonated with the organisation based on their discomfort with current performance. The competency model framework is well adapted to those seeking to understand the skills needed for complex system governance.

This discussion has focused on the development of the new competency model framework, but also opens the door to future research. Boulter et al. (1998) have described a sequence for competency model development and maturation that parallels the intended path for research. The framework has already been used to find gaps in one organisation’s competency model. This organisation will next be designing changes to fill those gaps and then at some future point assessing the efficacy of those changes in improving the organisation’s performance. Research is also beginning on how the competency model framework can be used to inform organisations that have problems with their SoS. These complex problems require different skills than the reductionist, siloed skill sets that predominate in their competency models today.

References


Competencies for governance of complex systems of systems


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Torres, B.L. (2009) Frontline Nursing Leaders and Staff Retention in an Acute Care Community Hospital, Virginia Commonwealth University, University Park, PA.

