

A Multi-Disciplinary View on Software Release Decisions

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ABSTRACT

A relatively unexplored area in the field of software management is the implementation or release decision, deciding whether or not a software product can be transferred from its development phase to operational use. Many software manufacturers have difficulty in determining the 'right' moment to release their software products. It is a trade-off between an early release, to capture the benefits of an earlier market introduction, and the deferral of product release, to enhance functionality, or improve quality. In this research project software release decisions are researched from three perspectives: economics, decision-making and software management. All perspectives are reviewed, explored in-depth, both from a theoretical and from an empirical point of view, by studying practical examples. The results are used in a proposed methodology to improve strategic software release decisions, characterized by the existence of large prospective financial loss outcomes, including the presence of high costs for reversing a decision. The methodology identifies the critical factors for a high quality decision outcome, being the sum of quality of the decision inputs and the quality of the decision-making process.

Categories and Subject Descriptors

K.6.3 [Management of Computing and Information Systems]: Software Management – *software development*.

General Terms

Management, Human Factors.

Keywords

Software releasing, decision-making, satisficing behaviour.

1. INTRODUCTION

There are many (indefinite) points of evaluation along the life-cycle of a software product. The various milestones in between the life-cycle stages in particular, draw the attention of researchers and practitioners in the software engineering disciplines. Important milestones are the upfront investment appraisal, the implementation or release decision, and disinvestment in an operational software product [10]. A relatively unexplored area in

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the field of software management is the implementation or release decision, deciding whether or not a software product can be transferred from its development phase to operational use. A release decision is a trade-off where, in theory, the objective is to maximize the economic value. Inputs into the release decision are expected cash inflows and outflows if the product is released. In a practical setting, the decision to release a software product can be a problem, best illustrated with examples:

- In practice, cost and time constraints will normally be present in retrieving complete and reliable information. This search for information should be taken into account as an economic activity with associated costs and time. This leaves the software manufacturer with the problem of finding the optimal level of information, where marginal value equals marginal costs and thus marginal yield is zero. Gigerenzer holds this optimal level is difficult, if not impossible, to find [5].
- Decision-making in the real world is often unstructured [9], and normally involves various stakeholders, and there might, for example, be reasons to release a system or software product, due to political or business pressures, even though knowing it still contains defects. A study of spacecraft accidents, for example, reveals that, although inadequate system and software engineering occurred, management and organizational factors played a significant role, including the diffusion of responsibility and authority, limited communication channels and poor information flows [7].
- Research has revealed there are many obstacles to the successful implementation of almost any decision [9], including:
 - The reduced importance of a decision once it is made and implemented.
 - The control of the outcome of a decision by stakeholders not involved in its making.
 - The development of new situations and problems to command the attention of the decision-makers once the choice has been implemented.

In this research project these different perspectives were reviewed, explored in-depth, both from a theoretical and from an empirical point of view, by studying practical examples. The results are used in a proposed methodology to improve strategic software release decisions, characterized by the existence of large prospective financial loss outcomes, including the presence of high costs for reversing a decision.

2. EXPLORATORY CASE STUDIES

2.1 Introduction

Seven exploratory case studies were conducted. The selected environments varied with respect to the software manufacturer types (custom system written in-house versus commercial software), geographical locations (The Netherlands and Switzerland), the product version developed (new product versus new version of existing product), and the process maturity level (ranging from CMMI level 1 to 3). The aggregated results are discussed in the next subsection (see [10] for a broader and more detailed overview and discussion).

2.2 Aggregated Case Study Results

Aggregating the results of the exploratory case studies leads to four main identified problem areas:

1. *Definition of the release criteria.* Documented and commonly-accepted product development strategies were not common in the cases studied. Not having consensus among stakeholders about priority setting in a product development strategy could imply that stakeholders do not work towards a common goal. It leaves room for self-imposed controls and restrictions, and performing activities (costs) that add no value.
2. *Information about the implemented values of the release criteria.* In all cases, information as input to the decision-making process was incomplete. Two examples are:
 - In most cases non-functional requirements were not broken down during product development to subsystems and/or lower level components. It was only during testing that reliability again received attention, which may be too late to guarantee a high reliability level. The level of maintainability obtained was not addressed.
 - Information on the availability of relevant documentation and the quality of this documentation was limited in a number of cases.

As a result, organizations faced difficulty in making firm statements about expected post-release maintenance costs.

3. *Decision-making process.* The process descriptions found did not explicitly focus on software release decisions. Through the questionnaires, and during interviews, informants confirmed that no formal collective decision-making process for release decisions was available, but that their organisation probably would benefit from such a process by creating transparency on responsibilities (who), activities (what), timing (when), and support methods (how).
4. *Implementation of the release decision.* The process descriptions found paid no or limited attention to the implementation of the release decision, once it was made. Although, in all cases, corrective actions were implemented for defects found after the release decision implementation, most cases revealed the absence of an institutionalized process to analyse the defects found and evaluate the business case, or project, afterwards to supplement organizational knowledge. This makes it difficult to plan expected post-release maintenance costs

for future projects based on prior experience, and prevents the identification of areas for improvement.

The problem areas identified in these exploratory case studies corroborate the need for a formal process to support software release decisions.

3. STRATEGIC DECISION SUCCESS

A formal process offers a structured mechanism to provide visibility of threats to release decision success. The net result of a formal approach is to help avoid preventable surprises late in the project, and improve the chance of meeting initial project commitments, and reducing the level of uncertainty. Reducing uncertainty has a cost, which should be balanced against the potential cost a software manufacturer could incur if the uncertainty is not reduced. It may not be cost-effective to try and reduce uncertainty too much. Formal approaches are of special concern when common interests increase, and when strategic value is present. A decision is considered as being of strategic value when large prospective financial loss outcomes to a software manufacturer and its customers/end-users of the software are present [7]. This is often true for software release decisions due to high costs for reversing the software release decision once made. Strategic value also has a long-term character as prospective loss outcomes may arise long after the decision has been made (for example, in cases where liability issues lead to lawsuits). Decisions with strategic value should be made at a high level of the organization, require a formal decision-making process, and should be of concern to top management [6]. Routine software release decisions, without strategic value, can be handled with a higher degree of certainty, and should be left to management at tactical, or even operational, level. Strategic software release decisions require a formal, collective decision-making process. Decision-making is defined as the combined activity of comparing alternatives and the act of choice. However, Harrison divides a decision-making process into six functions; broadening the scope with preceding and proceeding activities, as illustrated in Figure 1 [6].

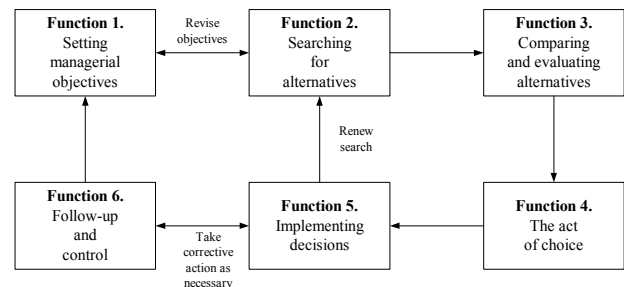


Figure 1. Components of a Decision-making Process [6].

In this framework, decision-making is illustrated as a dynamic process. Decision-making is considered to be a non-linear, recursive process. That is, most decisions are made by moving back and forth between the choice of criteria or objectives (the characteristics the choice should meet) and the identification of alternatives (the possibilities one can choose from). The alternatives available influence the objectives applied, and similarly the objectives defined influence the alternatives to be

considered. Other conditions increasing the likelihood of strategic decision success are [6]:

1. *Decision-making process*. The primary factors here are the availability of well-defined, *attainable objectives* (Condition 1) as opposed to unattainable objectives and a mindset toward an *open decision model* (Condition 2), giving weight to the environment (dynamic objectives, imperfect information, time and cost constraints, cognitive limitations), opposed to a closed decision model.
2. *Decision*. The primary factors here are a *judgmental decision strategy* (Condition 3): choosing an alternative based on judgment applied to information that is imperfect, instead of a computational strategy and the search for a *satisficing outcome* (Condition 4): strong preference for a desirable result; complemented by an acceptance of less-than-perfect knowledge about the outcome, meeting the defined objectives instead of a maximizing outcome.

4. METHODOLOGY

4.1 Overview

The framework was used to define a methodology for the software release decision-making process, existing of four process areas addressing the process from different perspectives. These process areas match problem areas identified for software release decisions, as discussed in section 2.

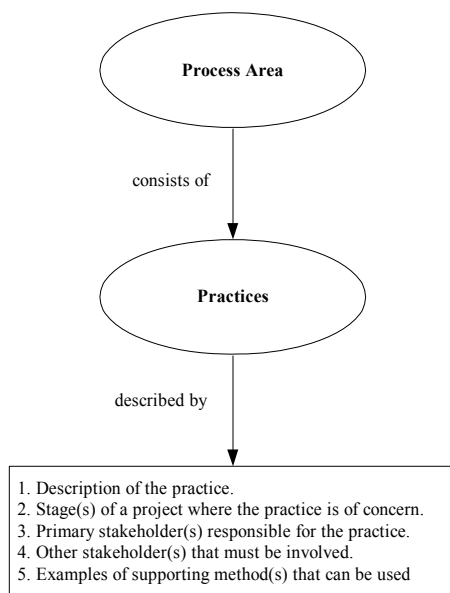


Figure 2. Structure of the Methodology [11].

A process area is defined as a cluster of related practices which, when performed collectively, achieve a set of goals considered important for establishing process capability in that area. Each process area in the methodology identifies relevant practices, which describe ‘what’ is to be accomplished (general guidelines) but not ‘how’. See Figure 2. Taking this approach, the descriptions of practices still offer the possibility for interpretation and customization to the external market

environment, and to internal strategic and functional characteristics of a software manufacturer organization.

The identified process areas are:

1. *Release Definition*. Decision-making is mainly viewed from a quantitative perspective, assuming that information is near to perfect: complete and reliable. It emphasizes the *maximizing behaviour* approach with emphasis on the mathematic, economic and statistic disciplines. In software release decisions, decision-making from a quantitative perspective is concerned with the definition and control of a product development strategy: setting the managerial objectives with their priorities (Function 1), and ensuring they are attainable (Condition 1). The availability of a product development strategy will enable the comparison/evaluation of different release alternatives (Function 3), thus answering the question: which alternative maximizes economic value?
2. *Release Information*. This process area is concerned with the search for alternatives (Function 2) during product development, for example, the identification and collection of information that is needed to compare and evaluate different release alternatives. This search is derived from the formulated product development strategy. Decision-making is also viewed from a quantitative perspective, but with the recognition that information is imperfect in the sense that not everything can be expressed in numbers, and that information has its price, in time and money. For this process the mathematic, economic and statistic disciplines still play an important role, but the maximizing behaviour approach is extended with an *optimizing behaviour* approach: what is the optimal volume of information? Insufficient information increases uncertainty and hampers the decision-making process, whereas too much information is a waste of scarce resources; there is an optimum above which the cost for searching for more information exceeds the benefits.
3. *Release Decision*. Decision-making is viewed from a psychological, sociological and socio-psychological perspective, addressing factors that influence individual and group behaviour. It recognizes the imperfections of information, and stakeholders, involved in the act of choice (Function 4), will possibly have different preferences with respect to the decision outcome; an open decision-making process (Condition 2). The challenge is to use a judgmental strategy (Condition 3) to reach a decision outcome that meets the objectives formulated, and is agreeable to all stakeholders involved. The concept of optimizing behaviour is extended with a *satisficing behaviour* approach (Condition 4): which outcome satisfies the needs of all stakeholders involved?
4. *Release Implementation*. Decision-making is viewed from an implementation perspective once a decision has been made and is implemented (Function 5), assuming a successful decision requires follow-up and control (Function 6) of the implemented decision. For software release decisions, it is necessary to identify the factors that ensure congruence between the expected and the actual outcome. To increase organizational learning, the

decision-making process and its outcome should be appraised.

In Figure 3, the data-flow-diagram of the methodology is illustrated, combining the four identified process areas.

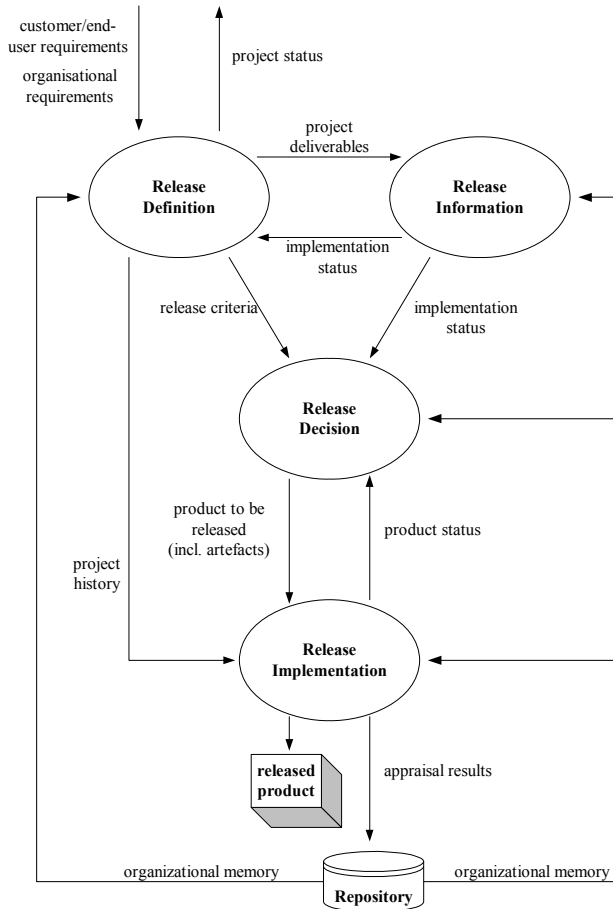


Figure 3. Overview of the Methodology [11].

4.2 Added Value

When comparing the methodology with project management methodologies, development methodologies, standards and models, some overlap can be observed: defining the project objectives and controlling the project's progress during its execution. However, the methodology offers added value by explicitly recognizing that:

- *Release Definition*: There needs to be a clear rationale for a project throughout its existence (economics).
- *Release Information*: Information has its price in time and money (economics).
- *Release Decision*: There is a need to reduce the aspiration levels of all stakeholders involved early during product development, and find consensus amongst all stakeholders when making the release decision (decision-making).
- *Release Implementation*: Product development only ends when the product has been successfully rolled out and lessons learned have been collected (organizational learning).

The methodology enables a software manufacturer to understand the different aspects relevant to strategic software release decisions (descriptive character) and offer the possibility of assessing its capability in this area (judgmental character), thereby creating an instrument to identify possible improvement areas.

In the following sections, the quality of software decision release decisions is discussed, taking the presented methodology as the reference framework. Distinction is made between the quality of the decision inputs, the quality of the decision-making process and the resulting quality of the decision outcome.

5. DECISION INPUTS

5.1 Uncertainty

Maximizing behaviour assumes that decision-makers have complete information about costs and benefits associated with each option. They compare the options on a single scale of preference, value or utility. Modern behavioural economics acknowledge however, that the assumption of perfect (complete and reliable) information is implausible. Etzioni and Amitai argue that because, normally, limitations on information will exist, it is impossible to undertake the precise analysis necessary to maximize economic objectives [3]. Rather than assuming decision-makers possess all relevant information for making choices, information is, itself, treated as a commodity, something that has a price in time and/or money. This argument of limitations on information can be used to 'soften' maximizing behaviour to optimizing behaviour, where an individual decision-maker makes a trade-off between information perfection (completeness and reliability) and the cost related to searching for additional information.

Simon argues that limited cognitive capabilities in decision-makers lead to simplification [12]. A decision-maker simplifies reality, leaves out information and applies heuristics as a consequence of limited cognitive capabilities: bounded rationality. Reasons are, for example, that the decision-maker has limited, unreliable or even too much information, available, or that the search for acceptable alternatives is felt to be too time, and cost, consuming. He suggests that in choice situations, people actually have the goal of satisficing, rather than maximizing, or optimizing, and a decision-maker applies heuristic rules of search in a heuristic frame.

Both imperfect information and bounded rationality are factors that contribute to uncertainty in the decision-making process.

5.2 Group Conflict

Studies have shown that the collective behaviour of a group is a direct consequence of individual decision procedures with the addition of a process for resolving conflict [1]. Harrison names as important determinants of conflict [6]:

- *Inter-dependence between Individuals or Units*. Normally, the higher the level of inter-dependence the greater the opportunity for conflict over decisions.
- *Performance Criteria and Rewards*. The more evaluations, and rewards, by higher management emphasize the separate performance of each department, rather than their combined performance, the more conflict.

- *Communication Problems.* May result from semantic difficulties, misunderstandings and ‘noise’ in the channels of communication.
- *Role Dissatisfaction.* Frustrating task conditions such as work overload, under-utilisation of skills, and scarcity of resources generally contribute to role dissatisfaction.
- *Personality Attributes.* Research finds that certain attributes, such as high authoritarianism, high dogmatism and low self-esteem, increase conflict behaviour. Differing personal value systems and perceptual differences fall in the same category.
- *Divergence in Goals or Objectives.* The major determinant of perceived inter-personal conflict is differentiation in the participant’s goals for the organization.

Stokman explains potential differences in aspiration levels during collective decision-making in the following way [13]. He makes a distinction between ultimate goals and instrumental goals. Instrumental goals are considered a means through which ultimate goals can be realized. Utility functions for ultimate goals are usually strictly convex (monotonously increasing or decreasing).

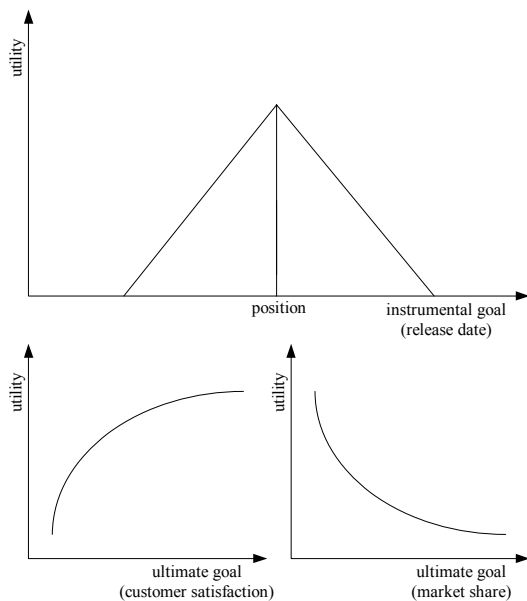


Figure 4. Example of Utility Functions of Instrumental and Ultimate Goals [11].

Controversial decisions usually concern instrumental goals and have an optimum: too much, or too little, is bad. The instrumental goal of a software manufacturer during product development is to release a product to the market. Ultimate goals may be to capture a high market share by releasing the product as early as possible (first-mover advantage), or to satisfy customers by delivering a high-quality product (customer satisfaction), turning the software release decision into a dilemma. Too late means market share will be lost, too early means dissatisfied customers due to a lower quality product, as in Figure 4. The optimum for the instrumental goal depends on the weighting of all ultimate goals. In collective decision-making, different stakeholders are likely to assign different weights due to different heuristics, and the presence of one, or more, determinants of conflict, leads to different aspiration levels for the decision outcome.

It is likely different stakeholders will assign different weights to the ultimate goals, due to the inter-dependence between stakeholders involved. In a practical setting, there may, further, even be more than two goals, while different stakeholders will not necessarily have identical goals: divergence in goals or objectives is likely to be present as well.

6. DECISION-MAKING PROCESS

Differences in aspiration levels among stakeholders involved, implies that one, or more, stakeholders must change his initial position in order to reach consensus. This is discussed from two perspectives: the presence of different sources of power in the decision-making process and theory describing processes and strategies through which stakeholders change their position.

6.1 Sources of Power

Individuals or groups have power if the consequences of their actions can be observed in the behaviour of other people. Power can be formulated as the ability to exert influence; that is, the ability to change attitudes or behaviour of individuals or groups, whereas the employment of power is referred to as politics. French and Raven identify five sources, or bases, of power, which are [4]:

- *Reward Power.* Based on one person (the influencer) having the ability to reward another person (the influencee) for carrying out orders or meeting other requirements. One example is the power of a supervisor. It reflects the ability to confer positive rewards of a monetary, or psychological, nature, as perceived by the influencee. The strength of this power varies with the expectation of the potential influencee that a particular kind of behaviour will result in attainment of the reward. It assumes that the reward is of some significance to the potential influencee.
- *Coercive Power.* Based on the influencer’s ability to punish the influencee for not carrying out orders or meeting requirements. It is based on fear of undesirable consequences if a particular form of behaviour is not forthcoming. The strength of this power varies with the expectation that punishment will follow as a result of non-conformance. It is the opposite of reward power.
- *Legitimate Power.* This type of power exists when an influencee acknowledges that the influencer has a right, or is lawfully entitled, to exert influence and derives, for example, from a position in the organizational hierarchy. Its strength varies with the legitimacy imputed to those who claim such power by those whose behaviour will be modified by its acceptance.
- *Expert Power.* Based on the perception, or belief, that the influencer has some relevant expertise or special knowledge. The demand for expertise confers on its possessor power that usually results in the acceptance of advice, or opinions, and compliant behaviour. The strength of expert power varies with others’ perceptions of the extent of knowledge or skill possessed by the expert.
- *Referent Power.* May be held by an individual or a group, based on the influencee’s desire to identify, or imitate, the influencer. It derives from identification with a particular individual or group possessing a high level of attractiveness for the identifier. The strength of this power varies with the degree

of attractiveness, which, in turn, elicits a desire to associate with the individual or group. A desire not to associate because of unattractiveness results in negative referent power.

6.2 Group Processes and Strategies

Stokman *et al.* describe three elements that determine the outcome of a decision [13]: the *positions* of the stakeholders, the *salience* for the stakeholders (the degree to which they are interested in each issue) and the *capabilities* of the stakeholders. The process of decision-making is described as the efforts of stakeholders to realise an outcome of the decision as close as possible to their own position. They distinguish three main processes and strategies whereby a stakeholder changes his position:

- *Management of Meaning*: the stakeholder receives convincing information implying that another position reflects his incentive structure better. Important aspects here are:
 1. New information is generally more acceptable in earlier stages of the decision-making than in later ones;
 2. A substantial amount of trust in the provider of the information increases the likelihood that information is accepted as relevant and reliable.
- *Exchange*: a stakeholder is prepared to take another position on an issue in exchange for a reciprocal move by another stakeholder on another issue. Three elements are of importance here:
 1. The selection of the issues one wants to include in the exchange process.
 2. The change one incorporates into one's own positions.
 3. One's prioritisation of the issues.
- *Challenge*: other stakeholders challenge the position of a stakeholder who feels more or less forced to change position. This is influenced by:
 1. One's own position at the beginning of the decision-making process.
 2. The leverage one shows to others.
 3. Explicit evaluation of the likelihood of success.

6.3 Relationship

The objective of the processes/strategies in the theory of Stokman *et al.* is: how can the positions of other stakeholders be moved towards one's own position? As such, they can be regarded as processes and strategies that exercise power over other stakeholders. The relationship, between the five bases of power and these processes/strategies is illustrated Table 1.

Table 1. Relationship between Bases of Power and Group Processes/Strategies [11].

Bases of Power	Group Processes/strategies
Reward Power	Exchange
Coercive Power	Challenge
Legitimate Power	Challenge
Expert Power	Management of Meaning
Referent Power	-

Referent power cannot be assigned to any of the group processes/strategies, and is assumed to be of lesser importance

when a negotiated decision-making strategy is chosen, where each stakeholder sees themselves as a representative of a particular organizational authority. For a creative decision-making strategy, the effects of referent power may however be significant as a result of a less formal group process and style.

7. DECISION OUTCOME

It is assumed the availability of a commonly-shared, and accepted, product development strategy (ultimate goals), which is kept up-to-date during product development, will contribute greatly to increasing the quality of the decision inputs. This is covered in the *Release Definition* process area. This helps reduce uncertainty by making the information needed in the decision-making process more explicit, thus enabling decision-makers to aim for information perfection within a zone of cost effectiveness, a bandwidth where the marginal yield of additional information is equal or close to zero. This is addressed in the *Release Information* process area.

It is argued that remaining differences in positions, or aspiration levels, during the decision-making process must be further reduced through the exchange, and acceptance, of convincing information. Therefore, a high presence of 'management of meaning' processes/strategies is favourable in software release decisions, as opposed to a low presence of 'challenge' and 'exchange' processes/strategies. A high presence of 'management of meaning' processes/strategies implies that possible differences in positions or aspiration levels are reduced through the acceptance of convincing information.

It will enable a group to reach consensus, meaning that everyone can and will support the decision. This does not mean everybody agrees on the best alternative, but the stakeholders involved have found an alternative they can all accept. The process to reach consensus may be slow, but when the group finally reaches consensus, it has developed a solution that will have the support it needs to be implemented. The influence of all stakeholders, and understanding of the decision by those required to carry it out, are also important factors for a high-quality decision outcome. In the case of software release decisions, the organizational authority responsible for post-release activities should be especially involved in the release decision-making process as an involved stakeholder.

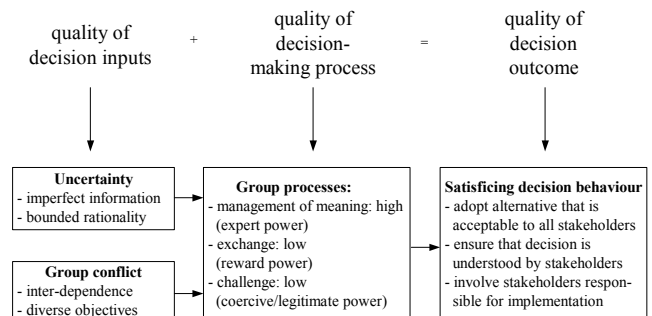


Figure 5. Collective Decision-making Model [11].

In summary, the quality of decision inputs influences the quality of the decision-making process, and their sum determines the quality of the decision outcome, as illustrated in Figure 5, showing a collective decision-making model. This derived model

has a strong resemblance to the Carnegie model of decision-making, based on the work of Cyert, March and Simon [2].

8. VALIDITY OF THE METHODOLOGY

The assumed descriptive and judgmental properties of the methodology were validated and confirmed in a practical context through a second series of case studies [10]. It was also confirmed that the presented collective decision-making model can be used to determine the quality of the decision outcome, as the sum of the quality of the decision inputs and decision-making process. No reasons were found to limit the conclusions to the particular software manufacturer type found in the cases, developing products for internal use. The properties of the methodology are assumed to be valid beyond the cases studied; to either similar or other software manufacturer types. For the external validity of methodology to a wider context beyond, the following conclusions are drawn:

- *Generalization of results to other product development decisions.* A question that arises is whether the conclusions are restricted to (strategic) software release decisions. Could, for example, the methodology also be used for investment decisions or product design decisions; important milestones during product development? Although the methodology has been designed for software release decisions with strategic value, its general nature makes this worth considering. The methodology focuses on the decision-making process (*Release Decision* process area), extending it with defining and controlling the decision objectives (*Release Definition* process area), the definition and collection process of information as input to the decision-making process (*Release Information* process area), and the implementation and evaluation of the release decision (*Release Implementation* process area). These are common aspects of decision-making and usage for other product development decisions can, therefore, be considered. The underlying practices should, for such cases be revised to focus more specifically on the decision type considered.
- *Generalization of results beyond the scope of software product development.* A second question that may arise is whether the application of the methodology is limited to strategic release decisions for software products only. Could the methodology be useful in other engineering disciplines like mechanical engineering and hardware engineering (and their combinations with software: systems engineering) or even product development in general? A review of the methodology indicates no practices, which are specific to software. However, software has certain specific properties. In the first place, software is an experience good: its lack of transparency introduces uncertainty to potential customers and end-users of the software on purpose and quality. Secondly, software differs in the manner in which it fails and thus influences the verification and validation process, as complete testing is not realistic. These two sources of uncertainty are strong arguments for adopting a methodology especially in cases where the release decision is of strategic value. In other engineering disciplines and product development both uncertainty and

strategic decision value can also be present, especially where new products are developed and introduced into the market. This indicates the methodology could be of interest beyond the scope of software product development.

Ongoing research is planned to investigate the completeness of the methodology both in software engineering and other product development environments. Organizations interested in participation are invited to contact the author.

9. REFERENCES

- [1] Clarkson, G.P.E., Tuggle, F.D., Toward a Theory of Group Decision Behavior. *Behavioral Science*, 1966, 33-42.
- [2] Daft, R.L., *Organization theory and design*. West. Publ. Comp., St. Paul USA, 1986.
- [3] Etzioni, Amitai, *Humble Decision Making*. Harvard Business Review (July-August), 1989, 112-126.
- [4] French, J.R.P., Raven, B., The Bases of Social Power. In *Studies in Social Power*, Cartwright, D., (Ed.), University of Michigan Press, 1959, 150-167.
- [5] Gigerenzer, G., Striking a Blow for Sanity in Theories of Rationality. In *Essays in honor of Herbert Simon*, Augier, B., March, J.D., (Eds.), Cambridge, MA: MIT Press, 2004.
- [6] Harrison, E.F., *The Managerial Decision-Making Process*. Houghton Mifflin Company, 1987.
- [7] Kunreuther, R.M., et al., High Stakes Decision Making: Normative, Descriptive and Prescriptive Considerations. *Marketing Letters*, 13, 3, 2002, 259-268.
- [8] Leveson, N.G., The Role of Software in Spacecraft Accidents. *AIAA Journal of Spacecraft and Rockets*, 41, 4, 2004.
- [9] March, J.G., Olsen, J.P., *Ambiguity and Choice in Organizations*. 2nd Edition, Universitetsforlaget (Norway), 1979.
- [10] Sassenburg, H., Berghout, E., A managerial release-decision model for IT-applications. *Proceedings of the 11th European Conference on the Evaluation of IT*, November 11-12, Amsterdam (The Netherlands), 2004.
- [11] Sassenburg, H., *Design of a Methodology to Support Software Release Decisions: Do the Numbers really Matter?* PhD thesis, University of Groningen (The Netherlands), 2006.
- [12] Simon, H.A., *Models of Bounded Rationality*. Cambridge, MIT Press, 1982.
- [13] Stokman, F.N., et al., Strategic Decision Making. *Advances in Group Processes*, 17, 2000, 131-153.
- [14] Stokman, F.N., Frame dependent modeling of influence processes. In *Rational-Choice-Theorie in den Sozialwissenschaften. Anwendungen und Probleme*, Diekmann, A., Voss, T., (Eds.), München: Oldenbourg Verlag, 2004, 113-127.