Applying System Dynamics to Overcome Unsuccessful Success Factor Research

Florian Kapmeier*

Heilbronn University
Max-Planck-Str. 39
74081 Heilbronn
Germany

Phone:
+49 7131 504 6683
email:
florian.kapmeier@hs-heilbronn.de

Meike Tilebein

University of Stuttgart
Institute of Diversity Studies in Engineering
Pfaffenwaldring 9
70569 Stuttgart
Germany

Phone:
+49 711 685 60700
email:
meike.tilebein@ids.uni-stuttgart.de

Alexander Voigt

PA Consulting Group GmbH
Eschersheimer Landstr. 223
60230 Frankfurt/Main
Germany

Phone:
+49 69 71702 296
email:
alexander.voigt@paconsulting.com

Ralf Dillerup

Heilbronn University
Max-Planck-Str. 39
74081 Heilbronn
Germany

Phone:
+49 7131 504 496
email:
ralf.dillerup@hs-heilbronn.de

* corresponding author

Abstract

In order to cope with the vast range of ambiguous, multi-causal and multi-faceted potential causes for firm success, managers tend to look for critical success factors as a reduced number of essential factors that determine future business success. Although scholars have been serving this need for more than four decades, the insights derived from empirical research on critical success factors have low impact on strategy in practice. We take this phenomenon to discuss potential causes and propose to complement empirical methods with the dynamic feedback perspective of System Dynamics modeling.

In the present paper we first portray benefits and limitations of both empirical methods and System Dynamics regarding critical success factor research. We then take a PIMS-based case example to contrast and combine the two methods. We compare insights from the PIMS study to observations from a System Dynamics-based strategy project conducted by PA Consulting Group for a large European automobile manufacturer. We discuss differences in the analysis of the two studies and conclude that empirical success factor research could overcome its practical shortcomings when accompanied by firm-specific System Dynamics modeling based on the main characteristics of System Dynamics models, including feedback processes, time delays, and non-linearity.

Key words

Critical Success Factors, Empirical Research, PIMS, Quantitative Research Methods, Success Factor Research, System Dynamics

1. Introduction

In their overview article to the 2010 Special Issue of Long Range Planning on Strategic Performance Measurement Micheli and Manzoni refer to recent reports suggesting that an average company with $1 billion sales spends over 25,000 person-days per year on planning and measuring performance (Micheli and Manzoni, 2010). When making these huge efforts companies are usually not only interested in calculating financial results, but also in addressing early determinants for future profitability.

Strategy research has developed two different theoretical perspectives on where to find such potential root causes for competitive advantages, the market-based view and the resource-based view (Spanos and Lioukas, 2001). The market-based view (Porter, 1985) builds on the structure-conduct-performance paradigm of industrial organization and attributes a firm's potential competitive advantage to the attractiveness of its respective market. The five forces determining the markets are buyers, suppliers, potential new entrants, substitute products and competitors' rivalry. This perspective identifies external parameters like the general attractiveness of a specific market and the firm's relative position in it as root causes for competitive advantages. To the contrary, the resource-based theory (Barney, 1996) attributes potential competitive advantage to the firm's specific resources. These resources need to meet certain criteria in terms of being strategically valuable, rare, difficult for competitors to imitate, and accessible by the firm's organization to qualify as root causes for superior performance (Barney, 1991). Thus, the resource-based view suggests that internal parameters drive a firm's competitive advantage.

Rather than being mutually exclusive, these two perspectives are complementary, with strategy acting as a bridge between a firm's valuable idiosyncratic resources in the broadest sense and its markets. The two general theory perspectives on sources of competitive advantages are commonly agreed on among strategy scholars. They are also widely used as a general framework by managers, but they bear some inherent difficulties regarding their practical use. For example, a resource's inimitability often relies on causal ambiguity, which hampers not only competitors, but to a lesser extent also the possessing firm in properly identifying the resource, let alone the bridging mechanisms translating it into market success (Rivkin, 2001).

Yet, strategy-making has to cope with the ambiguous, multi-causal and multi-faceted roots causes for firm success and has to reduce complexity to critical success factors (critical success factor - CSF), a manageable number of essential and preferably sustainable factors that determine future success. According to Rockart (1979), "Critical success factors thus are, for any business, the limited number of areas in which results, if they are satisfactory, will insure successful competitive performance for the organization. They are the few key areas where ‘things must go right’ for the business to flourish” (Rockart, 1979, 85).

By definition, CSFs are meant to particularly influence the future competitive situation of a company. To ensure future firm success, strategic management aims at protecting existing and developing new competitive advantages (Gälweiler, 2005). Competitive advantage and its potential contribution to success can either be based on external, market-oriented success factors like market positions, or on internal, resource-based success factors like cost or technology advantages (Gälweiler, 2005; Kieser and Walgenbach, 2010). CSFs act as leading indicators for a firm’s strategic situation. Realized success, however, is affected by a large number of influencing factors that are difficult to describe and measure. It is based on the existing competitive advantages and the effective implementation of management systems to exploit the success potentials (Dillerup and Stoi, 2011). The impact of CSFs on success is also influenced by time delays between an investment in strategic potentials such as new product development or new production capacities and the realization of these potentials and therefore carrying a high realization risk (Johnson et al., 2010; Gälweiler, 2005; Repenning and Sterman, 2002).

In addition to the existence of time delays, the interrelationship between potential success, success factors and realized success is influenced by four additional challenges (Kieser and Walgenbach, 2010; Dillerup and Stoi, 2011): First, the intensity of CSFs may vary over time with some CSFs dominating others. Second, multiple relations between CSFs and success potential include feedback structures. Third, cause and effect structures may evolve over time as markets or technologies are dynamic. Finally, CSFs may even be different for various business units within a single company – they need to be individualized to specific requirements.

Early publications on CSFs (e.g. Rockart, 1979; Leidecker and Bruno, 1984) stated that CSFs are firm-specific and that in order to identify them during the strategic planning process managers should involve the firm’s own staff specialists together with external consultants. Yet, as an attempt to identify general driving factors leading to differences in business performance and to quantify their impacts, the PIMS (Profit Impact of Market Success) project was initiated in the 1970s (Buzzell, 2004). However, even years after the PIMS project had started, large-scale scientific empirical studies like PIMS were seen as one CSF identification technique among others. In a review of different CSF identifications techniques, Leidecker and Bruno (1984) describe PIMS results as a potential identification technique. The authors point to the empirical basis of these large scale studies as an advantage of this technique and characterize PIMS results as an “excellent starting point” for a firm’s individual CSF identification process. Looking at potential disadvantages, they name the general nature of the respective PIMS insights, the questionable applicability to a specific firm or industry, and the lack in determination of relative importance among the factors identified (Leidecker and Bruno, 1984).

These disadvantages in general still hold true to date (March and Sutton, 1997; Nicolai and Kieser, 2002). Empirical CSF research has developed and diversified in terms of objects and methods since its beginning, with objects ranging from general to specific industries, markets, and functions (e.g. project management, information systems, start-up firms, each in combination with specific industries), and with research methods covering a broad range of approaches, e.g. from large-scale questionnaire-based studies to case-based explorative and more specific and focused studies (Schmalen et al., 2005). The number of CSF publications has grown accordingly, and managers' interest in identifying few key determinants of their business' success even seems to grow stronger as they perceive their businesses becoming increasingly complex. Although empirical CSF research methodology has matured over decades and managerial attention in CSFs is continuing, the insights empirical CSF research produces have low impact on strategy in practice (Nicolai and Kieser, 2002).

In the present paper we discuss potential causes and possible cures of this phenomenon. In Section 2 we describe the nature and the development of empirical success factor research and discuss its benefits as well as its limitations. Addressing the lack of practical impact and the methodological limitations of success factor research we propose to complement the respective empirical research with the dynamic feedback perspective of System Dynamics modeling in Section 3. We use a PIMS-based case example in Section 4 to contrast and combine the two methods and conclude in Section 5 that empirical success factor research could overcome its shortcomings in practical impact when accompanied by System Dynamics modeling.

2. Research Methods and Types of Success Factor Research

Much empirical research has been done on identifying success factors in strategic management (e.g. Nicolai and Kieser, 2002; Thune and House, 1970; Greenley, 1986; Sutton, 1983; Armstrong, 1991; Boyd, 1991; Capon et al., 1994; Miller and Cardinal, 1994; Mintzberg, 1994). The objective of CSF research is to explain differences in business performance and to quantify their impacts (Buzzell, 2004).

2.1. Traditional Success Factor Research Methods

CSF research can be characterized by various aspects (Schmalen et al., 2005), including sampling methods, for example. Some studies focus exclusively either on successful companies or on failed ones, others highlight the main differences between these two groups. Assuming that key success and failure factors do not necessarily need to be identical, only those methods contrasting success and failure groups allow valid results (Schmalen, 2005, 90).

Furthermore we differentiate into quantitative and qualitative research methods. Scholars use qualitative approaches in explorative research designs and address mainly soft factors or other factors that are not directly quantifiable (Peters and Waterman, 1982). These methods allow researchers to investigate a limited number of cases and deduce comprehensive profiles of these firm-specific success factors. For solving new problems, decision-makers usually rely on experience. Case-based reasoning is a general paradigm for reasoning from experience. Popular examples are Peters/Waterman's (1982) 7-S-Modell, Womack et al.'s (1990) productivity studies in the automotive industry or Simon's (1996) hidden champions. Theories based on case examinations are often highly generalized and lack reproducibility. They often do not generate new insights but "old wine in new skins" (Kieser, 1996, 23).

When investigating multiple cases, the case contrasting method can support theory-building by specifying research questions to explain differences in success and analyze the drivers for success. To date, theory-building with case studies has been reported only in a limited number of examples as this research approach is especially appropriate in new study areas (Eisenhardt, 1989). Theory derived from cases is often new and requires further verification. It may include ground-breaking insights and prove logical coherence.

Alternatively, quantitative methods are used in confirmative research designs. Quantitative methods use statistical and mathematical techniques to analyze the contribution of variables to success (Patt, 1990; Jacobs, 1992, Robers et al., 2009). Quantitative CSF research analyzes large data samples applying statistical methods to identify correlations between variables. It focuses on hypothesis testing based on representative data. As this method requires historical data it cannot be applied to analyze new challenges. Quantitative research methods apply multivariate statistics for simultaneous observation and analysis of more than one statistical variable. They are often used in success factor research based on a discriminant analysis to explain differences between groups of variables like successful vs. unsuccessful products. The variables explaining the differences are identified as CSFs (Schmalen et al., 2005). A well-established example for quantitative CSF research is the PIMS study, which will be detailed in Section 4.1.

To sum up, explorative research aims at screening the large pool of potential success drivers to identify those variables with the highest relevance for future firm success (Buzzell and Gale, 1987). In contrast, confirmative methods are used to test hypotheses. They focus on verifying a limited number of correlations. Minimum sample sizes are necessary to create significant results in confirmative research (Backhaus et al., 2000). In other words, confirmative research is characterized by rather general objects of investigation. Although confirmative CSF research has covered specific industries, markets, and functions, insights are not firm-specific. Still, researchers believe that confirmative quantitative research is the best approach to perform CSF research (Haenecke, 2002).

2.2. Critical Review of Quantitative Success Factor Research

Since CSF research has been practiced for more than 40 years an intensive academic discussion on methodological issues in quantitative success factor research is still ongoing (March and Sutton, 1997; Haenecke, 2002; Nicolai and Kieser, 2002; Klarmann, 2008). In the following we highlight some of the prominent benefits and limitations attributed to quantitative success factor research.

On the one hand, empirical CSF research can be beneficial for scholars and practitioners: For practitioners CFS research promises to reduce complexity and identify causal structures based on proven methodology and representative samples. Reliable insights of CSF research can be easily transferred into managerial practice. For scholars CSF research offers the potential to combine obvious relevance with the rigorous application of established methodology, thus increasing the chance of getting published in high quality academic journals (Nicolai and Kieser, 2002, 589).

On the other hand, empirical success factor research is subject to limitations some of which are related to empirical research in general whereas others refer to the specific research objectives of CSFs. One general methodological shortcoming of quantitative empirical research on success factors is that it is not able to capture the time-based evolution of success and the interactions and development over time of different success factors, just like any other cross-sectional study. Another methodological issue (Nicolai and Kieser, 2002, 584) is the potential key informant bias, e.g. causal oversimplification. Answers in questionnaires and interviews addressing complex phenomena like determinants of success are likely to reflect the informant's bounded mental model rather than a comprehensive unbiased assessment of the situation.

Success, however, is seldom single-caused but a multifaceted construct, with different studies highlighting different facets. This makes it difficult to fully understand practical implications of success factors derived from different studies. Moreover, the links between success and its determinants seem to be highly complex and ambiguous (Nicolai and Kieser, 2002, 582). This complexity and ambiguity limits the benefit of empirical success factor research for managerial practice, as the studies still lack the explanation of how success factors finally translate into success.

Moreover, as empirical success factor research often includes only samples of successful firms, it suffers from a survival bias and is therefore not representative (Nicolai and Kieser, 2002, 585). To the contrary, Makridakis (1991) asks "what can we learn from corporate failure?" He states that "success breeds its own failure" (Makridakis, 1991, 115) and points to common causes for corporate failure. These include ignoring or underestimating competition, preoccupation with the short term, overextending resources and capabilities, believing in quick fixes, overreacting, the personality and ability of the CEO and the decision-making process among the top executives.

Since the early days of CSF research, studies have become increasingly refined and focused, with insights turning from general recommendations to almost firm-specific success factors. This development should be attractive for research as growing specification of focus calls for even more empirical studies. Yet, this development might cause an even faster decline in managerial attention as firms may find it increasingly difficult to interpret the specific empirical findings and turn them into actionable recommendations.

A theoretical concern in CSF research is related to the nature of competitive advantage: If recommendations developed by empirical studies were clear, success factors were easily imitable, and all firms adopted them, the resulting strategy convergence would render these success factors useless as a source of competitive advantage (Nicolai and Kieser, 2002, 585).

To sum up, although identifying CSFs should be of high interest to practitioners and any single empirical study on specific success factors may make a rigorous contribution to research, there are many reasons for the obvious lack of impact the respective studies have in practice. Some of these reasons can be traced back to methodological issues; others refer to theory perspectives and general success factors as a paradox, or to the development of the research field itself.

3. Simulation as a Method for Success Factor Research

When research questions deal with complex relationships among large numbers of variables, simulation methods can provide superior insights (Law and Kelton, 1991). Simulation may reveal interacting effects of variables and their development over time (Davis et al., 2007). Simulation therefore is the research method of choice for explaining longitudinal, processual and dynamic phenomena that are time and data demanding. Simulation methods are capable of analyzing phenomena like emergence, feedback loops, tipping points, or thresholds (Davis et al., 2007). In the following we consider simulation methods and System Dynamics in particular as an approach for performing success factor research.

3.1. Criteria and Process for System Dynamics based Success Factor Research

According to Davis et al. (2007), using simulation methods for strategy and organizational research is particularly promising when the research question shows three specific characteristics: First, it addresses a fundamental phenomenon with limited theoretical backing or multiple theoretical roots. Second, longitudinal interactions that would be difficult to study empirically play a major role. Third, the research question focuses on tensions or trade-offs (Davis et al., 2007). CSF research questions entail these characteristics and thus qualify for a simulation approach. First, the range of perspectives becomes obvious when faced with the multitude of publications on CSF research. Furthermore, as described in Section 2.2, strategy theory points to the problem of strategy convergence as a fundamental problem attached to CSF research. Second, as indicated in the introductory section, there is strong support in the literature for the dynamic nature of CSFs and their interactions towards firm success. Finally, the definition of CSFs itself includes the fundamental trade-off between fully addressing business complexity and reducing it appropriately to a few factors.

Among the different simulation methods, System Dynamics (Sterman, 2000; Forrester, 1961) is particularly useful for simulating the interaction of quantifiable and related variables on an aggregated overall system level, as it is capable of describing and modeling the dynamic interaction of variables (Dooley, 2002; Simon et al., 2008). As a systems approach to simulate complex and dynamic managerial challenges System Dynamics offers the possibility to analyze system behavior over time and the underlying causal structures. It takes into account the complexity, the internal feedback loops and the non-linearity embedded in social systems (Sterman, 2000).

We suggest the following roadmap for conducting System Dynamics-based success factor research. With its seven steps it is along the lines of Davis et al.'s (2007) roadmap for developing theory through simulation methods (see Figure 1). First, a System Dynamics-based success factor analysis should start with a clearly defined research question. It reflects deep understanding of the existing literature on success factor research. It should be noted that System Dynamics is not necessarily the best approach to address any research question. It fits best if there are temporal, structural, or spatial tensions that indicate nonlinear relationships. The second aspect relates to the existing, limited knowledge of the research question. Davis et al. (2007) define simple theory as the "undeveloped theory that involves a few constructs and related proposition with some empirical grounding but that is limited by weak conceptualization" (p. 484). It is necessary to identify interdependent processes, nonlinearities and short-term and long-term effects in the simple theory. Third, it needs to be ensured that System Dynamics fits to address the research question. Fourth, the observed relationships need to be translated into a System Dynamics model, following the modeling approach (Sterman, 2000, for example), that requires operationalization of the theoretical concept. Fifth, it needs to be verified that the simulation results represent the underlying theoretical logic and the System Dynamics model needs to be checked on its robustness. Many structural or behavioral validation tests can be applied to increase confidence in the model (Sterman, 2000). Sixth, model assumptions need to be varied in order to learn from defined and conducted scenarios. Finally, the model needs to be externally validated by comparing simulation results against real-world data.

Steps		Activities
1.	Research question	• Identify temporal, structural or spatial tensions, indicating nonlinear relationships like tipping points or steep thresholds
2.	Simple theory	• Collect state of the art on research • Identify interdependent processes, nonlinearities and short- and long-term effects
3.	Simulation approach	• Ensure that the System Dynamics-based simulation approach that meets the requirements of the research question and the underlying assumptions and the theoretical logic • Model a system as a series of simple processes with causal loops, stocks, and flows
4.	Simulation model	• Operationalize theoretical concepts • Deduce underlying theories for representation • Specify model assumptions, check them against real world assumptions to establish internal validity
5.	Verification	• Ensure that simulation results represent the underlying theoretical logic • Check robustness of simulation model, applying model structure and model behavior tests
6.	Build novel theory	• Vary assumptions • Add new features
7.	External Validation	• Compare simulation results and theoretical data with real world data

Figure 1: Roadmap for doing System Dynamics-based success factor research
(adapted from Davis et al., 2007)

3.2. Benefits and Limitations of System Dynamics-based Success Factor Research

System Dynamics-based simulation models have general benefits and weak points and also specific ones when it comes to identifying CSFs. In the following we examine benefits and limitations of System Dynamics-based simulation models for success factor research.

Sterman (1991) identifies the accuracy of decision rules – or policies –, soft variables, and model boundary as some weak points. First, relating to decision rules, accurate description of policies is difficult for managers as they “accurately represent how the actors in the system make their decisions, even if their decision rules are less than optimal. The model should respond to change in the same way the real actors would. But it will do this only if the model’s assumptions faithfully describe the decision rules that are used under different circumstances. The model therefore must reflect the actual decision-making strategies used by the people in the system being modeled, including the limitations and errors of those strategies” (Sterman, 1991, 12). Accurate identification of policies is oftentimes difficult: statistical data cannot be generally helpful. Instead, decision-makers need to reveal their mental models about the challenge to be modeled. Decision-makers are, however, hesitant to talk openly about their understanding of the challenge as they might feel that they could be replaced by the model. They therefore need to become aware that a System Dynamics-based simulation model supports managers in answering strategic challenges for strategy development and strategy implementation. Once they are confident that the simulation model supports them, they perceive simulation models as efficient and objective instrument for communication between program teams, top management and other stakeholders – free of gut feeling or firm-internal power structures. This may lead to a constructive dialogue across organizational boundaries (Kapmeier, 2011).

Second, most data available are soft data (Sterman, 1991). Yet, gathering and handling soft data in models is difficult. They are, however, crucial for understanding and modeling complex systems. “Yet in describing decision making, some modelers limit themselves to hard variables, ones that can be measured directly and can be expressed as numerical data. They may defend the rejection of soft variables as being more scientific than ‘making up’ the values of parameters and relationships for which no numerical data are available” (Sterman, 1991, 219). Forrester states, however, that “[t]o omit such variables is equivalent to saying they have zero effect – probably the only value that is known to be wrong” (Forrester, 1961, 57).

Third, drawing a reasonable model boundary is another challenge. Simulation models should be rather inclusive than exclusive. A great strength of simulation models is the capacity to reflect the important feedback relationships that shape the behavior of the system and its response to policies. A model boundary that is too narrow disregards factors important for the dynamics of the system.

Yet, System Dynamics-based simulation models have benefits with regard to success factor research (Sterman, 1991; Sterman, 2000; Strohhecker, 2008): white box, integration of many viewpoints, and feedback loops. First, System Dynamics models are precise and objective in their representation. System Dynamics models can be regarded as white boxes, with assumptions and relationships laid open and thus open for intersubjective assessment. Interpretations done on the basis of a System Dynamics model with regard to the identification of success factors can be confirmed by other researchers. Second, with applying the System Dynamics methodology, many mental models can be integrated into one larger model. The model then shows a complete, adequate picture of the decision process. Concerning the identification of critical success factors it means that the model boundary may be spun as wide as necessary to include aspects of different corporate areas. It enables the modeler to test consistency with reference to hypotheses and assumptions. Third, System Dynamics models enable researchers to analyze complete cause-effect feedback loops – no relationship or variable is omitted in the analysis because of limited performance capacity. Therefore, insights on success factors are based on a complete picture of the decision making situation.

In summary, when being aware of the weak points of System Dynamics models, they can be overcome by thoughtful consideration. More important, the benefits of using the System Dynamics methodology for success factor research are strong.

4. Examples for Quantitative Success Factor Research and the System Dynamics Approach

In the following we contrast and combine traditional quantitative success factor research and the System Dynamics-based simulation approach to identify success factors. We start with the PIMS research as a prominent example for quantitative success factor research using statistical methods on a very valid data base. We compare it with a System Dynamics-based analysis to identify success factors for a large European automobile manufacturer and lay out differences in the approaches in the following section.

4.1. PIMS as an Example for Quantitative Success Factor Research

An established example for quantitative CSF research is the PIMS study. It is well-known for the analysis of a large sample of empirical real-world data since its beginning more than 40 years ago (Dillerup and Stoi, 2011; Buzzell, 2004; Buzzell and Gale, 1987; Abell and Hammond, 1979). The PIMS project was initiated in the 1960s as an internal project within General Electric to identify the Profit Impact of Market Success - PIMS. The project was later handed over to the Harvard Business School that expanded the database and invited other companies to participate. Since 1979, the Strategic Planning Institute has used the database for CSF research and provided consulting services to the participating firms. These days, the PIMS database includes data from more than 250 companies with more than 3,000 strategic business units and information of more than 200 quantified variables. Its objective is to analyze which factors influence success in order to discover the laws of the market place (www.pimsonline.com).

The PIMS database enables a cross-sectional analysis and creates empirical evidence from a large number of businesses in a large number of situations. PIMS scholars use multivariate statistical methods to establish relationships between a variety of different factors and separate measures of success. Performance variables are return on investment (ROI), profit margin, capital turnover, and cash flow. According to PIMS findings, performance measures are largely determined by a set of 20 variables out of the 200 variables analyzed. PIMS researchers empirically test whether, and if so, which relationships exist between dependent variables measuring performance and independent variables. The regression model focuses on ROI as the dependent variable and various market characteristics and strategy dimensions as independent variables. The variables with the highest statistical significance influencing performance are the identified CSFs.

According to the PIMS study the success factors with the highest statistical relevance explain about 40% of the variance in ROI for the business units in the database (Buzzell and Gale, 1987). Market attractivity, for example, has a significant positive impact on performance (see Figure 2). Attractive markets are determined by high market growth, low concentration of suppliers and customers and the position in the product life cycle. Furthermore, relative market situation of a business is also positively correlated to the ROI. Relative market situation measures the competitive strength of a firm by comparing the market shares of a business and relative product quality with the three strongest peers. Investment intensity is negatively correlated to the ROI: a firm’s capital expenditures policy is a construct of variables like degree of company-internal value added, capital intensity, capacity utilization or labor productivity. According to PIMS findings, overinvestments are negatively correlated to the ROI and thus represent a serious risk for companies.

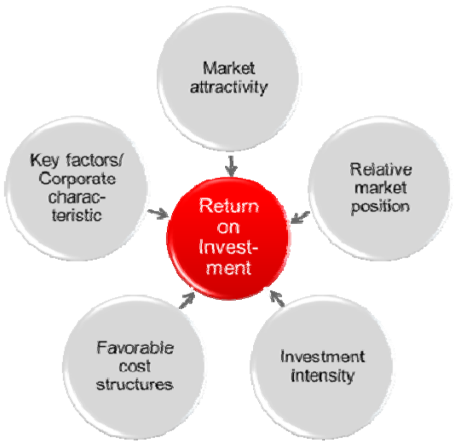

Figure 2: Key success factors as a result of the PIMS study

Next, favorable cost structures positively influence the ROI. Cost structures are measured relative to sales such as relative marketing or R&D expenditures. Finally, there are further success factors that are combinations of static corporate characteristics like firm size, degree of diversification or degree of organization and the dynamics of these factors like frequency of changes in product quality or restructurings of the organizations (www.pimsonline.com).

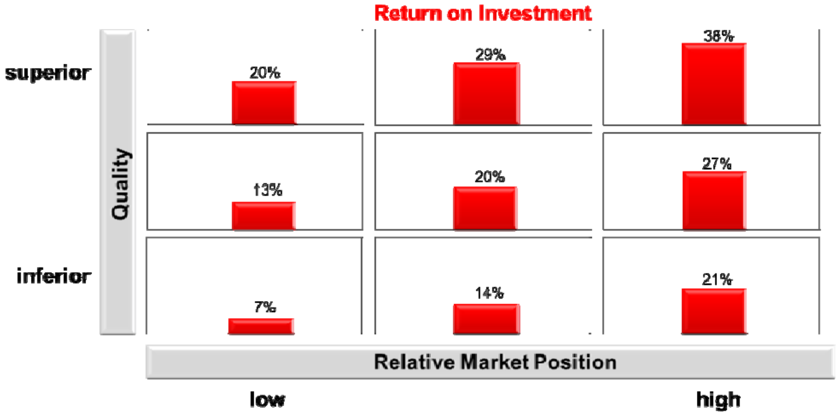

Figure 3: PIMS-result on the success factors relative market share and quality (www.pimsonline.com)

As an example, Figure 3 shows the correlations of relative market share, representing the relative market position, with the quality of the firm's product or service quality. It can be concluded from the figure that a company with inferior quality and low market share receives the lowest return on investments – or success – in an industry. Then again, a very strong market position combined with superior quality lead to the highest return on investment. It seems as if relative market shares and product quality activate one another, which cannot be measured with statistical quantitative methods. In addition, there may be other variables influencing the ROI and the two success factors, making it difficult to derive simple laws of the market.

To sum up, the PIMS study uses a highly sophisticated quantitative data base that allows scholars to investigate different market or industry conditions, long time horizons, and many variables using a representative sample. From the beginning, the objective of PIMS research was to identify laws of the market and the factors associated with differences in business performance and quantify their impacts. The results as shown in Figure 3 seem to prove the success potential of differentiation strategies according to the market-based strategy approach as a law of the market. However, the ROI is also influenced by market or industry conditions, a business unit's competitive position and the strategies adopted by the unit's managers during a given time period (Buzzell, 2004). Based on PIMS findings Jacobson (1988, 1990) and Jacobson and Aaker (1985) concluded that unobservable factors such as management skill and luck and other "firm-specific unobservable factors" (1990, 80) are the principal determinants of business performance with a higher significant effect on profitability than the success factors of PIMS. The PIMS methodology, like the majority of quantitative empirical research methods, requires that the success factors operate simultaneously in the regression equations, without any time-delays or mediators and only in one direction on the success variables with a either a positive or a negative correlation. Due to these restrictions it is difficult to derive the laws of the market place.

4.2. System Dynamics as an Approach for Success Factor Research

In the following, we critically reflect on the insights of the PIMS study by comparing them to observations from a System Dynamics-based strategy project conducted by PA Consulting Group

(PA) for a large European automobile manufacturer. The client had asked PA to develop a strategy to overcome current organizational weaknesses and identify key factors and high-leverage policies (Sterman, 2000) to gain back market share: the client had been well known for having challenged the status quo, with groundbreaking achievements in technology, performance and style. Then, however, the client experienced increasing competition, especially from uprising Asian competitors, which lead to decreasing market share.

PA's initial analysis of the client's state revealed that its challenge touched multiple aspects: it needed to bring new products to the market quickly, at high quality, and with competitive design and features. At the same time, it had to support meeting corporate profit objectives on the one hand and to meet cost objectives to attract customers on the other hand. The objectives were highly important for the client as it continued to invest heavily in the expansion of its product lineup.

The analysis also revealed that the dependencies were highly critical not only within a single new product project but also between multiple new product projects. In addition, the new product development processwas characterized by frequent modification of product strategies to accommodate changing market conditions and competitor actions, regular introduction of new ways of doing business, and unexpected imposition of new financial constraints or priorities, among others. Management looked for an innovative analysis approach including a quantitative simulation, having realized that traditional methods were not able to meet the requirements of identifying the main drivers – the critical success factors – and of capturing the dependencies described above and their developmentover time.

The PA team applied System Dynamics to capture the underlying dependencies and their implications for the client's project and program dynamics (Roberts, 1964; Cooper, 1980; Abdel-Hamid, 1988; Sterman, 1992; Homer et al., 1993; Ford/Sterman, 1998; Black/Repenning, 2001; Repenning, 2001; Repenning et al., 2001; Ford/Sterman, 2003; Rahmandad, 2005; Lyneis/Ford, 2007; Cooper/Lee, 2009; Rahmandad/Hu, 2010; Kapmeier 2010). PA is the world's market leader in program and project management simulation, having used the System Dynamics method in more than 100 complex programs in the construction, automotive, defense and software industry. In this particular client project, the PA team has developed, validated and calibrated the new product development process simulator against real-world data in close cooperation with the client in an iterative approach (Sterman, 2000; Lyneis, 1999; Kapmeier/Salge, 2010). The SD modeling process goes along with the process identified by Davis et al. (2007) that can be adapted to success factor research and which is described in Section 3.1.

The heart of the simulator is PA's archetypical project management Rework Cycle (see Figure 4). The overall assumption of the project management simulation model is that the workload involved in a large project can be broken down into a set of tasks. The stock and flow structure (Sterman 2000) explains that initially all tasks that need to be completed are in the stock called Work to be Done. Completing the tasks requires people who work at certain Productivity.

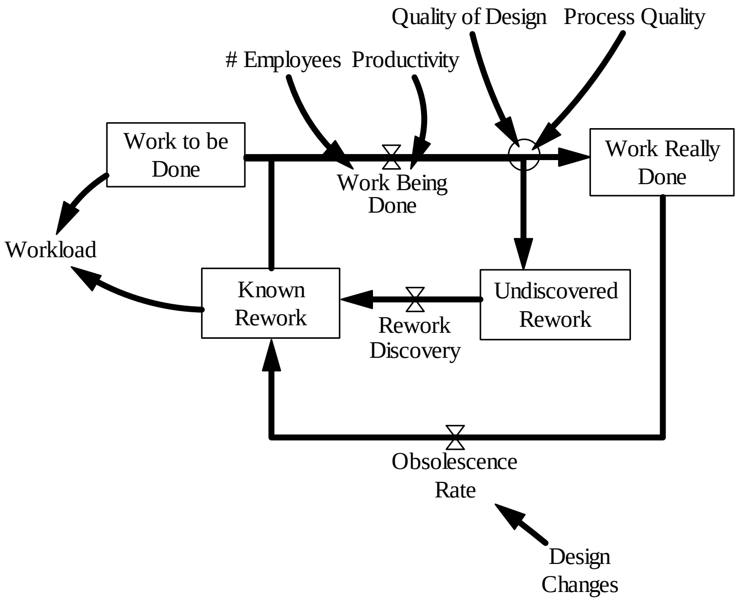

Figure 4: The Rework Cycle of projects (Source: PA Consulting Group, as adapted by Sterman 2000, 58, and extended for the purpose of this paper)

It can be seen in Figure 4 that tasks can be done correctly or incorrectly, depending on the Quality. In the first case, the tasks flow into the stock Work Really Done; in the latter case, they flow in the stock Undiscovered Rework. It takes time and manpower to uncover errors. Once the errors are discovered, the tasks flow into the stock Known Rework and need to be worked on again – and possibly again and again and again, if not done in the right quality. These dynamics are called the Rework Cycle (Cooper, 1980).

A similar effect involving rework results from design changes that occur after project start: design changes make previous Work Really Done obsolete. This situation is typical for PA's client as management oftentimes decides on design changes on cars under development. As a consequence, the stock Work Really Done decreases and Known Rework increases – the difference to the Rework Cycle is that rework is known immediately. As a consequence, the firm needs to increase staff on the project and attention devoted to rework, slowing completion of remaining basework tasks and potentially disrupting the entire project (Sterman, 2000).

The situation with PA's client is far more complex to be described solely with the Rework Cycle. In the following, we describe how the Rework Cycle structure is embedded in PA's client's larger managerial and organizational context (see Figure 5) in a highly simplified causal loop diagram. Note that for reasons of clarity we do not show the Rework Cycle in the CLD. Yet, the variables depicted in italic are also represented in Figure 4. Note further that the CLD is slightly extended compared to its original client version for reasons of argumentation for this publication.

Staff on the project primarily depends on the remaining workload, being the sum of Work to be Done and Known Rework. The larger the new car development project, the more people are being assigned to the project. The more people work on the project, the higher the Development

Costs. Development Costs drive Variable Costs, as do Warranty Costs, Marketing Costs, and Production Costs. With increasing Variable Costs and Fixed Costs the smaller the Profit Contribution. Profit Contribution is increased, however, by higher Revenues. The higher the Profit Contribution, the more people can be assigned to new development projects. In addition, the higher the Profit Contribution the more the firm can spend on necessary Process Innovations. All other things equal, Process Innovations lead to Process Improvements with a time delay (Repenning/Sterman, 2002).

Process Improvements affect two important aspects of new product development projects, Design Quality and Productivity. With the introduction of Process Improvements, tasks are done more efficiently and staff Productivity increases, Workload is decreased faster which means that fewer employees are needed to conduct the remaining tasks, thus reducing Variable Costs and increasing Profit Contribution. Higher Process Quality advances car design, function, reliability, and ease of maintenance. These aspects linked to a vehicle can be subsumed under Quality of Design. Higher Quality of Design leads to less rework, decreasing the remaining Workload, requiring less staff and reducing Variable Costs.

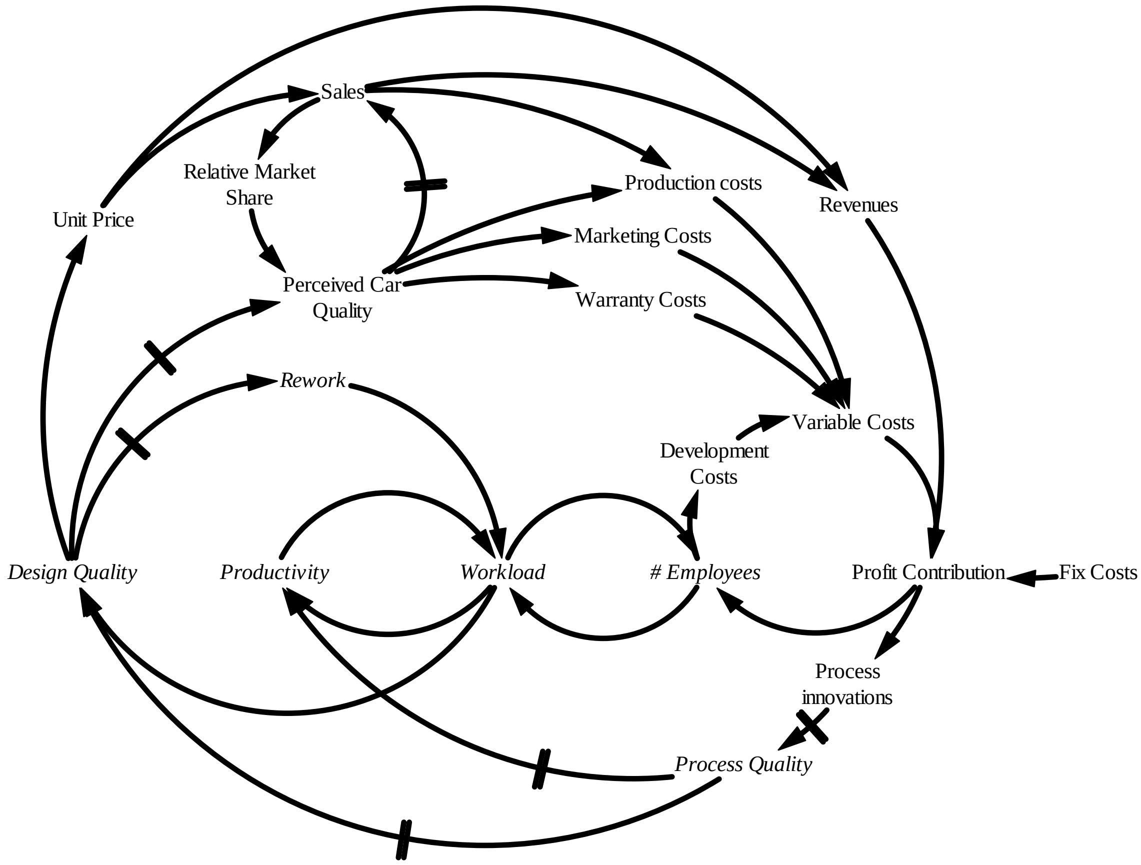

Figure 5: Causal loop diagram for new car development. Variable names in italic are also represented in Figure 4.

When cars are perceived as well-designed, reliable products, more customers are willing to buy and even pay more for them – marketing can enforce a higher price in the market per unit sold. In such a case and assuming everything else equal, Revenues and Profit Contribution increase. At the same time, the higher product quality displaces the price-volume curve: with higher Car Quality, Sales increase, which leads to a higher Relative Market Share. With more cars being sold, more people drive the cars and firm representatives receive more feedback from their customers. The feedback is used to improve Car Quality even further, which leads to even more sales.

The higher the Sales Volume, the morethe firm is able to realize economies of scale that go along with fewer Productions Costs. Higher Car Quality decreases Warranty Costs. The word spreads in among customers and potential customers that Car Quality has improved noticeably which encourages potential customers to buy the particular car. This means that less marketing expenditures are necessary to promote the car in the market. Fewer Production Costs, Warranty Costs, and Marketing Costs decrease Variable Costs, leading to higher Profit Contribution.

In the following we look at the dynamics of the system as it is reflected in the simulation model. The model structure has been developed in close cooperation with the client team that involved experts from different areas, including project management, marketing, production, finance, etc. The structure has been calibrated against real data with a high fit between the simulation base case run and the data. The good fit between simulation run and real world data is an important step in ensuring that the model structure correctly estimates short-term and long-term interdependencies between variables and depicts realistically the development of firm data and market data. Because this and several other typical validation steps (Sterman, 2000), the client team built up confidence in the model structure and thus accepted insights from its scenarios for their decision making and policy design. The PA team discussed many scenarios with the client. In the following, we analyze two different simulation runs (see Figure6) that are suited for the discussion on critical success factors.

The base run represents a ‘business as usual’ strategy (dashed line) and the scenario ‘With reengineering’ (solid line) shows consequences of management introducing a 2.5 year-long reengineering program after year four. We look at the development over time of Indicated headcount, Index of quality at launch, Warranty costs, and Profit contribution for the two scenarios.

The need for a reengineering program becomes evident in the base case, which shows that while Quality was still expected to increase for a few years, it was later expect to decrease, continuously and dramatically. Consequently, Warranty costs increase substantially over the time horizon of the simulation and profit contribution remains pretty much stagnant.

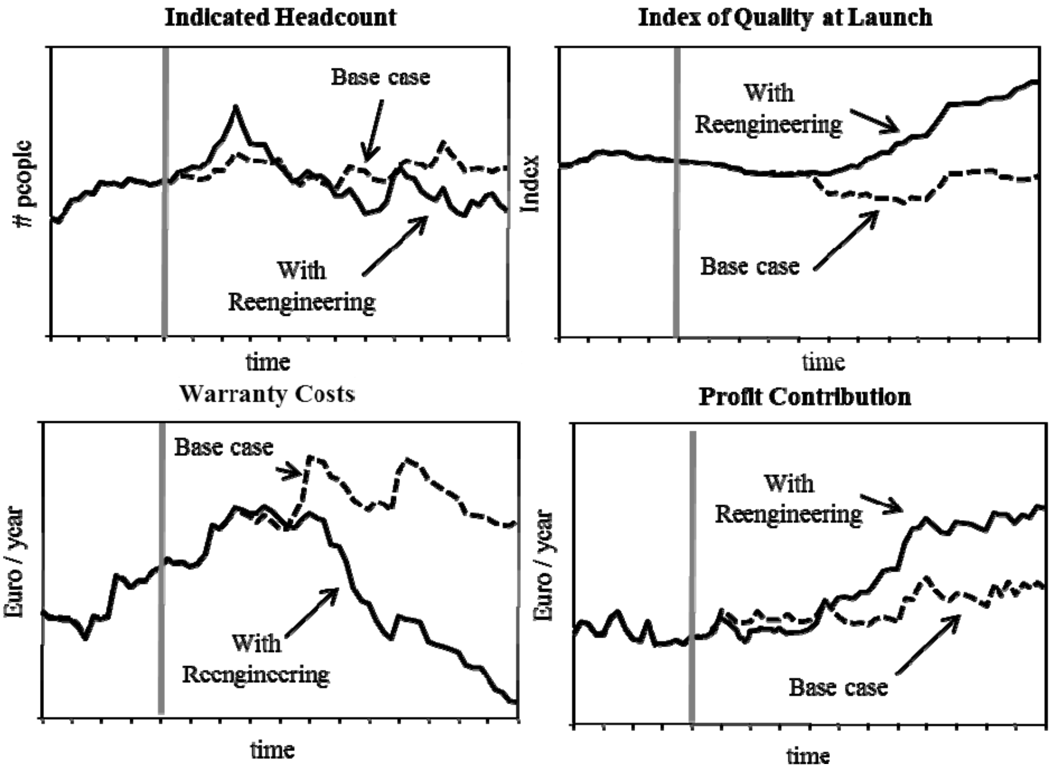

Figure 6: Simulation runs – Base case (dashed line) and scenario With Reengineering (solid line). The grey vertical line represents the kick-off of the reengineering project

If management launched a reengineering effort, though, the simulator shows that it would affect Quality at launch with a time delay of about 3 years, which is about the lag between the engineering work being done and the eventual appearance of its fruit (the car) on the market place. Car quality increases continuously until the end of the simulation horizon (upper right hand graph). Consequently, fewer cars are called-back for service which means that Warranty costs also decrease nearly continuously. Actual and potential customers talk about the increased product quality and their confidence in the perceived quality of the cars increase. More potential customers decide to buy the cars, more units are being sold and revenues increase.

Introducing new processes requires additional manpower (upper left hand graph): indicated headcount is much higher during the ongoing reengineering project than in the base case. After having implemented the new processes and once the new processes run smoothly, less indicated headcount is necessary to run the operations than prior – and less indicated headcount is necessary compared to the base case.

Compared to the base case, Profit contribution (lower right hand graph) first suffers from the investment in the process redesign and the additional people to run the reengineering. It is below the base case for the period of the reengineering in addition to another 2.5 years. After that, however, Profit contribution increases because of fewer costs (Warranty costs, among others) and higher sales due to higher product quality. Profit contribution increases to a level far higher than in the base case. This is a typical example for a ‘worse-before better’ behavior that is oftentimes characteristic for complex systems (Thun 2006, Repenning/Sterman 2002, Repenning/Sterman 2001, Richardson 1991).

5. Discussion: Contrasting PIMS and System Dynamics as Success Factor Research Methods

In this section, we relate aspects of the System Dynamics-based analysis for understanding the underlying structure of multiple new product development projects to the features of the PIMS model. We see that both models entail similar constructs from which we infer that the models can be compared (see Figure 7). First, primary focus of the two models is on financial measures. The objective of the PIMS study is to analyze which factors influence the ROI. For PA’s client a (higher) positive Profit Contribution (System Dynamics model) is important.

Second, there are similarities with regards to a firm’s cost structure in both models. The PIMS study identifies Low cost structure as one main driver for company success. The System Dynamics model entails financial measures in more detail like Variable Costs, Fixed Costs and Revenues that are driving Profit Contribution.

	PIMS	Client specific System Dynamics model
Financial objective	ROI	Profit contribution
Cost structure	Low cost structures	Variable costs, Fixed costs, Revenues
Market I	Market attractivity	Relative market share
Market II	Relative competitive position	Product price
Investments	Investment intensity	Investments in R&D
Additional factors	Key factors	R&D processes

Figure 7: Assigning aspects of the PIMS study to PA’s client specific System Dynamics model

Third, we subsume constructs of the two studies under the firm’s market structure with a similar underlying message: first, two drivers for an increased ROI, Market attractivity and Relative competitive position represent the PIMS study and Relative market share and Product price characterize the System Dynamics model. Furthermore and fourth, the relative Competitive position (PIMS) can be operationalized by the Product price (System Dynamics model) as the Product price determines the firm’s position in the market. The higher the firm’s Relative market share (System Dynamics model), the more attractive is the market for a firm to be active in it (PIMS).

Sixth, terminology is similar for both models when it comes to investments. Whereas the PIMS study talks about Investment intensity, the PA team identified Investments in R&D. Model analysis identified it as a high-leverage policy driver for long-term success (System Dynamics model).

Finally, there are other Key factors important for firm success (PIMS). For the client case, the client team identified R&D processes (System Dynamics model) as another key factor for success.As a next step, we position the success factors identified in the PIMS study within the causal loop diagram designed specifically to address PA's client's managerial challenge. We identify three differences in the analysis of the two studies (see Figure 8). They primarily deal with the main characteristics of System Dynamics models: feedback processes, time delays, and non-linearity (Richardson, 1991; Sterman, 2000).

First, we deduce from Figure 8 that the main success factors identified by the PIMS study do not affect the dependent variable ROI directly - the variables affect each other mutually and this leads to closed feedback loops. According to Sterman (1992), complex systems like large projects contain multiple interacting processes. In the client case described above, a higher ROI brings the firm into a position to invest more in order to improve process quality, for example. Product quality improves. Customers learn and talk about improved car quality and buy more, which strengthens the firm's Relative market position and Market attractivity improves. More sold – and produced – cars lead to economies of scale, a better cost structure, and eventually a higher ROI. This feedback loop works in a virtuous cycle – but it may also work the other way round: A lower ROI does not allow management to invest more in innovative processes. Process quality – a critical issue – becomes lower, leading to lower product quality, a smaller number of cars sold. The firm does not realize economies of scale which leads to a relatively higher cost structure and a smaller ROI. Now, the loop works in a vicious way, worsening the situation even further. Thus, the five identified success factors do not affect the financial measure directly but indirectly in a positive feedback process. In other words, the financial measure cannot only be seen as a dependent variable, as stated by the PIMS literature. It also determines future investments. Another typical feedback process in large projects is the possible managerial response to increase the use of overtime in case the project falls behind schedule. "The extra hours help bring the project back on schedule, reducing the need for overtime in the future. Such a feedback process is self-correcting. However, if overtime remains high for an extended period, workers may become fatigued and burned out, leading to lower productivity, a higher rate of errors, and increased employee turnover, thus further delaying the project and leading to pressure for still more overtime, in a vicious cycle or self-reinforcing feedback processes" (Sterman, 1992, 58).

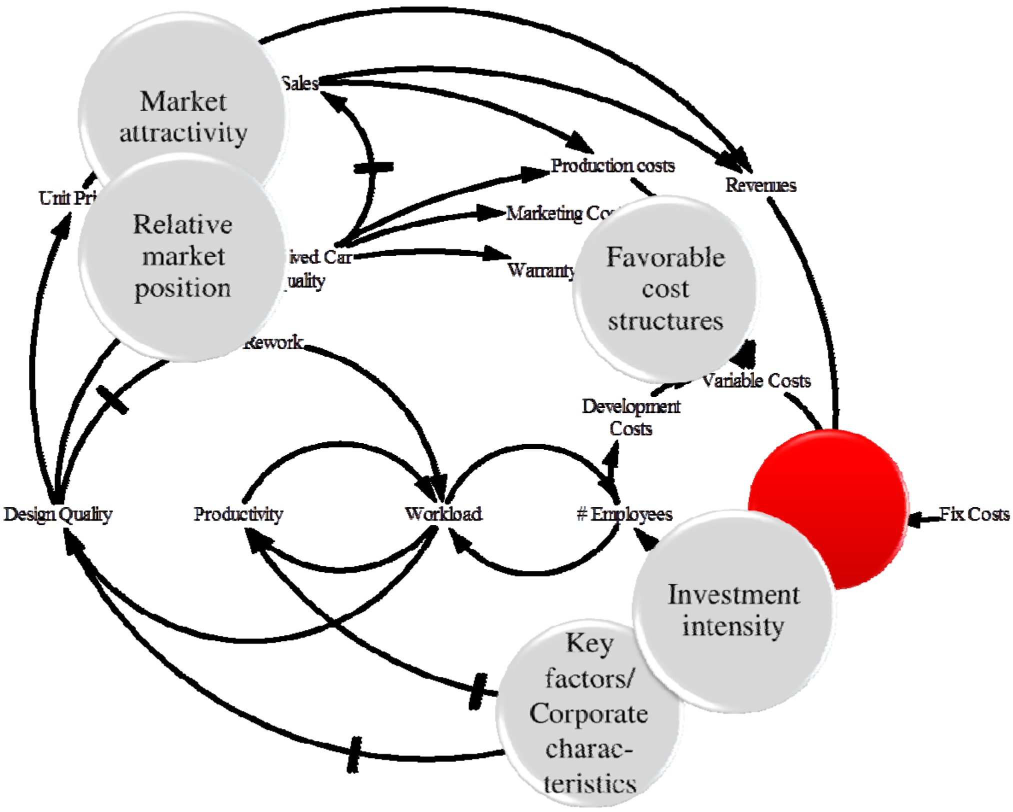

Figure 8: Aspects of the PIMS study assigned to the causal loop diagram representing the structure of new car development

Second, the identified relationships do not affect each other immediately. Large development programs are characterized by multiple time delays in carrying out large development programs like the discovery and correction of errors or the response to unexpected change in project scope or specifications (Sterman 1992). Another prominent example for time delays in managerial settings is that it takes time to realize process improvements (Repenning, 2002; Repenning/Sterman, 2001).

Third, non-linearity is also inherent in mostly all large projects and programs (Sterman, 1992; Richardson/Pugh, 1981; Forrester, 1987). Sterman (1992) points out that the relationship between workweek and productivity is not proportional, for example. Non-linearity is not captured in the equations of the PIMS model.

Fourth, the PIMS model identifies correlations between variables, like the correlation between market share and quality, as shown in Figure 2. System Dynamics models, however, do not show correlations but causations, as shown in Figure 5. Correlations reflect past behavior of the system and do not represent the structure of the system. They emerge from the behavior of the system when it is simulated (Sterman, 2000, 141). As higher quality displaces the price-volume curve in the client case, the user of the model is able to get a better understanding why the relationship is structured that way – instead of only looking at a black box, not understanding the roots for the correlation.

Fifth, we generate insights from the behavior-over-time analysis. Generally, 'worse before better' indicates that the performance of a system first suffers before improvement activities move the system forward. One reason for this counterintuitive effect occurring is that the system must be adapted to the necessary changes that involves time delays (Thun, 2006). For example, it takes time until staff has familiarized itself with new, more efficient processes that eventually lead to profit improvement. Time delays in feedback loops mean the long-run response of a system to an intervention like process improvement is often different from its short-run response. Low leverage policies often generate transitory improvement before the problem grows worse. High leverage policies often cause worse-before-better behavior (Sterman, 2000). The PA team has identified process reengineering for the European car manufacturer as such a high-leverage policy. Such a worse-before-better behavior cannot be identified by traditional empirical studies as they do not consider and reveal over-time-behavior. Traditional methods take pictures of certain situations while System Dynamics analyses can be interpreted as a movie revealing such over-time behavior. In other words, different critical success factors can be important in different phases. This fact can be well shown with System Dynamics analyses. In this particular example, only if the time horizon in an empirical study had been chosen long enough, process improvement could have been identified as a success factor. We claim that this had not been the case if the time horizon been chosen shorter.

6. Summary

Having a profound understanding of the actual drivers for firm success can be regarded as a core concern of decision-makers. For more than 40 years, scholars and practitioners have been making strong efforts towards identifying determinants for future firm success. While in the early days, recommendations from large-scale empirical CSF research had been more or less general recommendations, CSF studies have become increasingly refined and focused over time, now being nearly firm-specific. Yet, CSF research still has only little impact on strategy in practice. We critically review qualitative and quantitative CSF research methods and identify main weaknesses of the traditional success factor research. Main critics are the lack of over-time representation of CSFs and their drivers, lack of full understanding of practical implications, deficiencies in the studies being firm-specific, and increasing difficulty for managers to adapt the CSF findings for individual firms.

It becomes evident that some of the drawbacks of quantitative success factor research may be overcome by simulation methods like System Dynamics. In our case example, we first refer to success factors identified by the PIMS study, an established, large-scale empirical CSF study. We then present a client project conducted by PA Consulting Group in which the client, a large European automotive manufacturer, looked for specific success factors to improve its new product development process. The PA team developed a System Dynamics-based simulation model for the client that covers the CSF topics identified by the PIMS study. Comparing the PIMS results with the System Dynamics model we demonstrate that the System Dynamics model covers all aspects of PIMS including a financial measure as main performance variable and Market Attractivity, Relative Market Position, Investment Intensity, Favorable Cost Structures, and Key Factors/Corporate Characteristics as its drivers. Moreover, the System Dynamics model provides additional superior insights into the complex dynamics of the managerial challenge. We argue that a firm-specific System Dynamics-based simulation model expands traditional CSF research, especially because of its characteristics when considering over-time behavior in general and specifically feedback, time delays, and non-linearity.

For scholars, System Dynamics-based CSF research provides a new, promising way of building and testing theory, providing valuable insights into the research question. Yet, as simulation-based research currently cannot draw on a community as wide as traditional empirical research, it takes more efforts for scholars to convince the established scientific community of the applicability of the research approach in general (Repenning, 2003) and in particular to CSF research. System Dynamics-based research is beneficial for practitioners as System Dynamics models do reduce complexity but do not cut-off existing feedback loops. Because of the various validation concepts, users may build confidence in the model and its simulation results. We conclude that empirical success factor research could overcome its practical shortcomings when accompanied by firm-specific System Dynamics modeling. System Dynamics modeling not only enables decision-makers to identify firm-specific CSFs, but fosters a constructive dialogue across organizational boundaries.

Literature

Abdel-Hamid, TK. 1988. The Economics of Software Quality Assurance: A Simulation-based Case Study. *MISQuarterly* **12**(3): 395-411.

Abell, DF, and Hammond, JS. 1979. *Strategic Market Planning: Problems and Analytical Approaches*. Englewood Cliffs, New Jersey: Prentice-Hall.

Armstrong, JS. 1991. Strategic Planning Improves Manufacturing Performance. *Long Range Planning* **24**(4): 62-74.

Backhaus, K, Erichson, B, Plinke, W, and Weiber, R. 2011. *Multivariate Analysemethoden – Eine anwendungsorientierte Einführung* (13th ed.). Berlin: Springer.

Barney, JB. 1991. Firm Resources and Sustained Competitive Advantage. *Journal of Management* **17**(1): 99-120.

Barney, JB. 1996. The Resource-based Theory of the Firm. *Organization Science* **7**(5): 469.

Black, LJ, and Repenning, NP. 2001. Why Firefighting Is Never Enough: Preserving High-Quality Product Development. *System Dynamics Review* **17**(1): 33-62.

Boyd, KB. 1991. Strategic Planning and Financial Performance: A Meta-Analytic Review. *Journal of Management Studies* **28**(4): 353-374.

Buzzell, RD, Gale, BT. 1987. *The PIMS Principles: Linking Strategy to Performance*. New York: Free Press.

Buzzell, RD. 2004. The PIMS Program of Strategy Research: A Retrospective Appraisal. *Journal of Business Research* **57**(5): 478-483.

Capon, N, Farley, JU, and Hulbert, JM. 1994. Strategic Planning and Financial Performance – More Evidence. *Journal of Management Studies* **31**(1): 105-110.

Cooper, KG, and Lee, G. 2009. Managing the Dynamics of Projects and Changes at Fluor. *Proceedings of the International System Dynamics Society Conference*. Albuquerque, New Mexico, July 26-30.

Cooper, KG. 1980. Naval Ship Production: A Claim Settled and a Framework Built. *Interfaces* **10**(6): 20-36.

Dillerup, R. and Stoi, R. 2011. *Unternehmensführung* (3rd ed.). München: Vahlen Verlag.

Dooley, K. 2002. Simulation Research Methods. In JAC Baum (Ed.), *The Blackwell Companion to Organizations*, 829-848. Oxford: Blackwell.

Eisenhardt, KM. 1989. Building Theories from Case Study Research. *The Academy of Management Review* **14**(4): 532-550.

Ford, D, and Sterman, J. 1998. Dynamic Modeling of Product Development Processes. *System Dynamics Review* **14**(1): 31-68.

Ford, D, and Sterman, J. 2003. Overcoming the 90% Syndrome: Iteration Management in Concurrent Development Projects. *Concurrent Engineering: Research and Applications* **11**(3): 177-186.

Forrester, JW. 1961. *Industrial Dynamics*. Cambridge, Massachusetts.

Forrester, JW. 1987. Nonlinearity in High-Order Models of Social Systems. *European Journal of Operational Research* **30**(2): 104-109.

Gälweiler, A. 2005. *Strategische Unternehmensführung* (3rd ed.). Frankfurt a.M./New York: Campus.

Greenley, GE. 1986. Does Strategic Planning Improve Company Performance? *Long Range Planning* **19**(1): 101-109.

Haenecke, H. 2002. Methodenorientierte Systematisierung der Kritik an der Erfolgsfaktorenforschung. *Zeitschrift für Betriebswirtschaft* **72**(2): 165-183.

Homer, J, Sterman, J, Greenwood, B, and Perkola, M. 1993. Delivery Time Reduction in Pump and Paper Mill Construction Projects: A Dynamic Analysis of Alternatives. *Proceedings of the 1993 International System Dynamics Conference.* Cancun, Mexico.

Jacobson, R. 1988. Distinguishing Among Competing Theories of the Market Share Effect. *Journal of Marketing* **52**(5): 68-80.

Jacobson, R. 1990. Unobservable Effects and Business Performance. *Marketing Science* **19**(9): 74-85.

Jacobson, R, and Aaker, D. 1985. Is Market Share All that It’s Cracked Up to Be? *Journal of Marketing* **49**(5): 11-22.

Johnson, G, Scholes, K, and Whittington, R. 2010. *Exploring Corporate Strategy* (8th ed.). London/New York: Prentice Hall.

Kapmeier, F, and Salge, M. 2010. Robuste Bilder der Zukunft: Wie System-Dynamics-basierte Prognosesimulatoren Unternehmenslenker beim Steuern unter Unsicherheit unterstützen. *Risk Compliance & Audit* **2**(3): 22-28.

Kapmeier, F. 2010. Dynamische Balanced Scorecard eines europäischen Automobilherstellers. In Dillerup, R, and Stoi, R (Eds), *Unternehmensführung* (3rd Ed.), 328-333. München: Vahlen.

Kapmeier, F. Forthcoming 2011. Systemdynamische Überlegungen zum Portfoliomanagement – dargestellt am Beispiel eines europäischen Automobilherstellers. In Tilebein, M (Ed), *Tagungsband der Deutschen Gesellschaft für Wirtschafts- und Sozialkybernetik e.V.*

Kieser, A. 1996. Business Process Reengineering. Neue Kleider für den Kaiser? *Zeitschrift für Führung und Organisation (zfo)* **65**(3): 179-185.

Kieser, A, and Walgenbach, P. 2010. *Organisation* (6th ed.). Stuttgart: Schäffer-Poeschel.

Klarmann, M. 2008. *Methodische Problemfelder der Erfolgsfaktorenforschung*. Wiesbaden: Gabler.

Law, AM, and Kelton, DW. 1991. *Simulation Modeling and Analysis* (2nd ed.). New York: McGraw-Hill.

Leidecker, J, and Bruno, AV. 1984. Identifying and Using Critical Success Factors. *Long Range Planning* **17**(1): 23-32.

Lyneis, JM, and Ford, D. 2007. System Dynamics Applied to Project Management: A Survey, Assessment, and Directions for Future Research. *System Dynamics Review* **23**(2-3): 157-189.

Lyneis, JM. 1999. System Dynamics for Business Strategy: A Phased Approach. *System Dynamics Review* **15**(1): 37-70.

Makridakis, S. 1991. What Can We Learn from Corporate Failure? *Long Range Planning* **24**(4): 115-126.

March, J, and Sutton, R. 1997. Organizational Performance as a Dependent Variable. *Organization Science* **8**(6): 698-706.

Micheli, P, and Manzoni, J-F. 2010. Strategic Performance Measurement: Benefits, Limitations and Paradoxes. *Long Range Planning* **43**(4): 465-476.

Miller, CC, and Cardinal, LB. 1994. Strategic Planning and Firm Performance – A Synthesis of More Than Two Decades of Research. *Academy of Management Journal* **37**(6): 1649-1665.

Mintzberg, H. 1994. *The Rise and Fall of Strategic Planning*. Englewood Cliffs: Prentice Hall.

Nicolai, A, and Kieser, A. 2002. Trotz eklatanter Erfolglosigkeit: Die Erfolgsfaktorenforschung weiter auf Erfolgskurs. *Die Betriebswirtschaft* **62**(6): 579-596.

Patt, PJ. 1990. *Strategische Erfolgsfaktoren im Einzelhandel* (2nd ed.). Frankfurt: Peter Lang.

Peters, T, and Waterman, R. 1982. *In Search of Excellence*. New York: Harper & Row.

Porter, ME. 1985. *Competitive Advantage. Creating and Sustaining Superior Performance*. New York/London.

Rahmandad, H, and Hu, K. 2010. Modeling the Rework Cycle: Capturing Multiple Defects Per Task. *System Dynamics Review* **26**(4): 291-315.

Rahmandad, H. 2005. Dynamics of Platform-based Product Development. *Proceedings of the 2005 International System Dynamics Conference.* Boston, Massachusetts, July 17-21.

Repenning, NP, and Sterman, JD. 2002. Capability Traps and Self-Confirming Attribution Errors in the Dynamics of Process Improvement. *Administrative Science Quarterly* **47**(2): 265-295.

Repenning, NP, and Sterman, JD. 2001. Nobody Ever Gets Credits for Fixing Problems that Never Happened. *California Management Review* **43**(4): 64-88.

Repenning, NP, Goncalves, P, and Black, LJ. 2001. Past the Tipping Point: The Persistence of Firefighting in Product Development. *California Management Review* **43**(4): 44-63.

Repenning, NP. 2001. Understanding Fire Fighting in New Product Development. *Journal of Product Innovation Management* **18**(5): 285-300.

Repenning, NP. 2002. A Simulation-Based Approach to Understanding the Dynamics of Innovation Implementation. *Organization Science* **13**(2): 109-127.

Repenning, NP. 2003. Selling System Dynamics to (Other) Social Scientists. *System Dynamics Review* **19**(4): 303-327.

Richardson, GP, and Pugh, A. 1981. *Introduction to System Dynamics Modeling with DYNAMO*. Cambridge, Massachusetts: MIT Press.

Richardson, GP. 1991. System Dynamics: Simulation for Policy Analysis from a Feedback Perspective. In Fishwick, PA, and Luker, PA (Eds.), *Qualitative Simulation Modeling and Analysis (Advances in Simulation)*, 144-169. New York: Springer Verlag.

Rivkin, JW. 2001. Reproducing Knowledge: Replication without Imitation at Moderate Complexity. *Organization Science* **12**(3): 274-293.

Robers, D, Simon, H, Tilebein, M, and Gleich, R. 2009. Service Performance: The Intangible Drivers of Service Success. In Fähnrich, KP, Alt, R, and Francyzk, B. (Ed) *Practitioner Track - International Symposium on Services Science (ISSS'09)*, 151-162. Leipzig: LIV.

Roberts, EB. 1964. *The Dynamics of Research and Development*. New York: Harper & Row.

Rockart, JF. 1979. Chief executives define their own data needs. *Harvard Business Review* ***57***(2): 81-92.

Schmalen, C, Kunert, M, and Weindlmaier, H. 2005. Erfolgsfaktorenforschung: Theoretische Grundlagen, methodische Vorgehensweise und Anwendungserfahrungen in Projekten für die

Ernährungsindustrie. *45. Tagung der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaues*. http://www.uni-goettingen.de/docs/de3ce1be13dea20bce2d2fe660a78a26.pdf

Schmalen, C. 2005. *Erfolgsfaktoren der Markteinführung von Produktinnovationen klein und mittelständischer Unternehmen der Ernährungsindustrie*. München: Herbert Utz Verlag.

Simon, H. 1996. *Hidden Champions: Lessons from 500 of the World's Best Unknown Companies*. Boston, Massachusetts: Harvard Business School Press.

Simon, H, Meyer, S, and Tilebein, M. 2008. Bounded Rationality in Management Research – Computational Approaches to Model the Coevolution of Organizations and their Environments. *Proceedings of the International Federation of Scholarly Associations of Management (IFSAM) 9th World Congress*, Shanghai, China, July 26-28.

Spanos, Y, and Lioukas, S. 2001. An Examination into the Causal Logic of Rent Generation: Contrasting Porter's Competitive Strategy Framework and the Resource-based Perspective. *Strategic Management Journal* **22**(10): 907-934.

Sterman, JD. 1991. A Skeptic's Guide to Computer Models. In GO Barney, B Kreutzer, and MJ Garrett (Eds), *Managing a Nation: The Microcomputer Software Catalog*, 209-229. Boulder, Colorado: Westview Press.

Sterman, JD. 1992. *System Dynamics Modeling for Project Management*. Cambridge, Massachusetts: Sloan School of Management, MIT.

Sterman, JD. 2000. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Boston, Massachusetts: McGraw-Hill.

Sutton, CJ. 1983. Does strategy pay? *Managerial and Decision Economics* **4**(3): 153-159.

Thun, JH. 2006. Maintaining Preventive Maintenance and Maintenance Prevention: Analysing the Dynamic Implications of Total Productive Maintenance. *System Dynamics Review* **22**(2): 163-179.

Thune, SS, and House, RJ. 1970. Where Long Range Planning Pays Off: Findings of a Survey of Formal, Informal Planners. *Business Horizons* **13**(8): 81-87.

Womack, JP, Jones, DT, and Roos, D. 1990. *The Machine that Changed the World*. New York: Rawson.