Chapter 2
Decision-Making Principles

Abstract In this chapter, the principles of decision making relevant to program management are emphasized in a methodology what is critical to the program manager and conformity on how to standardize the decision-making process. Program management organization theories, structures, and environment will also be analyzed to provide program managers with informative structures and approaches. Large projects and programs are notorious for erosion of value during execution. Decisions made by program managers have a significant impact on the strategic value of the projects delivered and those decisions depend on the information feed on which they are based. This analysis applies theories of organizational behavior, decision making, and other informative tools to investigate the impact of information used by program managers on the strategic value delivered by large programs. This chapter aims to draw attention to how the decision making of program managers during construction execution can impact the long-term strategic goals of programs. Normative and descriptive decision theories and principles, organization theory and structure, chain-in command, systems structures, analysis and environments, formalization, and contingency factors are described in details.

Decision Theory in Programs

In a general sense, a decision is a position, opinion, or judgment reached after consideration. It is a cognitive phenomenon and the outcome of a complex process of deliberation, which includes an assessment of potential consequences and uncertainties. Decision involves thinking, judgment, and deliberate action to assign irrevocable allocation of resources with the purpose of achieving a desired objective. Basic elements of a decision process include information seeking, ascription of meaning (interpretation), applying decision criteria, and subsequent implementation action.

Decision theory has its root in economic theory, with the assumption that people make decisions to maximize utility on the basis of self-interest and rationality. This, however, does not consider the possibilities or effects of moderating or intervening

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factors that make decisions reference-dependent. Nonetheless, expected utility theory has been applied in the construction industry with some success and has been the predominant model for normative decision making. The theory is considered idealistic, however, because it focuses on how managers should make decisions rather than how they actually make decisions.

Technical people in the construction industry have been observed to exhibit a tendency for a normative approach to decision making, thereby weakening their ability to deal with uncertainty. Program management is dominated by technical staff and probably more than a few are struggling with tendencies toward this normative thinking phenomenon. An alternative approach is the descriptive decision theory.

Descriptive decision theory deals with how people actually make decisions. It postulates that people make decisions by choosing ways to satisfy their most important needs even if they do not have all the required information and their choice is not optimal. When people are faced with making decisions under uncertainty, they simplify the challenge by relying on heuristics or rules of thumb that are largely rooted in acquired knowledge and past experiences (Dillon 1998).

There are two relevant offshoots of descriptive theory, namely the prospect theory and the theory of bounded rationality. Both theories recognize the ample limitation of human beings to be rational most of the time and postulate that inductive thinking is more natural.

Prospect theory explains decision making under risk, which realistically reflects better the decision processes in megaprojects and programs. The theory distinguishes two phases in the decision process, namely, framing, and valuation. Framing consists of a preliminary analysis of the prospects offered (by the challenge) to the decision maker, leading to a representative construction of his or her perception of the challenge, associated contingencies and possible outcomes. A heuristic simplification of perceived risks or challenges takes place such that the decision maker can make some meaning out of it. During this phase, the quantity, quality, and timeliness of information (information feed) available to the decision maker, together with past experiences and knowledge about relevant subject matter, will have huge effects on how he or she models the possible prospects, which is the outcome of this process. Information timelines have also been hypothesized as a factor due to the time pressure that most program managers are under. Time pressure affects decision making and information suffers degradation when not delivered timely. Valuation follows framing, in which the decision maker assesses the value of each prospect on the basis of an "opportunity–threat" or a "gain–loss" principle and then chooses accordingly. Prospects are consequently labeled, for example, as "opportunity" or "threat." Figure 2.1 shows realization process in program management (Wakker 2010).

Ultimately, the aim of decision making is to minimize uncertainties, which arise from inconsistencies between what actually happens and what was expected to happen. Four reasons, largely related to the management of information to support decisions, have been advanced for why these discrepancies can occur following decisions:

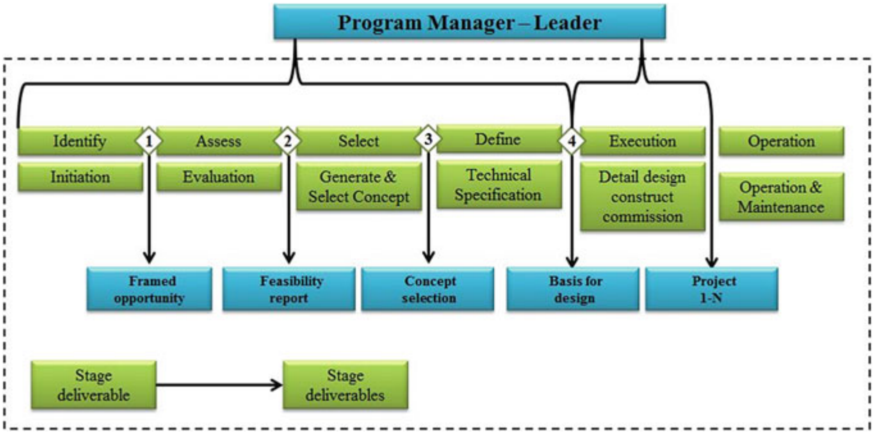

Fig. 2.1 Basic realization process in program management

1. Mis-information or input data decision process problem.
2. Mis-implementation of what was decided.
3. Change in the assumed context after the decision was made (such as design, resources, or budgetary context around the program).
4. The decision itself may be fundamentally flawed in quality, which would be a problem with the decision approach or process.

Information Feed in Decisions

The financial and social stakes in programs are so large they can endanger the survival of corporations and threaten the economic stability of some countries they are being built in. Underperformance includes substantial shortfalls in benefits such as financial performance of the delivered projects comprising the program, delays and disruptions and lack of quality in some instances. Therefore, decision making is essential for the main reasons:

1. Program and projects managers' decisions impact the strategic value of assets delivered by megaprojects,
2. These decisions are dependent on the information feed on which they are based,
3. The extent to which managers feel in control influences the scope and quality of information feed,
4. Information feed significantly influences strategic value creation on programs, and
5. Areas of uncertainty may impact long-term success in large programs.

It can be established that the root cause of almost all programs failure can be traced back to human error or misjudgment, and poor judgment can often be traced back to the way the decisions were made. As making decisions is considered the most important job of any executive, the ability to make right decisions on programs should be a principal indicator of professionalism in program management.

Information feed involves searching external and internal environments to identify important issues or events that could affect the program and its objectives. It is a key element of the decision process, enabling managers to formulate expectations about the future. As decision makers will usually have access to far more information than they can deal with, they become selective in favor of information they consider to be most useful. It has been established that decision makers who use more information tend to be more comfortable in dealing with ambiguity and uncertainty and consequently more positive about labeling their challenges.

Program managers who are positive about labeling (as suggested by prospect theory) tend to project positive outcomes with expectations of "gain" or "opportunity" rather than "loss" or "threat." They also tend to have a fair amount of control in organizing or directing the program. In contrast, "threat" labeling implies a negative situation in which a likely loss is projected by the decision maker, and over which he or she feels relatively little control.

Early detection of system disturbances is enhanced through good and timely information feed that allows for pro-activeness. Less timely information is generally considered inferior because the program manager's expectations will contain greater error. On the other hand, decision makers tend to use less information when they believe they are knowledgeable about their business environment or situation than when they feel it is poorly understood. However, decision makers may sometimes not be correct in their judgment. The quality and quantity of information available to decision makers in business organizations has been found to correlate with the quality of their decisions. As program management is similarly underpinned by decisions, one can expect that the information feed to the program manager (as a key decision maker) will influence program performance and derivable strategic value (Eweje et al. 2012).

The extent to which a program manager feels in control of strategic issues is an important influence on how information gathering toward decision support and interpretation will be approached. The level of confidence of being in control would largely be influenced by how the program manager perceives the quality and effectiveness of risk management on the program. The following areas of greatest challenges to mega projects and programs were identified as:

1. Design, including master plan
2. Appointment of consultants
3. Contracting and procurement management
4. Government relations management (the decision mechanisms of host governments are often unclear and can lead to significant complications)
5. Host community relations management
6. Joint venture interface management
7. Health, safety, security, and environmental (HSSE) issues

8. Multi-location management of fabrication and facilities integration
9. Resource allocation
10. Implementation of local content policies
11. Project governance
12. Managing the core program team, including attaining cohesion within the broader team
13. Impact of multi-cultural leadership within the project
14. Facility management (Haidar et al. 2014).

Note that the information feed in support of the program manager's decision will have a significant influence on the level of derivable strategic value. The magnitude of external focus within the information feed in support of the program manager's decisions will correlate positively with the long-term strategic value realized.

Program Management Quality

Programs are defined as collections of single projects that run concurrently. Fundamentally, these multiple projects must be operated efficiently. However, program management focuses on effectiveness of the execution of the right projects within the program. If a program is regarded as an organization's investment strategy, the right projects would be those that yield the most return on investment for this organization, based on the consideration of a single program and the program level risks.

Thus, program management is a decision-making process that steers the right projects from idea to successful implementation. These decisions are made on present and potential projects and include selection, prioritization, and completion as well as re-allocation of resources across the collection of projects. The process takes the following objectives into account:

1. Information quality is concerned with the availability, comprehensiveness, and transparency of information;
2. Resource allocation quality is related to the speed of assignment, reliability of commitment, and avoidance of conflicts during resource endowment; and
3. Cooperation quality implies empathy and readiness to help project managers and other project teams (cross-project cooperation).

Organization Theory

Organization theory suggests that the ability of a person within an organization to influence its strategic direction is a function of the amount of resource allocation he or she controls, and not necessarily his or her seniority. The managers of some programs can be responsible for the allocation of between $0.3 and $20 billion for a single program and, therefore, the ability of these senior program managers to influence corporate strategic direction should not be underestimated. Failure of just one program can potentially be disastrous to a contractor or a client.

Some of the topics of particular interest to organization theory are as follows:

1. Goals and value systems,
2. The use of technology and knowledge,
3. The structuring of organizations,
4. Formal and informal relationships,
5. Differentiation and integration of activities,
6. Motivation of program participants,
7. Status and role systems,
8. Organizational politics,
9. Power, authority, and influence in organizations,
10. Managerial processes,
11. Organizational strategy and tactics,
12. Information decision systems,
13. Stability and innovation,
14. Organizations' boundaries and domains,
15. Interface between projects within a program,
16. Planned change and improvement,
17. Performance and productivity,
18. Satisfaction and quality of work life, and
19. Managerial philosophy and organization culture (Haidar et al. 2014).

Program Organization Structure

Structure may be considered as the established pattern of relationships among the components or parts of the organization to effectively manage and construct a program or manage a portfolio. We consider that the structure of the organization of a program cannot be looked at as completely separate from its functions; however, these are two separate phenomena. Taken together, the concepts of structure and process can be viewed as the static and dynamic features of the programs to be constructed. In some programs, the static aspects (the structure) are the most important for investigation; in others, the dynamic aspects (the processes) are more important.

Static programs relate to schools, buildings, hospitals, airports, roads, and others. Dynamic programs are related to engineering, procurement, and construction (EPC) of power stations, desalination plants, district cooling plants, transportation programs in trains, metros and bus routes, and oil and gas. Renewable energy programs in wind, solar, or water motion are dynamic. Some programs are a hybrid of both static and dynamic. Figure 2.2 shows the generic program organizational structure.

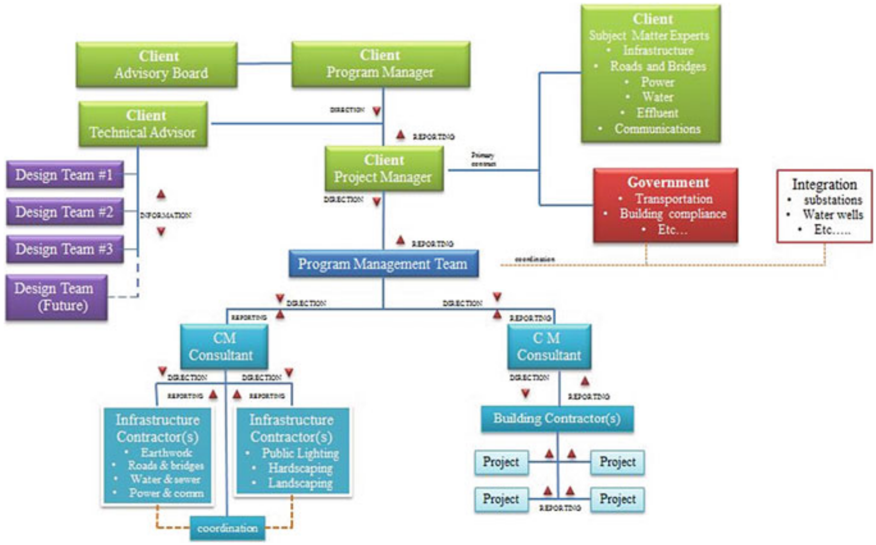

Fig. 2.2 Generic program organizational structure

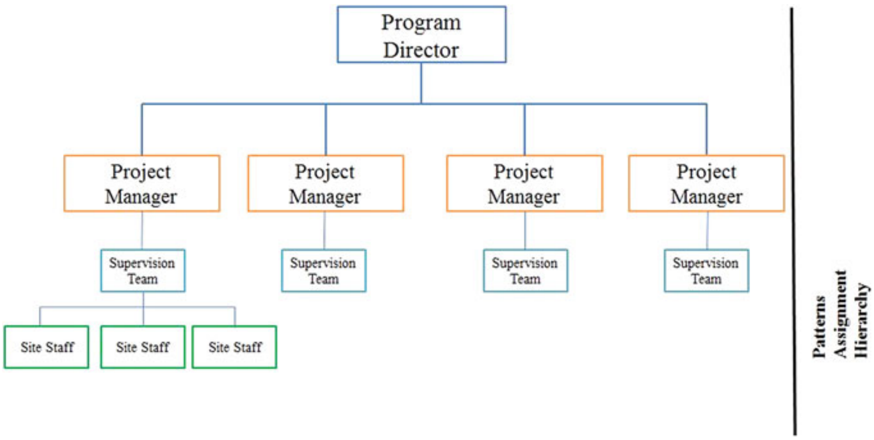

Fig. 2.3 Formal organization structure

Formal organization is the planned structure and represents the deliberate attempt to establish patterned relationships among projects that will meet the program objectives effectively. Figure 2.3 shows the formal organization structure. The formal organization structure is frequently defined in terms of the following:

1. The pattern of formal relationships and duties. This includes the organization chart plus job descriptions or position guides;
2. The way in which the various projects or tasks are assigned to different departments and/or people in the program organization (differentiation);

3. The way in which these separate projects or tasks are coordinated (integration);
4. The power, status, and hierarchical relationships within the program organization (authority system); and
5. The planned and formalized policies and controls that guide the program in the organization.

The informal organization refers to those aspects of the program that are not planned explicitly but arise spontaneously out of the activities and interactions of the projects. Informal organizations are vital for the effective functioning of the program organization. Informal organization relates to the projects themselves, whereas formal organization relates directly to the upper hierarchy of the program.

It is impossible to understand the nature of a formal program organization without investigating the networks of informal relations and the unofficial norms as well as the formal hierarchy of authority, and the official body of rules. The distinction between the formal and the informal aspects of a program life is only an analytical one and should not be ratified as there is only one actual program organization body (McCullough 2008). Figure 2.4 shows a hybrid formal and informal organization structure.

The concept of a program organization plan implies the process of developing the relationship and creating the structure to accomplish organizational purposes. Structure is, therefore, the result of the planning process. An organization program has a perspective and an action orientation; it is geared toward solving problems and improving performance to construct the projects.

Program organization including planning, orientation, and strategy is never complete; it is a continuing, ongoing process. Hence, a well-designed program is not a final solution to achieve but a developmental process to keep active.

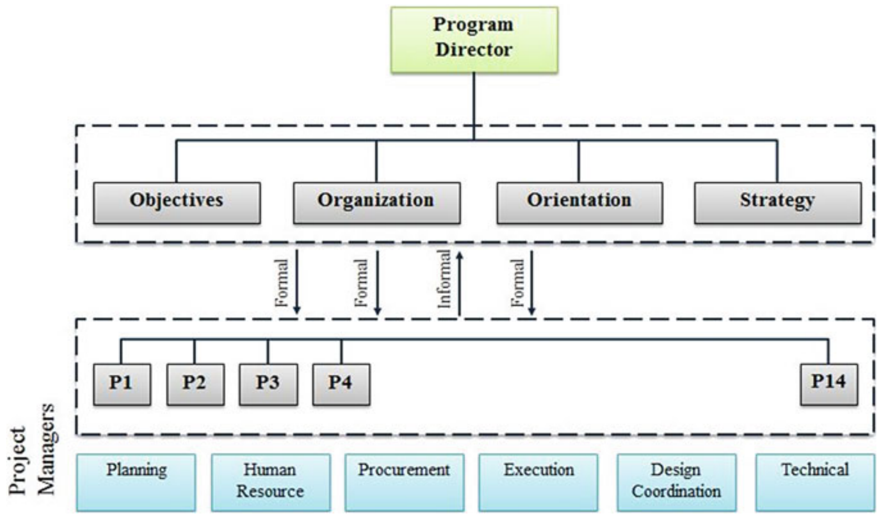

Fig. 2.4 Hybrid formal and informal organization structure

Coordination of activities within the various projects of a program is an important consideration of the organization structure. Integration is defined as the process of achieving unity of effort among the various sub-systems in the accomplishment of the organization task. The requirements of the environment and the technical system often determine the degree of coordination required. In some organizations, it is possible to separate projects activities in such a way as to minimize their resource requirements.

Responsibilities and Functions

Structure is directly related to the assignment of responsibility and accountability to various program organizational units. Delegation is fundamental in the assignment of both authority and responsibility. Control systems are based on the delegation of responsibility. Most organizations develop some means to determine the effectiveness and efficiency of the performance of these assigned functions and create control processes to ensure that these responsibilities are carried out.

Traditional management theorists were primarily concerned with the design of efficient decision-making techniques. They emphasized such concepts as objectivity, impersonality, and structural form. The program organization structure is designed for the most efficient allocation and coordination of projects that relate to the different parts of the constructability of the program. The positions in the program structure, not in the people, have the authority and responsibility for getting programs accomplished. Figure 2.5 shows some sophisticated decision-making techniques in construction.

The authority of the program manager is the right to invoke compliance by project managers and staff on the basis of formal position and control over rewards

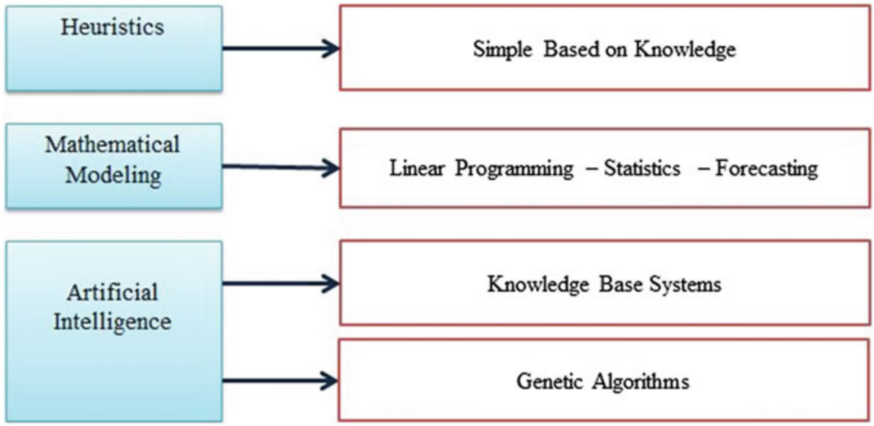

Fig. 2.5 Decision-making techniques in construction

and sanctions. Authority and responsibility should be directly linked; that is, if a subordinate is responsible for carrying out an activity or a project, he or she should also be given the necessary authority. Accountability is associated with the flow of authority and responsibility, and it is the obligation of the subordinate to carry out his or her responsibility and to exercise authority in terms of the established policies.

This view of authority, responsibility, and accountability provides the framework for much of traditional program management theory.

The Scalar Principle

There are different factors affecting the chain of command in a program, such as the geographical location of projects, the capability of the engineers, staff and workers, and the similarity of projects comprising the program. Other factors of much importance in constructing a program are the complexity of the projects, the level of the design, the availability of resources, and the technical know-how. In terms of program organization, delegation is very important to keep a tight control on a large number of projects comprising the program.

The program manager must be decisive and authoritarian with respect to the following:

1. Delegate as simply and directly as possible. Give precise instructions;
2. Illustrate how each delegation applies to the program objectives;
3. Develop standards of performance;
4. Clarify expected results;
5. Discuss recurring problems;
6. Seek project managers' ideas about how to construct and manage separate projects and specialist trades such as mechanical, electrical, cladding, and piling;
7. Recognize superior performance;
8. Keep your promises; and
9. Avoid excessive checks on progress.

The scalar principle establishes the hierarchical structure of the organization. It states that authority and responsibility should flow in a direct line vertically from the highest level of the program hierarchy organization to the lowest level. It refers to the vertical division of authority, and responsibility and the assignment of various duties along the scalar chain. Figure 2.6 shows a typical, scalar principle mechanism (Naidu and Krishna Rao 2008).

Although most organization charts are drawn to emphasize the vertical hierarchy and superior–subordinate relationships, very few indicate horizontal interactions, those integrative activities that flow between departments, units, or individuals at approximately the same level, such as the technical different departments dealing with quality assurance/quality control, planning, quantity surveying, cost control, value engineering, procurement, contracts. The function of horizontal relationships

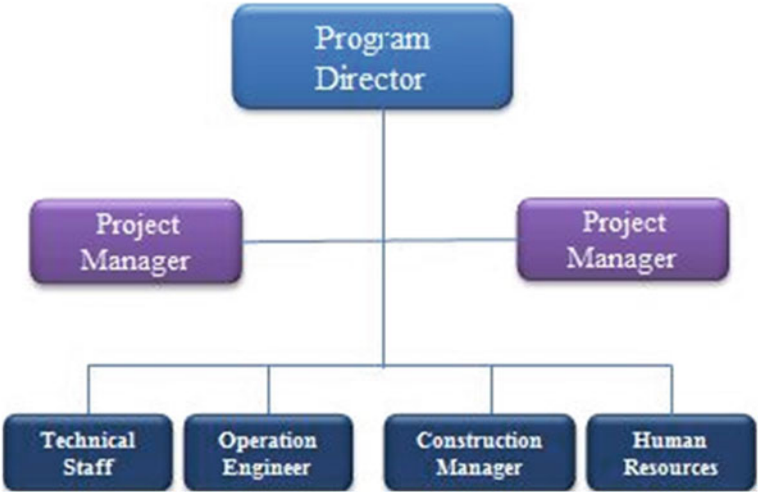

Fig. 2.6 Scalar principle mechanism

is to facilitate the solution of problems arising from division of responsibilities and the teams working on a program, and their nature and characteristics are determined by the participants having different organizational subobjectives but interdependent activities that need to intermesh.

Figure 2.7 shows the vertical and horizontal decision-making structures in a program hierarchy. In a vertical hierarchy in a program, the following are the main components:

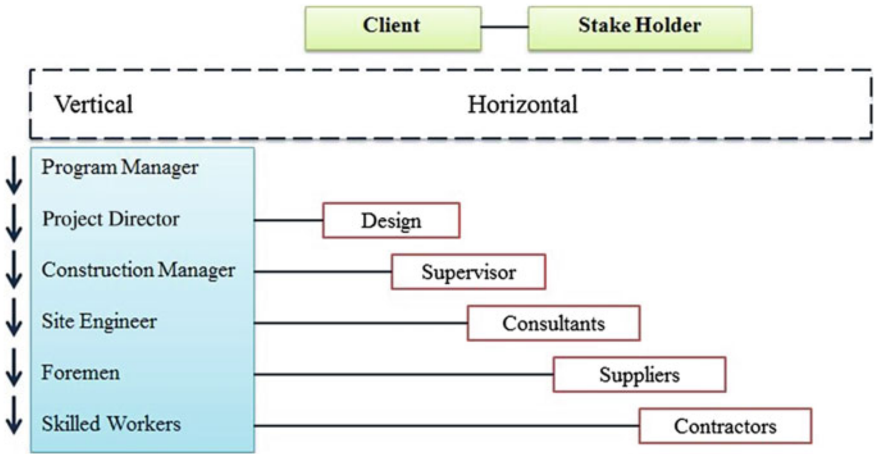

Fig. 2.7 Interrelationship between vertical and horizontal scalar in program structure

1. Program manager, program director, or program leader;
2. Project managers;
3. Senior engineers;
4. Site engineers;
5. Technicians dealing with matters such as quality control and quality assurance, AutoCAD operators, quantity surveyors, surveyors, and safety officers;
6. Staff such as document controllers, security officers, attendance supervisors, secretaries, and office support staff;
7. Foremen;
8. Skilled laborers; and
9. Laborers.

In a horizontal hierarchy in a program, the following are the main components:

1. Client and stakeholders;
2. Contractors;
3. Designers;
4. Engineering consultants;
5. Other consultants in contracts, cost control, LEED, mechanical and electrical, value engineering, etc.;
6. Supervision team; and
7. Facility management.

System Understanding—A Program Approach

A system is an organized, unitary environment composed of two or more interdependent parts, components, or subsystems and delineated by identifiable boundaries from its milieu. An engineering system consists of a large number of interconnected components, each of which may serve a different function, but all of which are intended for a common purpose. The degree of achieving the common goal is a measure of the system's effectiveness.

Every system is a sub-system of a yet larger system or component systems. No system is really independent of other systems, i.e., there are interactions between different systems. The state of a system at any moment is determined by the values of the relevant properties which the system has at that point in time. Any system has a large number of properties, only some of which are relevant to a particular purpose. The values of these properties constitute the state of the system.

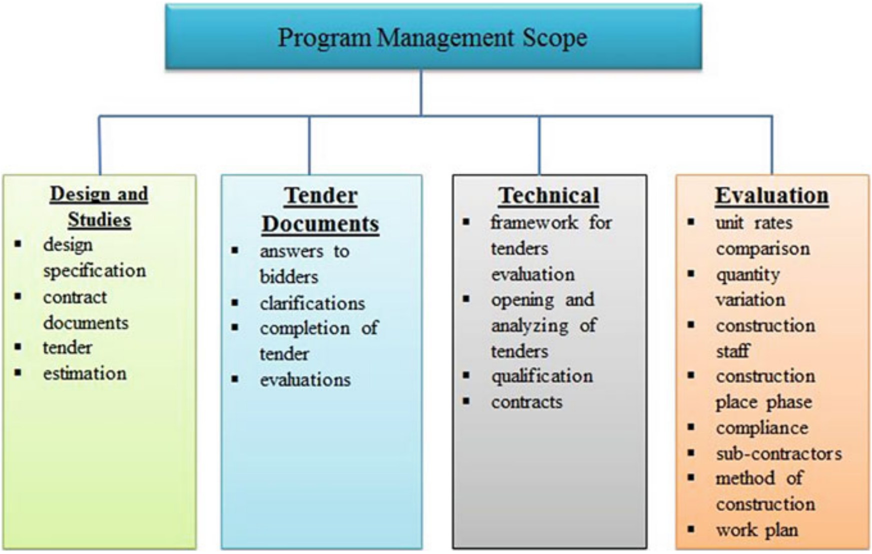

Fig. 2.8 Typical program management system components

Basic components of a system for a typical program consist in principle of the following:

1. Engineering system, including design and constructability;
2. Type of system that relates to each project within the program;
3. Environment of a system;
4. Hierarchical system (A basic concept in systems thinking is that of hierarchical relationships between systems. A system is composed of subsystems of a lower order and is also part of a super-system. Thus, there is a hierarchy of the components of the system);
5. Systems analysis and decision making; and
6. Systems models including mathematical modeling, optimization techniques, statistical analysis, and intelligent models and simulations.

The structure of the systems analysis process for a program can be summarized in the following components as outlined in Fig. 2.8.

1. Project design and engineering;
2. Formulation of the planning and scheduling techniques;
3. Generation of alternative solutions for constructability;
4. Evaluation of alternatives;
5. Selection; and

6. Feedback. (The concept of feedback is important in understanding how a system maintains a steady state. Information concerning the outputs or the process of the system is fed back as an input into the system, perhaps leading to changes in the transformation process and/or future outputs.)

System Environment

System environment comprises all other systems and their relevant properties which are not part of the system under consideration, but a change in any of them may affect the state of this system. The environment of a system includes also other systems that are affected by the system under consideration.

The system approach discourages the program manager from initially presenting a specific problem definition or adapting a particular solution to the problem; instead, the system approach emphasizes that the problem environment be defined in broad terms so that a wide variety of needs can be identified that have some relevance to the problem. These needs should reflect the complex relations and conflicts implicit in the problem environment.

System Analysis

System analysis covers the comprehensive aspects of program management engineering practice and the application of modern decision analysis techniques in the planning and choice of engineering systems. The focus of system analysis is to optimize the use of resources (people, materials, money, and time). System analysis involves the application of many analytical tools such as utility and theory optimization, sensitivity analysis, accounting, knowledge base systems, and network techniques. Figure 2.9 shows a system analysis configuration.

The significance of systems analysis consists of the following:

1. Sharpening the program manager's awareness of the objectives of the program he or she is designing and planning. The program manager is required to make explicit statements of what the objectives are and their definitions;
2. Making precise forecasts;
3. Generating large alternatives;
4. Helping to make a decision; and
5. Suggesting strategies of decision making which can be used to select among possible alternatives.

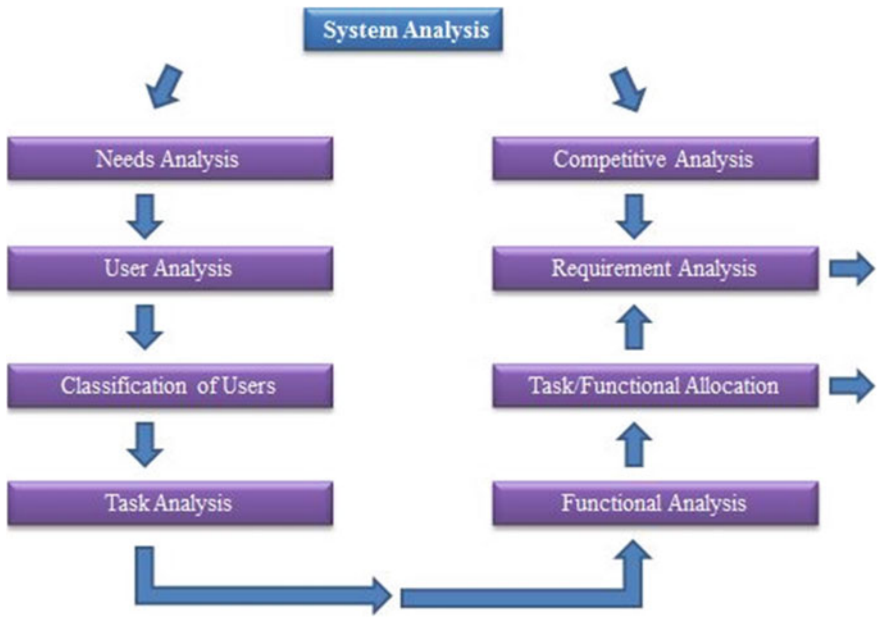

Fig. 2.9 System analysis configuration

The fundamental steps in the structure of the systems analysis process are as follows:

1. Problem definition and statement of objectives;
2. Formulation of measures of effectiveness (MOE);
3. Generation of alternative solutions;
4. Evaluation of alternatives;
5. Selection and implementation; and
6. Feedback.

System Models

These are abstract representations that describe the interactions between the complex factors of the program system environment and the causal dependencies among these factors so that the analysis can correctly perceive the effects of the substantial changes that may be introduced by large-scale projects. Refer to Fig. 2.10 for systems model building process.

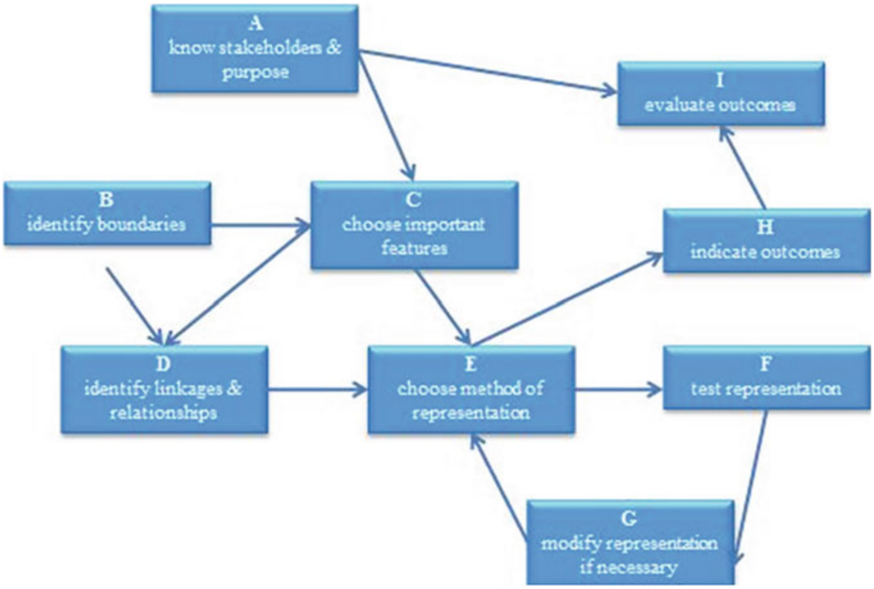

Fig. 2.10 Systems model building process

The types of models vary as follows:

1. Iconic,
2. Analogue,
3. Mathematical or analytical,
4. Computer simulation, and
5. Artificial intelligence.

The systems model building process, achieving the above, includes as follows:

1. Model formulation,
2. Model verification (existing data),
3. Model application to predict new observations, and
4. Model refinement to achieve precision (Jackson 2000).

Contingency View

The contingency view depends on a body of knowledge and research tasks that focus on interrelationships among key variables and projects in program management. It also emphasizes on the role of the program manager as diagnostician, pragmatist, and artist. The contingency view seeks to understand the interrelationships within and among projects as well as between the organization and its

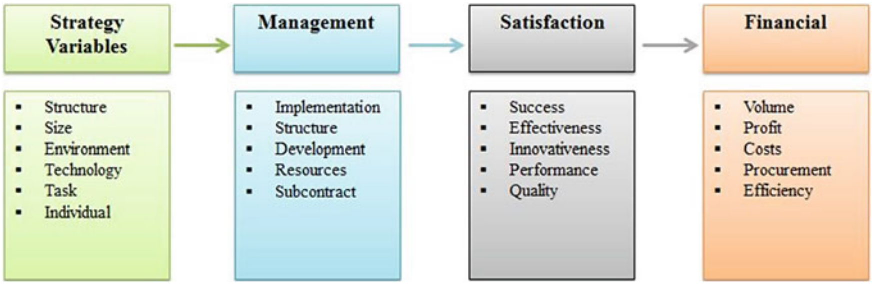

Fig. 2.11 Contingency view components

environment and to define patterns of relationships or configurations of variables. It emphasizes the multivariate nature of projects and attempts to understand how program management operates under varying conditions and in specific circumstances. Contingency views and managerial actions are most appropriate for specific situations. Figure 2.11 shows the contingency view components which are divided into strategy, management, satisfaction, and financial.

This approach recognizes the complexity involved in managing new programs but uses the existing body of knowledge to relate the environment and the design, to match the structure and the technology, to integrate the strategy and the tactics, or to determine the appropriate degree of subordinate participation in the decision making, given a specific situation. Success in the art of program management depends on a reasonable success rate for actions taken in a probabilistic environment.

Contingency views represent a middle ground between the view that there are universal principles of organization and program management and the other view that each organization is unique and that each situation must be analyzed separately (Grandori 1984).

Open and Closed Systems

Systems can be considered in two ways: (1) closed or (2) open. Open systems exchange information, energy, or material within their environments. Infrastructure and social development programs are inherently open systems. The closed system has rigid, impenetrable boundaries, whereas the open system has permeable boundaries between itself and a broader super-system. The boundaries set the domain of the organization activities. In a program comprising of residential buildings, the boundaries can be clearly identified. In an infrastructure program, the boundaries are not easily definable and are determined primarily by the functions and activities of the projects. Such an organization is characterized by rather vaguely formed, highly permeable boundaries. Figure 2.12 shows the advantages and disadvantages of open and closed systems.

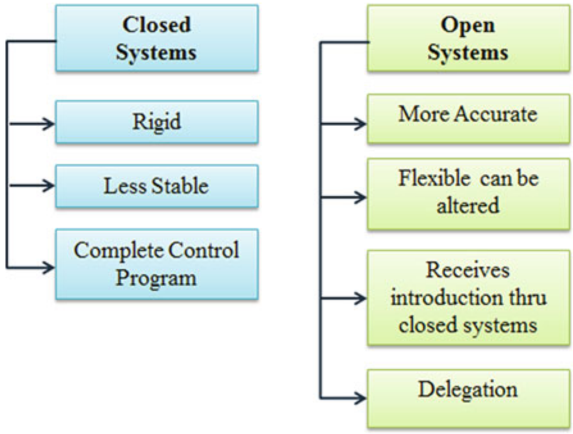

Fig. 2.12 Open and closed systems—advantages and disadvantages

Many systems grow through internal elaboration. In the closed system, subject to design, planning, and constructability, the programs move toward entropy and disorganization. In contrast, open systems appear to have the opposite tendency and move in the direction of greater differentiation and a higher level of organization.

Traditional program management theories generally use a highly structured, closed-system approach. Modern theory has moved toward the open-system approach. The survival of the system would not be possible without continuous inflow, transformation, and outflow of information. The system must also receive sufficient input of resources to maintain its operation and also to export the transformed resources to the environment in sufficient quantity to continue the cycle.

For example, programs, including the construction of public buildings such as schools, hospitals, and colleges, receive inputs from society in the form of people, materials, money, and information and transform these into outputs of products, services, and structures. Finance and the market provide a mechanism for recycling of resources between the program management team and its environment. Also, even when we consider that the open system is the most suitable for program management topics, we should recognize that the concept of open or closed is a matter of degree. In an absolute sense, all systems are open or closed, depending on the point of reference. Thus, all systems are "closed" in some degree from external forces (McCullough 2008).

Decision-Making Principles

Many principles are used to summarize the knowledge required for decision making in program management. They cover formulating a problem, obtaining information about it, selecting and applying methods, evaluating methods, and using decision-making techniques.

In this section, each principle is described along with its purpose, the conditions under which it is relevant, and the strength and sources of evidence. A checklist of principles is provided to assist in evaluating the decision-making process. The checklist can help one to find ways to improve this process and to avoid liability for poor selection, poor planning, and not providing the right information.

When program managers receive information, they often cannot judge its quality. Instead of focusing on the decision making, they decide whether the process is reasonable for the situation. Therefore, by examining decision-making processes and improving them, managers may increase accuracy and reduce costs.

It is crucial to separate the decision process from the analysis process. One possibility is to have one group do the planning and another do the analysis. Separating these functions could lead to reports showing different decisions for alternative plans. This principle is sensible and important, yet it is often ignored.

The program manager must describe how the decisions are to be made, and do so in intuitive terms. It may help to propose using a selection method on an experimental basis. The problem should be structured so that the program manager can use knowledge effectively for it to be useful for decision making. This will include identifying possible outcomes prior to making the decision. Determining possible outcomes is especially important for situations in which the outcomes are not obvious or in which a bias could lead to failure to consider a possible outcome. Brainstorming about possible outcomes assists in structuring the approach. For example, experts might be asked to brainstorm the possible outcomes from the imposition of an affirmative action plan in a workplace.

Other experts involved in a program, such as the designers, consultants, and specialists, should help to determine the prerequisite for a program specified by time, cost, specifications, constraints, and resources among other factors. Thus, program management can focus on the level of aggregation that yields the most accurate decision. As well as improving the use of program management by tailoring it to decisions, sufficient knowledge and information must exist to enable different levels of aggregation.

It is also essential to decompose the problem into parts. This will require the use of a bottom-up approach; that is, micro-managing each component, then combining them to improve the accuracy of decision making by improving reliability. Also, by decomposing the problem, a program manager can effectively use the alternative sources of information and the different methods. It is helpful to decompose the problem in situations involving high uncertainty and extreme (very large or very small) numbers.

The program manager must identify knowledge and information that might be useful in making a decision. While this should be guided by theory, the manager may need to be creative in seeking alternative types of knowledge and information.

It is also crucial to understand that information is critical as an input into the decision process. A positive correlation has been established between program performance and decision-making practice, and since a program is a temporary organization, a correlation between program performance and decision practices should be expected. The main challenges to a mega-project are inadequate, unreliable or misleading information, and the conflict between decision making, policy, and planning (Haidar et al. 2014).

Improving the Accuracy of Decision Making

To follow this principle, program managers must have good prior knowledge of the problem to be dealt with. That knowledge can be based on the experience or research studies such as follows:

1. Received wisdom with little empirical testing. Received wisdom has been questioned, sometimes, in the belief that more information is always better;
2. Some researchers have ignored this principle in favor of knowledge and information mining, which assumes that the knowledge and information will reveal causal patterns;
3. Ensure that the information and knowledge match the situation;
4. Knowledge and information about past behavior in that situation are often the best predictors of future behavior;
5. Avoid biased knowledge and information sources; and
6. Avoid knowledge and information collected that are obviously biased to particular viewpoints.

Program managers must find alternative ways of measuring the same thing. If unbiased sources are not available, the manager may find sources with differing (and hopefully compensating) biases. For example, allocation of staff from project A to project B should equal the transfer of staff to project B from project A.

Methodology and Knowledge Preparation

This is an essential part of the decision-making procedure and involves the program manager in preparing knowledge and information for the decision-making processes such as follows:

1. Clean up the knowledge and information;
2. Adjust for mistakes, changing definitions, missing values, and contingency. Keep a log to record adjustments; and
3. Use graphical displays for knowledge and information;
4. When judgment is involved, graphical displays may allow the program manager to better assess patterns, to identify mistakes, and to locate unusual events. However, experts might also be misled by graphs if they try to extend patterns from the past;
5. Program managers should be trained so that they do not try to match time patterns when making judgments in uncertain situations.

Program managers are required to select the most appropriate methods for making decisions. They can expect that more than one decision-making method will be useful for most problems. This will involve the following:

1. List all the important selection criteria before evaluating methods and
2. Accuracy is only one of many criteria. The relevant criteria should be specified at the start of the evaluation process.

Structured methods are those consisting of systematic and detailed steps that can be described and replicated. Structured methods are useful when accuracy is a key criterion and where the situation is complex.

Program managers are advised to select methods that are appropriate given the criteria, the availability, and type of knowledge and information. Prior knowledge, presence of conflict, and amount of change expected are also important. The selection of the most appropriate decision-making method, when alternative methods are feasible and there is much uncertainty, is summarized as follows:

1. Assess acceptability and understandability of methods to the consultants involved;
2. Ask project managers what information they need in order to accept a proposed method;
3. Examine the value of alternative methods; and
4. Examine whether the costs are low relative to potential benefits. Program managers seldom do this, primarily because of the difficulty of assessing benefits. This principle is unnecessary when potential savings are obviously large relative to the costs of the effective methods.

Program managers must try to keep decision-making methods simple as complex methods may include errors or mistakes that are difficult to detect. Simple methods are important when many managers participate in the planning and selection processes and when the stakeholders want to know how the decision was made. They are also important when uncertainty is high and little knowledge and information is available.

The decision-making methods should provide a realistic representation of the situation. Program managers should follow the following criteria:

1. Realize that they may have to add some complexity when developing optimization models;
2. Compare the matching of the method to the situation. This principle is most important when the match is not obvious. It is important when the situation is complex, as often happens for situations involving conflict among groups;
3. Be conservative in situations of high uncertainty or instability; and
4. Reduce changes to the extent that uncertainties and instabilities occur in the knowledge and information or in expectations about the future.

Some principles for decision making concern only judgmental methods. In general, program managers need to ask the right questions at the right time. These methods include as follows:

1. Pretest the questions you intend to use to elicit judgmental decisions;
2. Prior to collection of knowledge and information, questions should be tested on a sample of potential respondents to ensure that they are understood and that they relate to the objectives of the problem;
3. Frame questions in alternative ways;
4. The way the question is framed can affect the decision. Sometimes, even small changes in wording lead to substantial changes in responses;
5. Ask project managers to justify their decision making in writing; and
6. Support them in showing the reasons supporting their decisions.

Judgmental information can be combined with optimization methods and techniques in many ways to obtain the right decisions. This principle is important when the model used for decision making would not otherwise include judgmental knowledge. The use of this information as an input rather than to revise the decision is especially important when the decision could be subject to biases, as, for example, in scheduling and planning on the basis of the effects of new structural models where the program manager is more familiar with one system. The program manager, in order to combine a hybrid of empirical information, feed analysis, and optimization methods, must be consistent with the following:

1. Use structured procedures to integrate judgmental and quantitative methods;
2. Use prespecified rules to integrate judgment and quantitative approaches. In practice, analysts often violate this principle. The principle is relevant when you have useful information that is not incorporated in the optimization method. Whether to integrate will depend on the knowledge and information, types of method and expert information;
3. Use structured judgment as an input to optimization models;
4. Use judgment as an input to a model rather than revising the model's structure;
5. There is some empirical support and it challenges received wisdom;
6. Use pre-specified domain knowledge in selecting, identifying, and modifying the variables in the optimization methods; and
7. Subjective adjustments should be limited to situations in which you have domain knowledge that is independent of the model.

Evaluation of Decision-Making Methods

When many solutions are needed for a particular situation, program managers should compare alternative methods of decision making. The comparison should include accuracy and other criteria. Among these other criteria, it is of particular importance to properly assess uncertainty. The principles for evaluating decision-making methods are based on generally accepted scientific procedures, namely:

1. Compare reasonable methods;
2. Use at least two methods, preferably including the current procedure as one of these. Exclude methods that would be considered unsuitable for the situation;
3. Whenever biases can affect the evaluation (which is often); knowledge of alternative approaches is helpful;
4. Use objective tests of assumptions;
5. Use quantitative approaches (statistics analysis, optimization techniques, knowledge-based systems, and genetic algorithms will be discussed in subsequent chapters) to test assumptions;
6. Design test situations to match the problem; and
7. Test decision-making methods by simulating their use in actual situations.

Presenting the outcome of the decision making is also crucial to improve the program manager's understanding and to reduce the likelihood of overconfidence. This process will include the following:

1. Present decision outcomes and supporting knowledge and information in a simple and understandable form;
2. Keep the presentation simple yet complete. For example, do not use insignificant digits because they imply false precision;
3. Graphs are often easier to understand than tables;
4. Clear presentations are especially important on the effects of program phase changes;
5. Provide complete, simple, and clear explanations of methods; and
6. Periodic assessments should be made to examine how the decisions are being used.

Contextual Influences

Policy implementation, based on the decisions made, refers to the mechanisms, resources, and relationships that link the program execution policies to the program objectives. Understanding the nature of policy implementation is important because experience shows that policies, once adopted, are not always implemented as envisioned and do not necessarily achieve intended results. Moreover, some solutions and systems are provided with little attention as to how such activities fit into or contribute to broader program goals. Too often, policy assessments emphasize outputs (e.g., number of projects delivered) or outcomes (e.g., increased production in certain areas such as concrete activities) but neglect the policy implementation process which could shed light on barriers or facilitators of more effective implementation. Assessing the implementation process provides greater understanding of why programs work or do not work and the factors that contribute to program success.

Various factors influence the implementation of decisions, including their content, the nature of the implementation process, the parties involved in the process, and the context in which the policy is designed.

Program characteristics and contextual factors influence the program manager's approach to information feed and how challenges may be classified as "threats" or "opportunities". In particular, what a program manager perceives as important to senior management (an organizational context) is expected to influence his or her management priorities, hence decisions.

Literature on organizational behavior and decision making also infers that experience plays an important role in decisions and has a positive relationship with decision outcomes. So the program manager's professional experience (a personal context) could be expected to influence the information framework adopted on the program, hence the potential impact on the strategic outcomes. Figure 2.13 shows the different factors influencing a program manager decision implementation process.

The elements measured are the quantity, quality, and timeliness of information gathered by the program manager. These are combined to form the construct variable, information feed, derived from how the facts are constructed. These same subvariables could also be segregated as internally or externally focused information as a means of further sensing where problems may be coming from. The components of information feed include as follows:

1. Performance information on corporate financial services, HR management, and other performances;
2. Information on the "pulse" of internal and external stakeholders (stakeholder pulse factor);
3. Information on program efficiency, stakeholder management, benchmarks, etc. (project performance factor); and
4. Timeliness of information to the program manager toward decision making (information timeliness factor).

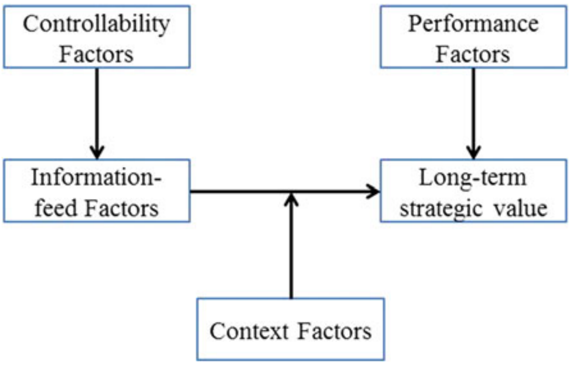

Fig. 2.13 Factors that influence the implementation of decisions

The contextual variable has two main components. First is the program manager's perception of what his or her senior management drivers are, for example, cost, schedule, stakeholder management, safety, quality, and economics. The second is information on the program manager's professional tenure, obtained as a measure of experience.

Strategic value is measured from the viewpoint of the program manager. Items measured are as follows:

1. Projects performance in comparison with objectives and aspirations of the host client and stakeholders on the program;
2. Health, safety, security, and environmental performance of the program;
3. Economic profitability; and
4. Making a significant socioeconomic contribution to society.

Integrating program performance information into a program manager's decisions has a positive influence on promoting the program value to the stakeholders, while exerting a negative influence of similar value to host communities who have their interest mainly tied to the benefits they expect to receive from the program (Gareth and Maynard 2013).

Formalization Advantages

Program management formalization is directly connected to program success. Despite the merits of formalization, oversystematic and formalized systems may halt the progress of the program and increase organizational inertia as well as resistance to change. To understand the specific conditions that support the positive effects of formalization, it is essential to adopt a contingency perspective when investigating its effectiveness. Various characteristics, such as the size, complexity, or location of projects in the program, may influence the effectiveness of formalization. However, most studies do not take contingencies into account. Program complexity is of particular importance in the context of program management because larger programs and interdependencies between projects pose challenges for the manageability of programs. Figure 2.14 demonstrates the effect of single project management framework and its effect on formalization, program quality, and program success.

Formalization is defined here as the degree to which processes, procedures, work rules, and policies are clearly specified and followed. In program management, this includes the consistent use of defined procedures, methodologies, and tools. Formalization can take place at the level of single projects or at the program level. Established standards that have been developed explicitly for the program management domain describe processes and tools and provide guidelines and support to organizations in their application of management practices.

Formalization of processes helps to exploit economies of scale and of scope. Learning of processes becomes easier, coordination between processes is simpler,

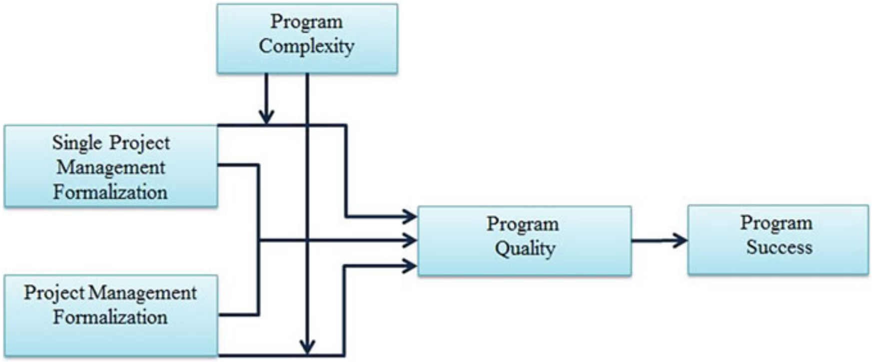

Fig. 2.14 Relationship between formalization, program quality, and program success

processes become more reliable, and processes can be performed in a shorter time. Formal procedures include a shared and reproducible core process in which all project managers follow the same sequence of program phases, milestones, activities, and major deliverables for each program.

The benefit of consistently applied processes across a program is the ability to transfer process knowledge from one project to another. Through shared knowledge, program managers achieve a common understanding that is positively associated with information quality, thereby improving the speed and quality of communication within processes. A well-structured process provides predictability and control, and prevents malpractice by, for example, inhibiting the unjustified use of resources. Periodical program status reports and routine program reviews are beneficial for program tracking and initial program planning, which increases the percentage of projects completed on time.

Predictability of the scope, schedule, and cost of the program leads to higher transparency and reduces the residual performance risk, which increases performance. Furthermore, formalization can improve clarity in decision making. However, formalization is not always beneficial as, in specific scenarios with radical innovations, it may have negative effects; too much formalization may constrain creativity and interrupt innovative activities. While some authors argue that formalization has negative effects, in general, the positive effects of formalization prevail (Carpenter et al. 2013).

Formalization Complexity

In contrast to single project management, program management is conducted at a higher hierarchical level. With an eye on the entire project program, a more holistic view is required to reflect previous experience, simultaneous projects, the organizational environment, and future organizational intention. Therefore, the exchange of information, management of resources, and coordination of the collection of projects become even more important for program. Various studies support the notion that the formalization of program processes significantly influences program performance.

In a decision tree (branch and node) procedure, after each process stage, a yes or no decision is made, and each project is assessed against pre-defined criteria to decide whether to continue with the same methods of execution for the project. If applicable, an action plan for the next stage is developed. At each branch, it is ensured that decisions and resource allocations reflect the needs of the entire program. These formal processes introduce structure, sequence, and clarity to all projects. Establishment of clear rules and guiding principles at the decision points lead to data integrity, and facilitate the comparison of divergent projects, ensuring that processes are comprehensive and responsibilities are well defined. Program process formalization, therefore, improves information and coordination quality by supporting interactions between different functional groups and projects, and facilitating interproject learning.

Formal procedures and rules enhance the availability and determine the format of information, thereby facilitating the comparison of diverse projects. For example, high levels of formalization in single projects result in clear resource requirements and a transparent planning and scheduling for these single projects. In turn, this increases the efficiency and speed of the formal resource allocation and prioritization process, and facilitates coordination between projects.

Without single project management formalization, the formalization of program management is elusive. Therefore, an increase in the formalization of program management without formal processes for single project management will be ineffective. However, formalization of single project management alone will not be effective either because it lacks a holistic view. Furthermore, the definition and implementation of a formalized program process will increase, and reinforce the formalization of the single project process. While single project management improves efficiency, program management enables organizations to increase their effectiveness. Simultaneous single project management formalization and project program management formalization increase the positive effect on program quality (Byrne 1998).

Program Complexity as a Contingency Factor

The optimal degree of formalization depends on the characteristics of the task, which are a core theme in task-related contingency theories; hence, it is necessary to adopt a contingency perspective to specify the conditions under which formalization becomes more or less desirable and effective. Two kinds of task related contingency theory have been developed in relation to the impact of formalization. The first uses the complexity of a task as a moderating factor, and the second uses the uncertainty, risk, or innovativeness of a task.

In program management, the systemic perspective is often used to describe the complexity of a program which is defined as the size of the project program and the degree of interdependency between projects. This perspective includes the following determinants of complexity:

1. The number of projects;
2. The degree of interdependency between the projects; and
3. The magnitude and predictability of changes in the projects and interdependencies.

Similar arguments have been used to define the complexity of single projects. Because the magnitude and predictability of changes in the projects are also central elements of uncertainty, the size of a program, and the degree of interdependency between the projects are measures of complexity. The more these interdependencies occur, the higher is the complexity of a program. Projects in a program may be linked by outcome, resource, or knowledge interdependencies as such:

1. Outcome interdependency occurs when one project uses the resources of another project,
2. Resource interdependency occurs when different projects concurrently compete for the same resources, and
3. Knowledge interdependency occurs when the knowledge generated in one project is relevant for another project.

Any collection of interrelated projects requires coordination of project management activities. The need for coordination results from the inevitable effect of changes in one individual project on the execution of another project in the program. For example, delays in one project place the resources availability of the entire program at risk when projects share the same scarce resources. Therefore, with increasing program size and stronger project interdependency, coordination becomes even more important. Because formalization enables better coordination, it may be especially beneficial in programs with high complexity. Program complexity also increases the opportunity to leverage synergies into knowledge, technological platforms, and end users. Resource conflicts become more likely and the allocation of resources becomes more challenging.

Decision-Making Formalization Methods

Typically, the program manager is responsible for the immediate management of the program as well as conceptual and advisory activities to shape the program processes. Thus, the program manager is in a unique position to judge the applied procedures, methods, and processes for managing the program. Although program managers can be considered the best source for the variables, the chosen key is that there are no right or wrong answers. The key methods for formalization include the following:

1. The program is consistently aligned with the firm's future;
2. Firm strategy is implemented by the program in an optimal way;
3. The program resource allocation reflects strategic objectives;
4. The program has a good balance between opportunities and risks;
5. Transparency is important;
6. Accessibility to all relevant information on a project's status is made easily and quickly;
7. Presentation of information on the program is standardized at the top management level;
8. Program managers are continuously provided with relevant information on the entire program;
9. Program status and resource information can be interpreted easily and quickly;
10. Resource information is delivered as is necessary for decision making;
11. A detailed plan is provided for each project;
12. Each project gets assigned a defined project budget within the program;
13. Program monitoring takes place continuously for the whole duration of a program;
14. Program progress is regularly tracked, as well as completely and routinely recorded, for each project within the program;
15. Program management process is divided into several phases;
16. All process phases are concluded by an explicit approval gate;
17. Program management process is precisely specified;
18. During a program review, all projects are rigorously examined;
19. A shared understanding of the program management process is reflected in the activities of all projects;
20. A very structured program management process is implemented;
21. A high degree of alignment between projects is required with respect to the scope of each;
22. The output of one project is often part of another project or a component of the whole program;
23. Scope changes of individual projects impact on the execution of other projects; and
24. Often projects can only be continued if the precise results of other projects are known.

Reliability and Validity of Decision Making

Reliability is the consistency of measurement, or the degree to which an instrument measures the same way each time it is used under the same conditions with the same subjects. In short, it is the repeatability of your measurement. Reliability is usually estimated as test/retest and internal consistency.

Test/retest is the more conservative method to estimate reliability. Simply put, the idea behind test/retest is that you should get the same score on test 1 as you do on test 2. The three main components of this method are as follows:

1. use your measurement instrument at two separate times for each subject,
2. compute the correlation between the two separate measurements, and
3. assume there is no change in the underlying condition (or trait you are trying to measure) between test 1 and test 2.

Internal consistency estimates reliability by grouping questions in a questionnaire that measures the same concept. For example, one could write two sets of three questions that measure the same concept and, after collecting the responses, run a correlation between those two groups of three questions to determine whether the instrument is reliably measuring that concept.

The primary difference between test/retest and internal consistency estimates of reliability is that test/retest involves two uses of the measurement instrument, whereas the internal consistency method involves only one use of that instrument.

Validity is the strength of our conclusions, inferences, or propositions. More formally, it can be described as the best available approximation to the truth or falsity of a given inference, proposition, or conclusion. There are two types of validity commonly examined in program management:

1. Internal validity asks if there is a relationship between the program plan and the outcome; in other words, if it is a causal relationship or not; and
2. External validity refers to our ability to generalize the results of our study to other settings.

The real difference between reliability and validity is mostly a matter of definition. Reliability estimates the consistency of the measurement, or more simply the degree to which an instrument measures the same way each time it is used under the same conditions and with the same subjects. Validity, on the other hand, involves the degree to which we are measuring what we are supposed to, or, more simply, the accuracy of the measurement. Many scholars believe that validity is more important than reliability because if an instrument does not accurately measure what it is supposed to, there is no reason to use it even if it measures consistently (reliably).

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