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Integrated System Analysis for Understanding Complexity in Small Business Management – Concept Development and Applications in Horticultural Retail Companies

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“Complexity is the stuff of management”

(Stafford Beer, 1981:31)

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Short summary

The thesis presents a systemic approach to analyzing horticultural retail companies and their particular management challenges. Based on the principles of system theory and cybernetics, an innovative participatory approach was employed to capture the viewpoints of multiple stakeholders in a model that demonstrates the complexity of these family-run companies. Simulated interventions and changes applied to the model contribute to an improved understanding of their multiple dynamic effects, and improves decision-making in small businesses.

Reader's note

The present thesis was submitted as a cumulative thesis based on articles published in peer-reviewed scientific and research journals. For copyright reasons, the full versions of the published articles on which it is based were only included in the version provided to the thesis reviewers. The version of the dissertation thesis provided here is constructed in such a way that the content of the entire thesis can be understood without having read each individual peer-reviewed scientific publication. Tables 1, 4, and 5 and figure 9 in this thesis are reprinted with permission of Taylor & Francis Ltd., on behalf of the Journal of Small Business & Entrepreneurship. Figure 5 is a reprint with permission of Springer Science+Business Media New York.

Zusammenfassung

Methoden zur Analyse von Wirtschaftsunternehmen (wie z. B. Einzelhandelsgärtnereien) dienen vorrangig der betrieblichen Optimierung oder der Lösung spezifischer Problemstellungen. Dabei können multiple und langfristige Auswirkungen von Veränderungen oder unternehmerischen Entscheidungen oftmals nur unzureichend erkannt werden. Viele konventionelle Ansätze zur Unternehmensanalyse konzentrieren sich auf einzelne Disziplinen oder spezifische Einzelprobleme, ignorieren jedoch komplexe und dynamische Wechselbeziehungen zwischen den Unternehmensbereichen, beteiligten Akteuren und dem Unternehmensumfeld. Besonders bei strategischen Entscheidungen oder kritischen Ereignissen in Unternehmen, ist es von großer Bedeutung, dynamische Auswirkungen auf alle Bereiche eines Unternehmens zu erkennen.

Systemische Ansätze zur Analyse von Unternehmen werden bereits seit Mitte des vorherigen Jahrhunderts entwickelt, finden aber aufgrund fehlenden Grundverständnisses in der Praxis und wegen der bislang aufwendigen Umsetzung nur selten Anwendung als Analysewerkzeug in der landwirtschaftlichen Unternehmensberatung oder in kleineren Familienunternehmen. Die vorliegende Dissertation schließt diese Lücke anhand folgender Zielsetzungen: (1) Entwicklung eines konzeptionellen Rahmens für eine Systemanalyse von landwirtschaftlichen Unternehmen mit einem spezifischen Fokus auf gartenbauliche Einzelhandelsbetriebe, (2) Aufstellen eines Systemmodells für einen Musterbetrieb im gärtnerischen Einzelhandel unter Verwendung eines partizipativen Ansatzes, (3) Erkennen von komplexen Verhaltensmustern, zeitlichen Dynamiken und der Rolle einzelner Schlüsselelemente bei maßgebenden Systemeingriffen und (4) Entwicklung eines anwendungsfreundlichen Untersuchungskonzeptes zur Anwendung einer Systemanalyse in kleineren und mittleren Unternehmen. Die Ergebnisse zu diesen Zielsetzungen wurden in vier Artikeln ausgearbeitet und in dieser Dissertation zusammengefasst.

Der erste Artikel bekräftigt die Relevanz von Systemanalysen zur gesamtheitlichen Untersuchung landwirtschaftlicher Familienunternehmen mit ihren komplexen Strukturen und spezifischen Herausforderungen. Vor der Anwendung einer Systemanalyse ist es notwendig, einen inhaltsunabhängigen konzeptionellen Rahmen zu erstellen, um eindeutige Terminologien, Systemstrukturen und -grenzen zu definieren. Dieser Rahmen beruht auf den Prinzipien der Systemtheorie, kybernetischer Grundregeln und diverser Konzepte systemorientierter Managementmodelle, adaptiert auf die Situation von Familienunternehmen in der Landwirtschaft. Der entwickelte konzeptionelle Modellrahmen beinhaltet alle relevanten internen Unternehmensbereiche, Perspektivenbeteiligter Stakeholder, sowie Interaktionen mit dem externen Unternehmensumfeld. Der Rahmen hilft Anwendern dabei, eine zielorientierte Systemanalyse von landwirtschaftlichen Betrieben durchzuführen, und dabei alle notwendigen Perspektiven zu berücksichtigen.

Der zweite Artikel beschreibt die methodische Umsetzung einer Systemanalyse innerhalb des im vorherigen Artikel ausgearbeiteten konzeptionellen Rahmens. Die dabei angewandte Methode des Vester Sensitivitäts Modells® (VSM) greift auf Prinzipien des vernetzten Denkens zurück und verwendet einen partizipativen Ansatz, um eine Muster-Einzelhandelsgärtnerei in mehreren Schritten in einem Systemmodell abbilden zu können. Die VSM-Methode folgt einem festgelegten Schema der Informationsgewinnung durch den Wissenskonsens der teilnehmenden Experten (u. a. Betriebsleiter von Einzelhandelsgärtnereien, Mitarbeiter, Zulieferer, Verbandsvertreter) anhand mehrerer Arbeitsschritte. Um diese üblicherweise sehr aufwendigen Prozesse zur gemeinsamen Wissensgenerierung zu optimieren, wurden erstmalig innovative und benutzerfreundliche Instrumente angewandt, um die Interaktionen des Expertenpanels zu erleichtern (u.a. interaktive Tools wie Online-Umfragen, Foren und Glossare). Das generierte Systemmodell der Einzelhandelsgärtnerei besteht aus insgesamt 35 Elementen mit unterschiedlichen Funktionen im System, die in vielfältigen Wirkungsbeziehungen miteinander interagieren. Als besonders kritische und wirkungsstarke Systemelemente erweisen sich beispielsweise die Fähigkeit der Betriebsleitung zur strategischen Planung, das Betriebsklima und die Außendarstellung der Gärtnerei.

Die Artikel 3 und 4 behandeln im Schwerpunkt die bewertenden Arbeitsschritte von VSM, die es ermöglichen, ausgewählte Themen und Problemstellungen in der untersuchten Mustergärtnerei dezidiert zu betrachten. Auf Basis des generierten Systemmodells der Gärtnerei können mittels Szenarientechnik und dynamisch-interaktiven Simulationen komplexe Auswirkungen von Veränderungen und Eingriffen im System identifiziert werden.

Kleine und mittelständische Unternehmen wie Einzelhandelsgärtnereien als Schnittstelle zwischen der Pflanzenproduktion und dem Verbraucher mit steigendem Nachhaltigkeitsbewusstsein können sich der Nachhaltigkeitsdiskussion kaum verschließen. Die Vielzahl an Aspekten bei der Anwendung von Strategien für eine nachhaltige Produktion fördert oftmals die Unsicherheit der Betriebsleiter hinsichtlich der Umsetzung und der Rentabilität solcher Maßnahmen im Unternehmen. In Artikel 3 wurden deshalb potentielle Bereiche der Nachhaltigkeit innerhalb des Gesamtmodells der Einzelhandelsgärtnerei identifiziert, um anschließend deren Wirkungen auf das Gesamtunternehmen und auf einzelne Unternehmensbereiche bewerten zu können. Die Ergebnisse der durchgeführten Wirkungsanalyse weisen darauf hin, dass zur erfolgreichen Umsetzung von nachhaltigen Maßnahmen in Einzelhandelsgärtnereien das zentrale konventionelle Management miteingebunden werden muss. Ebenso müssen vorhandenen Ressourcen (z.B. Mitarbeiter, fachliche und unternehmerische Kernkompetenzen) berücksichtigt werden, und die angewandten nachhaltigen Strategien sollten zum Kerngeschäft passen.

Artikel 4 betrachtet auftretende Folgeerscheinungen in kleinen Familienunternehmen, wenn eine innerfamiliäre Betriebsübergabe geregelt werden muss, unklar ist, oder von weiteren Faktoren beeinflusst wird. Hierfür wurden wesentliche Systemelemente des Modells, die besonders stark von der Nachfolgesituation der Mustergärtnerei abhängig sind (z. B. Strategische

Planungsweise, Produktivität, Lieferantenbeziehungen), in einem Teilszenario zusammengefasst. Die Anwendung mehrerer Ursache-Wirkungssimulationen (Policy-Tests) dieses „Nachfolgeszenarios“ erleichtert das Verständnis vielfältiger und zeitverzögerter Auswirkungen. Insbesondere Schlüsselelemente, wie auftretende Konflikte zwischen Familie und Beruf, oder die Situation der Mitarbeiter in der Gärtnerei erwiesen sich als sehr sensibel gegenüber den unterschiedlichen Zuständen im Prozess einer Nachfolgeregelung. Ist beispielsweise die Nachfolge längere Zeit unklar, hat dies negative Auswirkungen auf die strategische Handlungsfähigkeit und auf das Betriebsklima. Ebenso konnten langfristige negative Auswirkungen auf betriebswirtschaftliche Bereiche (Rentabilität, Produktivität, Finanzieller Spielraum) ausgemacht werden, die sich nur sehr langsam von der Situation einer ungewissen Nachfolge wieder erholen.

Eine abschließende kybernetische Bewertung des Systemmodells attestiert einen insgesamt moderaten systemischen Reifegrad der untersuchten Mustergärtnerei. Das System zeigt eine gewisse Robustheit gegen externe Einflüsse, einen hohen Grad an Steuerbarkeit durch das Betriebsmanagement, sowie Stabilität durch vorhandene betriebliche Kapazitäten. Obwohl für diese Dissertation ein fiktiver Referenzbetrieb als Untersuchungsgegenstand gewählt wurde, kann das innovative Methodenkonzept auf reale Gartenbaubetriebe mit unterschiedlichen unternehmerischen Herausforderungen angewandt werden, um die Entscheidungsfindung zu unterstützen. Der inhaltsunabhängige konzeptionelle Rahmen sollte jedoch hinsichtlich der Relevanz der einzelnen Komponenten, ihrer spezifischen Struktur und der Art ihrer Wechselwirkungen mit Umweltbereichen individuell überprüft und angepasst werden. Eine wiederholte praktische Anwendung des in dieser Dissertation entwickelten Untersuchungskonzeptes auf reale Unternehmen wird die eingesetzten methodischen Instrumentarien weiter verbessern, und die Aussagekraft der gewonnenen Erkenntnisse durch derartige Analysen für die untersuchte Branche sukzessive erhöhen.

Table of Content

1. Introduction

1.1 Motivation and thesis goals

The problem statement of the present thesis had its origin in previous experiences and observations in research projects in the field of horticultural business, conducted initially at the University of Applied Sciences Weihenstephan-Triesdorf (HSWT), and subsequently at the Technical University of Munich (TUM). Only in rare cases is it possible to analyze small business companies and the problems they face by examining a limited set of impact factors. In many business cases, these problems must be analyzed with broader and more complex approaches.

1.1.1 Approaching the problem statement

The basic impulse to apply an alternative empirical method to analyze exploratory research questions in the field of business management originated from experiences in a previous project conducted with 40 retail companies in Southern Germany between the years of 2008 and 2010. The research project "Customer Satisfaction and Corporate Success of Horticultural Retail Companies" was initially intended to quantify the impact of customer satisfaction rates on the economic success of each of the horticultural retail companies participating in the study. At the beginning of the project, the economic success was determined based on multiannual operational data and profit records (see Gabriel, Menrad, & Schöps, 2012).

Already in the conceptualization phase of this research project, and especially during the phase of data collection, it became apparent that business success is not measurable with single economic figures, and results of such analyses conducted on several similar companies are not easily comparable. Success was interpreted very differently by each of the participating company managers. Also, the perceptions of the degree to which corporate and personal goals had been achieved varied strongly among the different stakeholders of those companies. Exclusive orientation towards profit maximization or high shareholder value without regard for other non-economic goals is rarely effective (Sailer, 2012:83; Schwaninger, 2001:1213). The diversity of goals in small companies, in turn, is dependent on a variety of aspects, such as existing company structures, production and trading portfolio, managers' characteristics (e.g., attitudes, skills, proficiency), current business environment, and the various interests of numerous stakeholders both inside (e.g., employees, family members) and outside the company (e.g., customers, suppliers, investors).

Given these complex challenges, the objectives of the original research project were expanded to include multiple additional relevant perspectives in these companies to help meet the needs of each of the different stakeholders. Regression analyses were used to determine multivariate correlations between various company goals, and factors influencing success. However, the identification of reliable cause-effect-relationships was not possible due to methodological restraints and statistical thresholds.

These and other methodological inadequacies of multivariate business analysis are the subject of much discussion in the field of success factor research, where the majority of studies in several business sectors struggle with low sample sizes, too many variables, data gaps or insufficient data validity and reliability, and further impairments to the informative value of the results.[1] Many studies in this field suffer from a combination of incomplete consideration of relevant stakeholder perspectives and the inability to consider all important business areas (Haenecke, 2002). Incorporation of systemic approaches seems to be a valuable alternative to achieve integrated analysis of the complex situation of companies in order to help meet the managerial challenges in the field of small business.

[1] A broader debate on methodological deficits in the research field of company success factors in German-speaking countries can be followed on the website of A. Nicolai, and A. Kieser (Zeitschrift für Betriebswirtschaft, DBW): http://www.dialog-erfolgsfaktorenforschung.de/

1.1.2 Definitions and thesis goals

The present thesis combines the results described in four articles, each of which had its own intrinsic goals. The articles document the process of system modelling and analysis of small businesses in the specific case of horticultural retail companies. This specific type of companies is allocated to the agricultural sector– a sector which is dominated in Germany by family-run enterprises.

The understanding of 'family' and 'family business' differs widely among research studies (Harms, 2014; Chua, Chrisman, & Sharma, 1999). For the purpose of the present thesis, the term 'family' refers to a multigenerational community of solidarity (biologically related or related by marriage) with similar basic objectives (e.g., reproduction, security, maintaining quality of life), but specific individual roles (Gabriel et al., 2016). In the context of family business, it is assumed that the main interest of the generation currently in charge of a business enterprise (parents) is the continuation of the lifetime achievement of the predecessors (grandparents) and establishment of the following generation (children) in the enterprise in preparation for a successful succession within the family.

A broad range of definitions for 'family businesses' also exists in the field of family business research. The German Institut für Mittelstandsforschung (IfM, see Haunschild, & Wolter, 2010) defines family business in terms of unity of ownership and leadership, whereby the family owns the majority of the shares of the enterprise. For the context of this thesis, family-run companies are defined as business organizations where "the manager is also the owner or a member of the owner family and makes decisions about short and long-term issues in the interest of the enterprise" (Hauser, 2005:2).

Family-run enterprises, which are typical for the German agricultural sector (BMEL, 2014), have to cope with and manage the complex interactions of family, business (Pieper, & Klein, 2007), and ownership (Ward, 2001; Gersick et al., 1997). These enterprises dominate the production level in German agriculture, defined as business units that grow plants and crops and/or raise animals for food, other human needs. The proprietors themselves manage nine out of ten enterprises in this sector (BMEL, 2014). In contrast to other small business sectors in Germany, in agriculture, more than half of family businesses (55 %) are run on a part-time basis (DESTATIS, 2016). Agricultural enterprises have also become more specialized and mechanized, and crop and livestock production have increasingly been undertaken in separate enterprises which, in many cases, are concentrated in key regions of Germany (BMEL, 2014).

As a specific type of company in the agricultural sector, horticulture retail companies (HRCs) produce and market flowers, ornamental plants, and nursery products. HRCs play a significant role within the German horticultural sector, and are significant market actors in the plant market in Germany. The horticultural sector generates 13.8 % of total agricultural revenues on only 1.3 % of the production area (Dirksmeyer, & Fluck, 2013). The combination of production and marketing of horticultural products in HRCs is characterized by high labor and capital intensity in combination with a proportionately small production area, and a corresponding high value-added (Behr, & Niehues, 2009). Most of these companies are small, with fewer than ten employees, and have greenhouse facilities smaller than one hectare (BMEL, 2016).[2]

Each of the articles included in the present thesis is based on the sector and company definitions described above. Article #1 addresses the requirement that a general content-independent conceptual framework must be generated prior to applying any specific model of system analysis to a company or group of companies in order to provide clearly define unique terminology, system structures, and system boundaries (Principe, 1994:183). The intention of this conceptual article was to develop such a framework suited to the type of organization to be

[2] More detailed descriptions of the agricultural sector are provided in Article #1 (Gabriel et al., 2016:328–330), and an illustration of the horticultural retail sector in Germany in Article #2 (Gabriel et al., 2017:147–149).

analyzed (in this case, family-run enterprises in the agricultural sector) to facilitate the application of systemic approaches. A conceptual framework provides a "map for orientation" for applying integrated analysis methods in socio-technical systems such as businesses (Rüegg-Sturm, 2004:65).[3] The central goal of Article #1 was to apply the integrating principles of system theory, management cybernetics, and reliable concepts of system-oriented business management to family-run enterprises in the agricultural sector. The specific focus on such enterprises in Germany was intended to represent farming in industrialized countries.

Article #2 describes the operational implementation of the system analysis, integrated into the conceptual framework elaborated in the previous article. The second article focuses on a reference horticultural retail company (HRC) in Germany, meant to represent a specific type of company in the agricultural sector. It highlights the first analytical steps in application of the Vester Sensitivity Model® (VSM) up to the finalized system model (= effect system) using a participatory approach (Schlange, & Jüttner, 1997), and considering principles of system thinking (Ulrich, & Probst, 1990:51). The importance of system thinking for analyzing organizations is well recognized in business research, particularly with regard to learning, dealing effectively with complexity, and responding to changing dynamics (Kim et al., 2014). In addition, Article #2 investigates the feasibility of simplifying the multistage process of the applied method of system analysis, and thus, making it less time consuming without compromising the quality of the results.

Article #3 and Article #4 both document the interpretive and evaluative phases of VSM which were undertaken in an effort to better understand selected management topics in the reference HRC. Article #3 identifies areas of sustainability in HRCs, and aims to assess their significance in the company's effect system. An impact analysis was conducted to determine the

[3] Ulrich (2001a:44) provides an overview on the classification of systems. He allocates companies and business organizations as socio-technical systems to artificial systems (as opposed to natural systems) and real systems (as opposed to mental systems).

effects that the identified areas of sustainability have on other business areas to which they are linked in the HRC system model.

Article #4 investigates the specific challenge of succession in small family-run companies. A case study approach was used to identify significant business areas that are affected by the current succession situation of the reference company. The VSM method applied to this question facilitates understanding of the complex and time-lagged effects of either an uncertain succession situation or a succession that is already in the process of implementation. The topical focus of Article #4 allows for comparison of the results of system analysis with pertinent research in the field of family business management much of which has been conducted using non-systemic approaches to investigating succession.

In conclusion, the present thesis aims to answer the general question of to what extent complexity in the management of small organizational units such as HRCs can be depicted and analyzed using a systemic decision-making tool that is based on system theory and management cybernetics. The following activities supported this task: **(1)** developing a conceptual framework for an integrated analysis of agricultural companies with a specific focus on the horticultural retail sector, **(2)** generating a system model within this framework by using a participatory approach, heuristics and system thinking, **(3)** understanding patterns, dynamics and complexity-induced challenges in the management of a HRC, including the role of single key elements in the HRC system, and **(4)** developing a conceptual method for business analysis that can provide managers and decision-makers in small companies a user-friendly instrument for modelling the complexity of their businesses.

1.2 Theoretical background: from system theory to system-oriented business modeling

System theory can be interpreted as a meta-theory with the main purpose of explaining generalized behavior of complex systems and providing a unique terminology and methodology

(Guntram, 1985). As a meta-theory, it is not restricted to a single discipline (Weber, 1996:24ff.). System theory first achieved scientific attention in the 1940s, and at the time was strongly associated with the work of mathematician Norbert Wiener (Ulrich, 2001a:42).

Concepts that rely on system theory and system thinking have been established in several different fields of research, such as ecology, sociology, physics, biology, and information science. These concepts have since been expanded upon in the fields of business management theory and education. Most of these concepts refer to Ludwig van Bertalanffy's doctrine of general system theory (GST) which postulates universal principles that can be applied to generalized systems, independent of the level of systems, the elements they include or the type of relationship between those elements (Van Bertalanffy, 1968).

Overall, GST principles are still key elements in present-day systemic approaches used in business management and research. System theory enables analysts to obtain an overview of behavioral characteristics, structural patterns, and changes in systems in order to explain phenomena in the real world (Schwaninger, 2001; Gomez, 1981). This mainly involves three aspects: considering the interdependencies amongst a large number of system elements and coherencies, thinking in terms of open systems in that environmental conditions and long-range effects are considered, and thinking in terms of feedback loops instead of linear causal chains (Gomez, & Probst, 1999; Probst, 1985).

Parallel to the evolution and implementation of system theory in management theories, another neighboring scientific field came to the fore: cybernetics, defined as the "science of the (self-) control and communication in and of dynamic systems" (Wiener, 1948). The similarity of cybernetics to system theory and their simultaneous evolution can be explained by the parallel development of related principles. However, cybernetics is most often applied to "manageable" systems (e.g., socio-technical systems such as businesses) that are to some extent organized, determined and reproducible (Ashby, 1956). In the 1980s, Heinz von Foerster introduced "second order cybernetics" which specifies systems that are self-organizing and self-sustaining in accordance with ideas and functions of natural systems (Von Foerster, 2006). The adaption of cybernetic principles in the sense of the management of complexity in man-made organizations is discussed in terms of 'management cybernetics' (Malik, 2009; Schwaninger, 2004b).

Within the frames of system theory and cybernetics, system-oriented management theory focuses on forming and controlling social or socio-technical systems. Thus, system-oriented management represents the conceptual basis of system theory and management cybernetics (Christ, 2006:57). System analysts define it as an intermediate step between basic research and management practice (Ulrich, 2001a:59).

1.2.1 System theory in the agricultural context

System theory and cybernetics have also found their way into agricultural practice and farm management. Seuster (1982:168) showed that there are multiple areas of application of general system theory (GST) to agricultural management. In particular, many efforts have been made to use system approaches in relation to agro-technical processes and to create models of farm production management. Bywater (1990) provided an overview of a number of system models related to different farm products and production processes. Keating, & McCrown (2001) summarized the advances system modelling has made in combining biophysical production systems with farm management systems. Fisher et al. (2000) analyzed the utility of systemic simulation tools for supporting farm managers' decision processes in relation to innovation and the adoption of new technologies. They included both endogenous and exogenous factors in farm management and enterprise environment in their system model to understand the adoption and diffusion of innovations such as yield-monitoring technologies. Dogliotti et al. (2014) used a system approach to analyze sustainable agriculture and innovation processes of family farm systems.

A substantial number of researchers have used system approaches to analyze the management of small and medium-sized enterprises (SME) in agriculture (e.g., Fairweather, & Hunt, 2011; Parrilli, 2008; Harney, & Dundon, 2006) and the role of agricultural SMEs in communities, rural development and ecosystems (e.g., Knickel et al., 2009; Kropff, Bouma, & Jones, 2001; Doyle, 1990). System approaches have also been introduced in the field of management in family business (e.g., Piper, & Klein, 2012), but not within the specific context of agriculture. Up to now, no literature is available that deals with systemic approaches applied to companies in the horticultural sector.

1.2.2 Concepts for system-oriented business modeling

In the course of long-term research in system-oriented management theory, several modeling concepts and instruments have been developed and applied in a general business management context. They incorporate management knowledge in the respective framing structures.

The viable system model developed by Stafford Beer in the 1970s is considered the basis for "management cybernetics" (Beer, 1972). The model concept draws parallels between findings with regard to natural or biological systems and the business management context; thus, transferring the basic intention of the concept of viability to socio-technical systems (Espejo, & Harnden, 1989). The main value of the viable system model is its ability to help regulate complex organizational systems. It facilitates decision-making in business management through a formalized model that is built upon functional interactions among the "regulatory subsystems" of a company analyzed.

The Integrated System Methodology (ISM) is another modeling concept that has been widely used in management theory. It that combines both the principles of (business) system dynamics (Sterman, 2000; Forrester, 1968) and management cybernetics. Specifically, it deals with the “requisite variety of [organizational] systems” (Ashby, 1956:206). ISM considers not only the problem under investigation exclusively on a content level, but also on the context level and the associated complex dynamic interrelations (Schwaninger, 2004a:416). The concept uses general heuristics to help actors in businesses at various levels (individuals, groups) to deal with variety and complex issues (Schwaninger, 2009:230). Variety and dynamics are basic characteristics of complexity (Honegger, & Vettiger, 2003:20). Thus, effective management of variety in complex systems can only be achieved by incorporating variety in the modeling of such systems (Ashby, 1956).

A broad-based movement of integrated problem-solving processes in business management originated in the School of Management at the University of St. Gallen in the 1970s. Continuous development and advancement of the basic concepts of system models were applied widely in management education and research conducted predominantly in German-speaking countries. Problem-focused concepts were further advanced by the inclusion of corporate methods of model-based management and organizational practice (Schwaninger, 2001:1211). Continual improvement of the “St. Gallen management models” through the integration of essential management schemes has helped decision-makers manage the increasing complexity in business companies more efficiently. The content-independent framework developed for the system analysis in the present thesis is grounded in several of these established modeling concepts.[4]

1.2.3 The need for an initial conceptual framework

Utilizing systemic approaches to analyze business management requires a conceptual framework adapted to the object of investigation (Principe, 1994:133). Such a “content-independent” set of concepts has great significance for the application of any system analysis in

[4] The derivation and application of the conceptual elements that form the bases for the St. Gallen management models are described in detail in Article #1 (Gabriel et al., 2016:337–339).

enterprises, as it defines basic terminology and classifications to be used in the modeling process (Schwaninger, 2010:1422; Bleicher, 2004:57). Regarding relevant literature, a number of different frameworks have been applied to analyze agricultural enterprises as integrated systems and to explain dynamics and new developments. One widely applied framework is the “farming styles approach” taken by Sørensen, & Kristensen (1991), which allows modeling of management and production on livestock farms. The Bawden framework, which is based on Checkland’s soft system modeling approach, emphasizes human activity in the organization of farming companies (Sriskandarajah, Bawden, & Packham, 1991). Noe, & Alrøe (2003) and Bywater (1990) both provided a broad summary of established transdisciplinary frameworks and technical designs for agricultural enterprises.

The development of a content-independent framework for applying a systemic approach to business organizations requires an understanding of the operational modes of systems, and their embeddedness in the business environment of a company (Malik, 2008). Such a framework must be able to cope with two basic functions of system-oriented management: the management of complexity (Malik, 2009:83; Ulrich, 1981:298) and dynamics (Principe, 1994:16). An understanding of the basic principles of system theory and cybernetics forms the required starting point for a system analysis. A systemic look at a company in its business environment must be undertaken with the understanding that such a business is an open-dynamic system. Behavior and developments of open systems are only controllable to a limited extent (Krallmann, Bobrik, & Levina, 2013).

Principe (1994: 132), whose work focused on application-oriented modeling of business management, introduced the approach of “enclosing filters for systemic modelling of a company and problem situation”. According to his approach, the four nested filters of system theory, cybernetics, disciplinary knowledge and situational knowledge are required to transfer the "situation of the company to the situation model" (Principe, 1994:37). The primary filter of system theory provides the comprehensive frame of reference for modeling complexity (openness, integrity and interdisciplinarity), and provides a uniform terminology. The second filter of cybernetics supports the handling of the universal functions of system behavior necessary for the control and steering of systems. It considers the cybernetic principles of complexity, behavioral patterns, dynamics and iteration (see also Probst, 1987:53). The third filter of disciplinary knowledge forms the basis of a contextual reference framework. The fourth and innermost filter contributes by inserting situational, real-world knowledge into the content-independent framework which has been defined by the three enclosing filters. The framework can be adjusted by optimizing the basic system structure through the process of knowledge input during the subsequent business analysis (Bleicher, 2004; Mole, 2004; Rüegg-Stürm, 2004). Methods and tools of system analysis such as VSM support the collection of situational knowledge, and its integration into the framework.

1.3 Research method and working process

The Vester Sensitivity Model® (VSM) is both a method and a software tool for modeling and analyzing different kinds of social systems based on principles of system theory and (bio-) cybernetics. Thereby, social-technological systems such as companies are assumed to behave like natural systems in that they follow nature's fundamental principles of evolution, viability, and self-regulation (Vester, 2007; Ulrich, & Probst, 1990:87).

VSM was initially developed as a product of the UNESCO-program Man and the Biosphere (MAB II). The aim of MAB II was to solve complex problems of livelihood and ecosystems on a global scale (Vester, & Hesler, 1982). Since its initial development, VSM has been refined and applied in a variety of fields and disciplines, such as resource management, environmental planning, and risk management.[5] Several business studies have used VSM to

[5] A selection of published studies is listed on: http://www.frederic-vester.de/eng/sensitivity-model/projects/

analyze management issues, corporate strategic planning, and business consulting practices in German-speaking countries (e.g., Brexendorf, 2013; Freisl, 2011; Burkhard, 2006).

1.3.1 Specifics of the VSM method

In contrast to non-systemic approaches used in business analysis, integrative methods such as VSM help cope with complexity, interdisciplinarity, and non-linear causal relationships in business management (Ulrich, 2001), as they are compatible with the principles of system theory. While many conventional methods of business analysis rely solely on precise parameters and quantifiable input data, VSM enables the incorporation of fuzzy logic and qualitative assessments.[6] Thus, complex systems can be investigated without full precision with regard to single elements, and with a manageable number of parameters. The range of methods and software tools that are employed to help deal with complexity can be classified according to method and data medium (**Figure 1**).

VSM can be thought of as a method of qualitative analysis, complemented by features of concept mapping and computer-aided simulation options (Neumann, 2015). VSM can be differentiated from software based on system dynamics (e.g., iThink, Powersim), and branch-specific solutions (e.g., Axxom).

[6] Fuzzy logic uses the diffuse knowledge of real experience and allows for compromises in cases whereof contradictory information exists (Wolf et al., 2012).

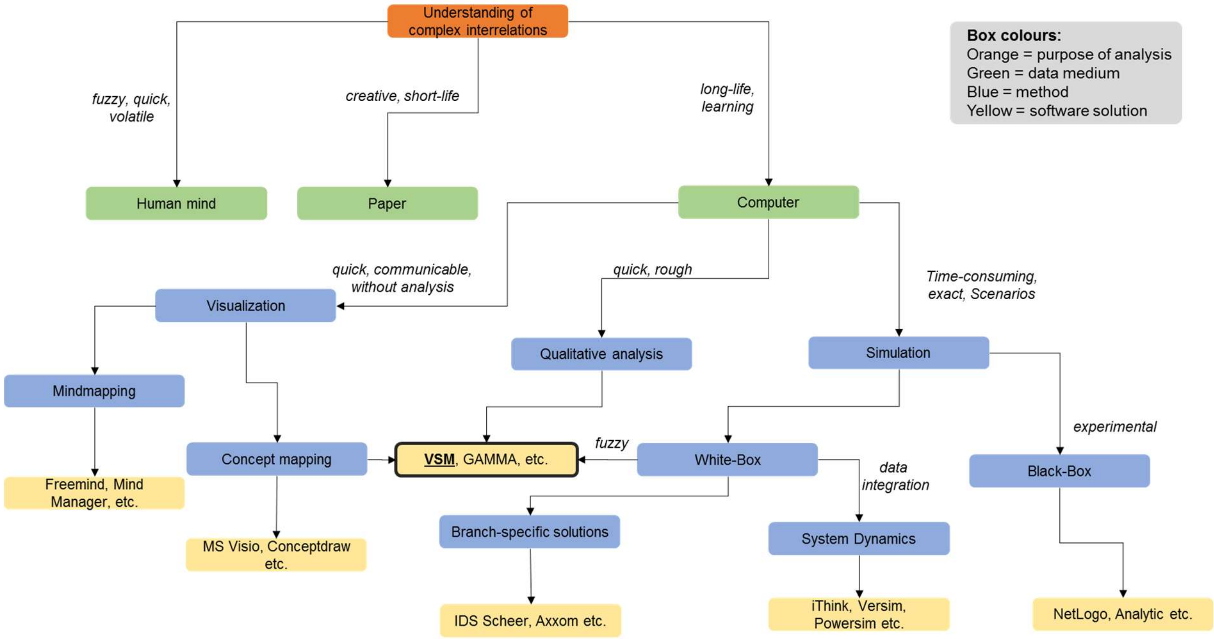

Figure 1 Methods and software for understanding complexity; own illustration based on Neumann (2015)

The Vester Sensitivity Model® (VSM) involves nine successive analytic steps that are grouped into three procedural phases (**Figure 2**). During each of the working steps in the analysis process, VSM operates using qualitative methods of knowledge generation, including participatory approaches, heuristics, and system thinking. The first (description) phase starts with a general description of the system to be analyzed (working step 1), and the identification and cybernetic evaluation of a set of variables (system elements) that are considered decisive for the system's dynamic development (working steps 2 and 3).

The second interpretation phase serves to analyze the cause-effect relationships between various system elements (step 4), and define the systemic role of each variable (step 5). The knowledge gained in the first two phases is incorporated into an integrated effect system (working step 6).

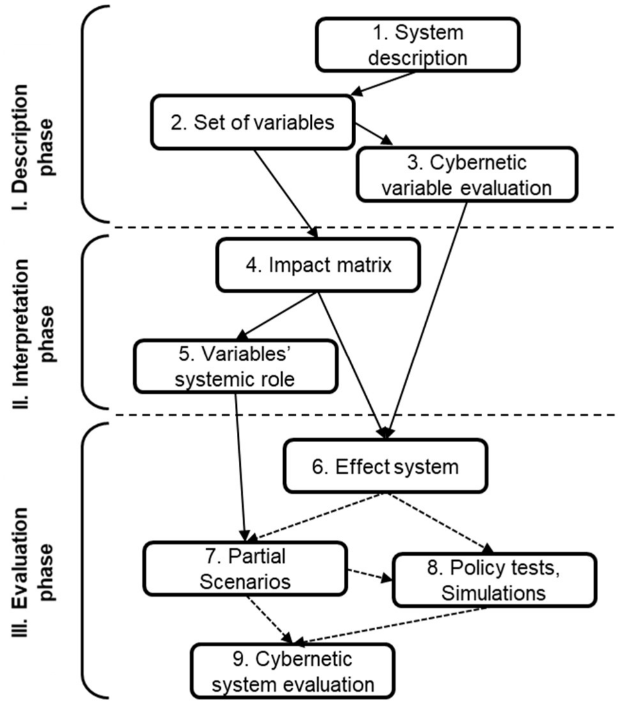

Figure 2 Phases and the nine analytical steps of VSM; own illustration based on Vester (2001)

Generation of the effect system following the first two phases of VSM allows for an in-depth analysis of dynamic effects triggered by changes or interventions in the system. Therefore, VSM provides procedures for extracting partial scenarios for closer investigation of specific areas of the system model (working step 7), and subsequent scenario simulations (working step 8). Partial scenarios help gain a better understanding of the dynamics at work in specific areas that are most relevant to a particular problem, and allow the simulation of the effects of potential system interventions (Vester, 2007). The ninth working step, the final cybernetic evaluation, rates the "cybernetic state of maturity" of the system being analyzed.

1.3.2 Participatory approach using a selected expert panel

Analysis of complex systems such as business organizations requires an integrated understanding of the interrelationships and multiple dynamic effects of interventions and changes (Schlange, & Jüttner, 1997). The various stakeholders of a company being analyzed (e.g., owner-manager, family members, employees, advisors, customers) have diverse viewpoints that are based on individual interests, experiences, and level of involvement. Participatory methods enable the researcher to explore and integrate these different viewpoints, and to deal with uncertainties (Bammer, 2005). Thus, participatory processes in systemic approaches focus on communication, cooperation, and compromise among the various stakeholders involved in order to help build consensus during the analysis and modeling processes (Chan, & Huang, 2004).

The inclusion of multiple perspectives and stakeholders in the analysis generates two additional benefits – a structured dialogue between participants, and self-reflection among all parties involved (Bleicher, 2004). Incorporating stakeholders' different viewpoints into the modeling process enhances collaborative learning (Newig et al., 2008), fosters motivation and consensus building (Bleicher, 2004), and improves the quality of issue-driven knowledge generation (Pohl, & Hirsch Hadorn, 2008:113). Thus, the quality of the modeling process is not so much dependent on the number of participants as on the completeness of the perspectives considered and the level of knowledge of the participating experts.

The working steps of VSM rely on the inclusion of multiple viewpoints and stakeholder knowledge. Within this thesis project, an expert panel was selected based on their level of long-time experience either in HRCs (managers, employees) or in the national horticultural retail sector (business consultants and advisors, suppliers, scholars, and association representatives). The selection of the panel experts was influenced by targeted recruitment of known stakeholders, and regional proximity. Their willingness to participate was enhanced by the opportunity the project offered them to derive new insights into their own businesses and the daily work. In total, eighteen experts agreed to participate in the development of the system model. The complete panel consisted of currently active HRC managers (6), advisors (3), HRC employees (2), suppliers (2), scholars with expertise in the different fields of HRC management (4), and an association representative.

1.3.3 Description of methodological procedures and innovations

The required consensus of the participants (experts) in the multilevel VSM working steps is generally achieved through several face-to-face meetings of the experts in workshops or similar meeting formats lasting several days (see for example the working processes described in detail in Wolf, Persson, & Jelse (2012)). The presented thesis project integrates for the first time innovative methods of interaction to help limit the necessary effort participants had to make through eliminating the need for multiple panel encounters. Diverse tools such as a closed online platform, online surveys and discussion forums enabled continuous and transparent collaboration amongst all project participants during the entire analysis process. Optimized procedures prevented the potential decline of motivation, and thus, the improved the level of contribution from the experts. All online tasks and workshops used to elicit the experts' input were organized during the period from June 2014 to January 2016.

Working step 1 - Developing the system description

The thesis project started in 2014 with the selection of the expert panel to participate in the process of system analysis. To minimize some of the normally very time consuming steps of the VSM process, an online platform (Moodle) was prepared to provide easy and flexible access for the participants to study the information generated from their input as well as any intermediate results. The experts involved had open access to the online platform with both reading and writing permissions.

A fundamental precondition for a system analysis through an open participatory process is that all participants involved have a common understanding of the object of investigation (Vester, 2007). In order to achieve such a common basis for an interdisciplinary expert panel, a description of a reference HRC was presented to them. The reference company was portrayed as an average HRC located in a rural area of Southern Germany. This description was based on official statistics and experience from earlier studies with companies in the horticultural retail sector (Gabriel, Menrad, & Schöps, 2012), and included structural data, such as such as sales area, turnover, and number of employees, as well as the family situation, managerial elements, and customer structure of the HRC. **Table 1** shows an overview of the characteristics of the reference HRC. The characteristics of the reference company were provided to the participants through an interactive story-telling process that took place on the online-platform.

Table 1 Overview of characteristics of the reference company
(table used in Gabriel, A., Bitsch, V., & Menrad, K. (2017:153))

Characteristics	Reference HRC
Sales area (sqm)	608[a]
Share of in-house production (%)	24.5[b]
Total turnover (EUR)	594,266[b]
Sales turnover / paid working hours (EUR/h)	103,577[b]
Index of region's quality of life (0.00=min., 1.00=max.)	0.51[a]
Index of purchasing power (1.00= national average)	1.09[c]
Index of competitive situation (1=easy, 5=fierce)	4.83[a]
Family members involved in company (without owner-manager)	1.64[b]
Non-family employees	5.90[b]
Index of service diversity (variety of services and product categories) (0=min., 1=max.)	0.59[a]
Existence of the company in 2nd generation (years)	22[a]
Additional information: e.g., family situation, management organization, company location, customer catchment area	

[a]Average sales area of comparable HRCs in Southern Germany (Gabriel et al., 2012). [b]Results from HRCs economic performance were provided by the Bavarian Regional Office for Viniculture and Horticulture; Average in-house production of comparable companies nationwide (ZBG, 2014); [c]Average index of purchasing power across rural districts in southern Germany (German purchasing power index at the county level 2014)

Working step 2 - Defining the set of variables

To develop the initial description of the system components, potential criteria based on purported relevance to HRCs were collected through an initial literature review. The classification of criteria was adopted from the market- and resource-based framework structure used by Barney (1991) and by Freiling (2001). Based on the literature, an initial set of 150 criteria thought to potentially affect competitiveness of the reference HRC was identified. The catalogue of potential criteria was compiled in a structured online evaluation form. The online form was provided to the 18 participating experts who were asked to use a five-point scale to evaluate the individual significance of each of the criteria with regard to the reference company. The experts were also allowed to add criteria they felt were missing as well as to make comments on each of the variables provided. The experts' evaluations and comments were summarized in a work sheet for use in the first face-to-face workshops.

In January 2015, two expert workshops were organized. At the beginning of each workshop, the scope of the study and concepts behind VSM were introduced and any questions regarding the planned course of the system analysis were clarified. The results of the expert feedback compiled in the previous working step were summarized on a worksheet which was used as the basis of a structured course of action during the workshops. The evaluated criteria were discussed; items considered irrelevant by the experts were either excluded or combined with similar criteria to create new system variables. Discussions of the significance of individual variables were based on the present situation of the reference company. Variables identified and condensed during the two workshops were illustrated in a cognitive map. Audio recordings of the workshop discussions were also made. In addition to the procedures of the first workshop, the participating experts had the opportunity to review the findings from the first event during the second workshop.

In the next step, based on the results of the workshop discussions, the initial set of criteria was condensed into 40 variables to form the provisional set of system variables. The reduction to 40 variables resulted from both the consensus of workshop participants and the subsequent standardization of the variables discussed to a similar level of generalization ("level of abstraction"; Krallmann, Bobrik, & Levina, 2013: 15). Integration of several lower level criteria into one variable was compensated for by paraphrasing the definitions of each of the lower level for incorporation into the definition of the more abstract, higher level variable. At this stage of the analysis, it is important that participants develop a feeling of ownership for the model construction using VSM, and build a common language for the system variables under investigation (Schlange, & Jüttner 1997:780). Thus, the definitions of systems variables were paraphrased according to the participants' suggestions during the workshops and combined with common definitions of similar terms used in the literature (e.g., definition of economic terms such as *profitability*). Definitions were distributed to the participants as a draft glossary via the online platform. The glossary allowed the expert panel to carry out an interactive dialog in order to purposefully improve the definitions, make further suggestions, and express criticisms of the phrasing of the definitions. This process resulted in more precise definitions of each of the variables, and a further reduction of the variable set to the final number of 35 system variables.[7]

Working step 3 - Cybernetic evaluation of variables

After finalizing the variable definitions, the completeness of the set was examined using a cybernetic checklist provided in the cybernetic evaluation scheme included in the VSM software. This criteria matrix assigns each of the system variables to the seven life sectors of socio-technical systems (economy; participants; space utilization; human well-being; environment and resources; infrastructure; rules and norms). Additionally, the criteria matrix allocates each of the system variables to one of eleven system-relevant states of physical categories (matter, energy, information), dynamics categories (flow quantity, structural quantity, temporal dynamics, spatial dynamics), and system relation (openness of the system to output, openness of the system to input, internal impacts, external impacts). This working step of VSM verified the completeness of the set of variables via the cybernetic checklist, supplemented by suggestions from the VSM handbook (Vester, 2001). Furthermore, allocation within the criteria list was compared to classifications and subject catalogues from other studies that used VSM in a business management context (e.g., Freisl, 2011; Burkhard, 2006; Schlange 1994). The distribution of the assignments to each of the 18 cybernetic criteria is intended to identify whether a balanced or unbalanced set of variables has been selected. The resulting well-balanced distribution of the variables in the criteria matrix confirmed the usability of the identified set of variables.

[7] The final set of variables and the short definitions of each of the system variable are attached in the appendix of this present thesis

Working step 4 - Generating consensus using the impact matrix

A central step of VSM is the rating of the variables' impacts on one another by the expert panel. Based on the variable set defined, the strength of the cause-effect relationships between the variables was examined to help identify their functional roles in the system. The participants' conception of the relative strength of each of the cause-effect relationships was determined by asking the participants, "*if variable x changes, what will be the direct impact on variable y*". The experts were asked to rate this relationship based on a scale of four intensities (0 = 'no impact', 1 = 'weak impact', 2 = medium impact', and 3 = 'high impact'). Because each pair of variables was evaluated in both directions, the number of assessments by each participant would have been very high (34x35). For that reason, the panel of 18 experts was split into three subgroups. Participants in each group were asked to assess the relationships between each potential pairing of twelve selected variables. Pairwise evaluation of the impacts of each of the variables on one another was accomplished through an online questionnaire, which each participating expert completed within two weeks. After the expert input was entered into the VSM software, the expert evaluations were compared and quality checked. Next, the evaluations were assembled into a consensus impact matrix using the VSM software. The impact matrix generated was posted on the online-platform and made accessible to the entire expert panel. The final evaluation of the impacts formed the basis for the system interpretation that followed.

Working step 5 - Illustrating the roles of variables

The VSM software package includes procedures for variable interpretation and pattern recognition. The values of the cause-effect-relationship strength of each variable from the impact matrix were added up by rows and columns to identify the roles of variables in the system. The product and quotient of the sum of intensity values in the rows of the impact matrix (= active sum, AS) and in its columns (= passive sum, PS) determine the position of each variable in the system grid. The location of a specific variable within the system grid (active, reactive, critical, inert) provided initial evidence about the system's behavior (**Figure 3**).

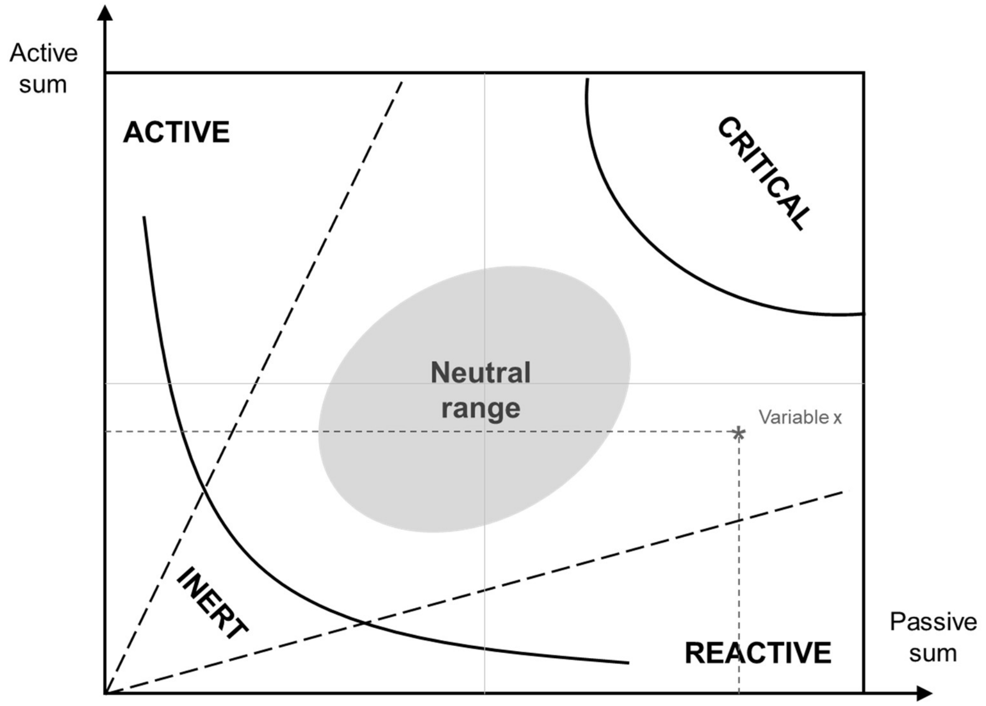

Figure 3 Interpretation of the system role of each variable in the system grid (modified from Vester, 2001)

A variable with both a high quotient value (AS/PS) and a high product value (AS*PS), is allocated to a dominant (active) state in the system grid. Active system elements are expected to have major impacts on several other system variables, and to stabilize the system as a whole due to their strong influence on it (Gentz, 2010:195), while reactive elements are assumed to have a low level of impact on the system as a whole, while they themselves are strongly influenced by other system variables. Critical elements have strong impacts on many other variables. Simultaneously, they are also highly affected by other variables in the system. Variables can also show an inert character. Inert system elements are only weakly inter-linked with the system.

Changes or removals of specific system variables have strong impacts on the system as a whole, when they are effective levers (active system role) or accelerators in the system (critical system role) (Vester, 2007). The evaluation of the systemic roles of the variables was a central working step in the analysis of the importance of areas of sustainability in HRCs, as presented in Article #3 (Gabriel, and Bitsch 2017). The system grid is helpful for determining strong levers of potential change within the system in order to show where interventions in the system are likely to be most effective (see **Figure 6** on page 48 of this present thesis). In addition, the VSM provides tabular output of the system variables classified according to the role they have been assigned in the system (see **Table 3** on page 44).

Working step 6 - Modelling the effect system

In this working step, a comprehensive causal network of the identified system variables of the HRC and their interrelations was modeled. The purpose of the effect system is to analyze feedback loops and select parts of the system model (subsystems) for closer investigation of specific problems. Modeling of the effect system focuses on the strongest cause-effect-relationships between the variables identified through creation of the impact matrix in the previous step. Relationships with 'high impact' rates in the criteria matrix are primarily those used for modeling the effect system. Additionally, indirect relationships (effects of a third variable), and doublets (variables with similar effects) are removed (Vester, 2001). Based on the impact matrix, the direction and strength of the effects between each pair of variables was used to determine the model of the effect system. The final system model involves various types of evaluation of the variables involved (e.g., frequency analysis), and description of the general characteristics of the HRC system.

Working step 7 – Extracting partial scenarios

Finalization of the effect system after the first six working steps during the two phases of description and interpretation enabled the analysis of feedback loops, and allowed for the selection of specific areas of the system model (partial scenarios) for closer investigation. Partial scenarios help gain a better understanding of the dynamics of specific areas that are most relevant to a particular problem, and allow for the simulation of the effects of potential system interventions (Vester, 2007).

The partial scenario simulations conducted in this thesis project focused on elements of the system that could potentially be affected by the succession situation of the reference HRC (see Article #4, Gabriel, & Bitsch, 2018). Therefore, the variables from the effect system with the strongest and most frequent interrelations with *succession situation* were then extracted from the effect system to develop the succession scenario. A frequency analysis of the feedback loops in the effect system revealed key variables that strongly interact with the target variable of succession situation. The frequency of occurrence of the individual key variables indicated their relevance for the analysis of the succession situation scenario (see **Figure 7** on page 51 of this present thesis). The extracted partial scenario with the most highly interactive key variables was provided to a reduced group of six experts within the panel that had direct experience with the subject of succession in family business (two consultants, a researcher, two managers, and an employee). These experts took part in a one-day scenario workshop in which they first identified measurable indicators for the key variables that had been selected for inclusion in the partial scenario. Subsequently, they defined the cause-effect relationships between these indicators. Each of the six experts rated the change in the level of the indicators for an affected variable (horizontal axis) by hand drawing the effect of a stepwise change in the influencing indicators (vertical axis) from minimum (m_1) to maximum (m_5).

In the illustrated example of one such expert assessment (**Figure 4**), the indicators for the variable *organizational climate* (indicated by ‘employee fluctuation’, ‘sickness rate’, ‘employee complaints’, ‘communication intensity’) are on a low level when the succession situation (indicated by ‘stage of succession’), is completely unclear, increase slightly when the prospect of a potential candidate within the family emerges, and improve disproportionally when signs indicate that a succession is imminent.

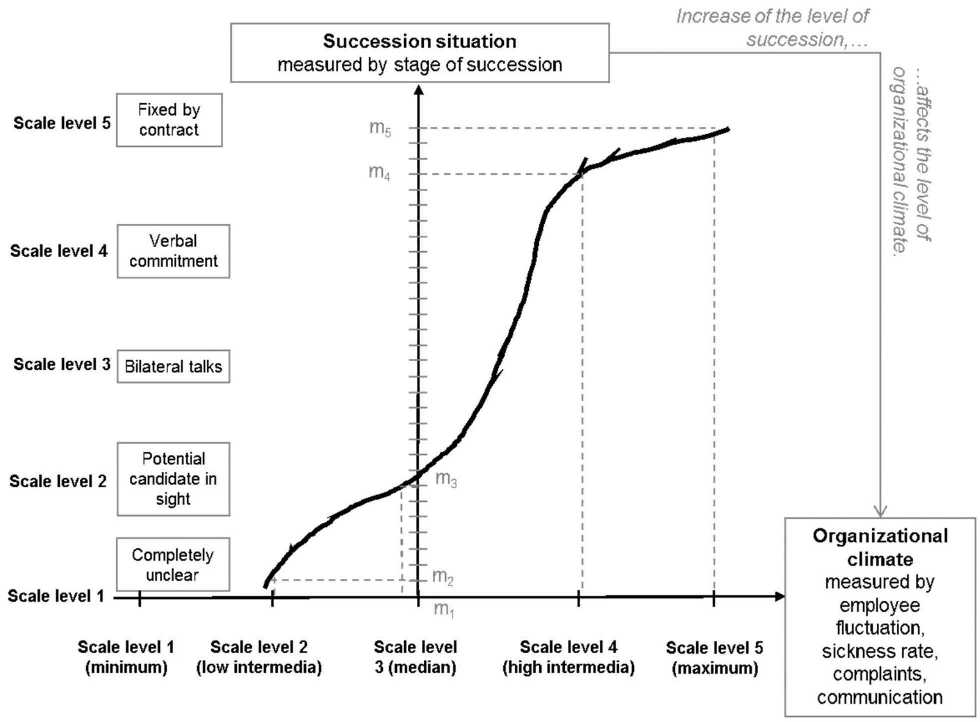

Figure 4 One expert's handwritten assessment of the impact of *succession situation* on *organizational climate*; m_i=points of measurement of the variable affected (figure used in Gabriel, & Bitsch (2018, Fig. 2))

The experts' assessments of the pairwise relationships between the variables in the scenario allowed the determination of non-linear and event-driven interrelations between pairs of variables (Vester, 2001) based on the experts' real-world experiences (Högl, 1996:16). The five points of measurement (m1 to m5) of the affected variable for each of the cause-effect-relationships assessed were quantified, aggregated, and entered into the database of the VSM software package. Based on the identification of variables and their non-linear cause-effect-relationships, the partial scenario was prepared for use in simulating system dynamics in several policy tests.

Working step 8 – Conducting policy tests and simulations

Policy tests in VSM allow the use of different indicator constellations to simulate possible events and business strategies in the scenario being analyzed. The experts' assessments of the 18 pairs of cause-effect relationships in the *succession situation* scenario were then used to conduct policy tests and dynamic simulations. The VSM software was used to run simulations for four policy tests – lack of a known successor, an ongoing succession, a delayed (stepwise) succession in the family company, and an ongoing succession which is additionally impacted by a particularly high potential for *conflicts between family and work*. Based on different initial settings and interventions in the system, individual simulations resulted in trends for each of the key variables involved in the *succession situation* scenario.

Working step 9 – Cybernetic system evaluation

The description of the final step of the VSM procedure is included in this present thesis (see chapter 6.1). The cybernetic system evaluation is intended to evaluate the total system's viability and long-term resilience in a way that is analogue to evaluation of the same criteria in a self-regulating ecosystem. It also serves to help analysts derive suitable strategies for dealing appropriately with the system being analyzed (Wolf, Persson, & Jelse, 2012:8). The requirements of Vester provided by the eight "bio-cybernetic rules" in this last of the nine working steps in order to evaluate the state of maturity of the HRC system are difficult to implement, and in many applications of VSM results are difficult to communicate (see Hübner, 2007:21). Thus, the cybernetic evaluation according to the eight bio-cybernetic principles was supplemented with further findings deduced from the previous analytical steps of VSM that provided specific indications of the cybernetic state of the system and its associated system elements (variables).

Methodical innovations of the VSM working tasks

The VSM method and software package follows a rigid scheme of gathering information and building consensus among the participating experts along the nine working steps In the present thesis project, innovative and user-friendly instruments were introduced to support the data collection and enhance the multilevel interplay among the experts in the panel (**Table 2**). To minimize some of the normally very time consuming steps of the VSM process, an online platform was prepared to provide easy and flexible access for the participants to study information and intermediate results. Interactive tools such as online surveys, forums and glossaries were used to foster communication, transparency, and discourse during the analysis process. Processing of interim results by the analyst (e.g., frequency analysis in working step 7) and posting these results on the online platform provided participants additional opportunities to better understand project outputs and facilitated the participatory process.

Table 2 Procedures and innovative adaptations of the VSM method
(extended table used in Gabriel, Bitsch, & Menrad (2017:152)

Working Step	VSM procedures	Feasibility-oriented adaption
1. System description	- General project information - Providing reference company	- Initialize online-platform - Desk-research conception
2. Set of variables	- Providing 150 preselected market and resource-based criteria - Identifying set of variables: reduction, aggregation and discussion - Generating variable definitions	- Desk-based conception; pre-evaluation of provided criteria via online form - Summarizing results of online-survey, audio records and cognitive map of workshops discussions - Open discussion via draft glossary on online-platform
3. Cybernetic evaluation of variables	- Cybernetic evaluation of variables for final set of variables	- Analyst using cybernetic checklists
4. Impact matrix	- Evaluating strength of all cause-and-effect relations - Building consensus impact matrix	- Online-survey with sub-groups - Providing consensus matrix to panel for review via online-platform
5. Systemic roles of variables	- Characterizing systemic roles of variables in system grid and variable list	- Providing results to the panel for review via online-platform; feedback functions
6. Effect system	- Illustrating comprehensive causal network with strongest cause-and-effect relationships	- Providing final results to the panel via online-platform
7. Partial scenarios	- Extracting focus areas from the effect system for use in analysis of individual problems and preparation of subsequent policy testing	- Pre-defining scenario key variables via frequency analysis - Providing pre-defined scenario to expert panel for evaluation via online-platform
8. Policy tests and simulations	- Determining indicators and state limits for the scenario variables - Assessing effect process between each of the scenario variables within the lower and upper state limits - Testing of different indicator constellations (policy tests) for their system dynamics	- Reduced expert panel in the scenario workshop - Mailing questionnaire: manual assessment of effect processes - Providing interim results to the expert panel via online-platform
9. Cybernetic system evaluation	- Applying the eight “bio-cybernetic rules” to the system to evaluate the system state	- Extending the cybernetic evaluation using results on the assessment of cybernetic roles of variables and the feedback loop analysis

1.4 Thesis progress and scientific discourse

During the development of the thesis, the intermediate results were presented and discussed in the context of multiple outlets for scientific discourse. Elaboration of the research objectives, construction of theory, and implementation of the methodological process was discussed with relevant experts, researchers, and with academic colleagues at each of the successive stages of the thesis project. Intermediate results were presented periodically in the *Internal PhD-Seminar* of the Chair of Economics of Horticulture and Landscaping of the TUM. Furthermore, the project was presented at the *Weihenstephan Socioeconomic Colloquium* organized jointly by the TUM School of Life Sciences Weihenstephan and TUM School of Management. Another cooperative discourse was possible through presentation of the VSM method at the *Doktorandenseminar* at the Straubing Center of Science. Additionally, the applied method and preliminary results were presented to a broader audience at relevant national and international conferences:

- "Concept development of a system analysis in horticultural retail companies." Poster presentation at the 53. Tagung der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaues e.V., 25-27 September 2013 in Berlin. (Abstract: http://www.gewisola.de/files/Schriften_der_GEWISOLA_Bd_49_2014.pdf , p. 373)
- "System analysis of small horticultural retail companies." Oral presentation at the 29th International Horticultural Congress, 17-22 August 2014 in Brisbane, Australia.
- "Heuristical approach for a system description of SMEs in hortibusiness." Poster presentation at the 1st HEZ-agrar PhD Symposium, 21 April 2015 at the Hans Eisenmann-Zentrum, Freising. (Abstract: http://www.hez.wzw.tum.de/fileadmin/Veranstaltungen/2015/HEZagrar_Symp_2015_Proceedings.pdf, p. 51)

- “Weiterentwicklung der ganzheitlichen Unternehmensanalyse nach dem Systemkonzept unter Anwendung eines partizipativen Ansatzes am Beispiel von Einzelhandelsgärtnereien“. Oral presentation at the 52th Deutsche Gartenbauwissenschaftliche Tagung, 28 February-3 March 2018 in Geisenheim. (Abstract: → https://dgg-online.org/website_neu/wp-content/uploads/2018/02/Tagungsband_52_2018.pdf, p. 73).

2. Article #1: Conceptual framework for system analysis of family-run agricultural enterprises

Article abstract

The article discusses the relevance of system analysis approaches for family-run agricultural enterprises with their complex structures, and challenges. A conceptual framework for system analysis of family-run agricultural enterprises, considering the interdisciplinary and integrating principles of system theory and management cybernetics, is developed. A comparison of system-oriented modelling of such enterprises with exclusively analytical and single-discipline methods of business analysis demonstrates the benefits of system approaches. Situational knowledge of specific internal structures and the business environment of family-run agricultural enterprises can be used to enrich the framework. Managers and business consultants of these enterprises benefit from a better understanding of interrelations within the enterprises to cope with complexity. The concept further allows a differentiated analysis of management and owner manager behavior, and of conflicting needs of enterprise and family. The adapted framework helps practitioners to use the basic system structure to execute a goal-oriented system analysis of agricultural enterprises.

Keywords: agricultural enterprises; conceptual framework; family-run enterprises; management cybernetics; system analysis

Central results presented in Article #1

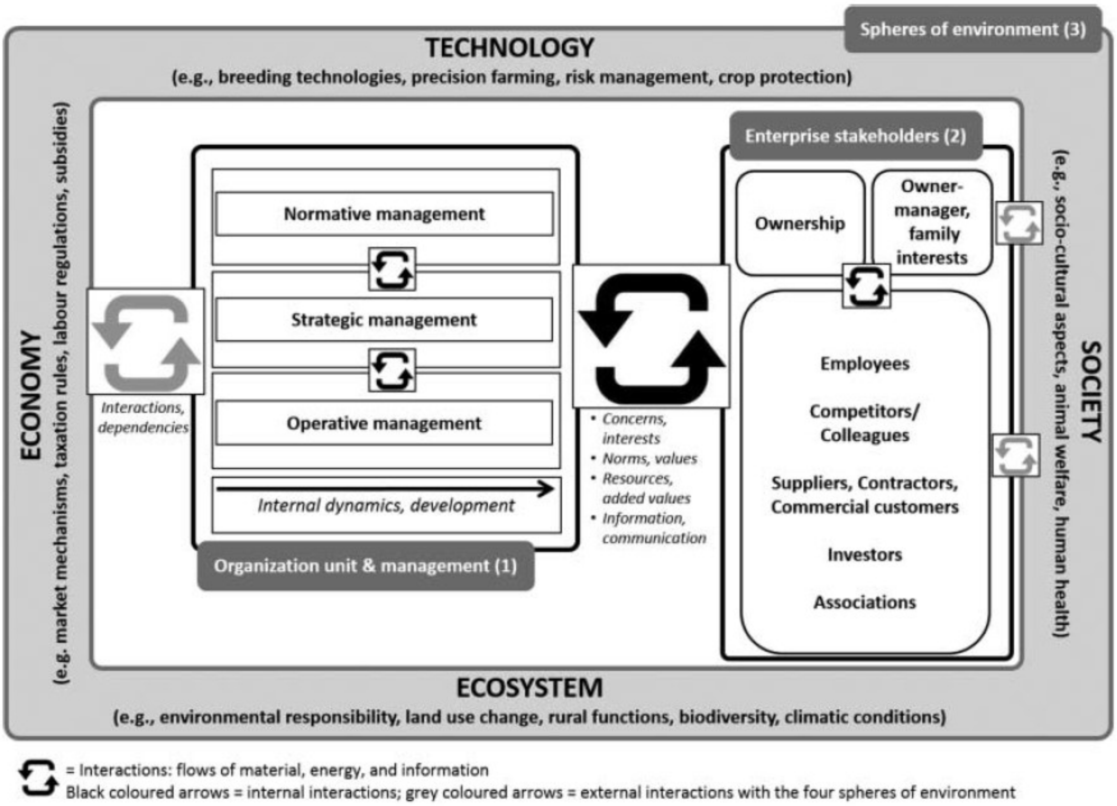

Figure 5 Conceptual framework for system analysis of a family-run agricultural enterprise (see Gabriel, Bitsch, & Menrad, 2016, Fig.1, p. 337)

The basic structure of the framework developed shares characteristics with the management concepts of Rüegg-Stürm (2004) and Bleicher (2004). Both concepts are business reference models developed at the University of St. Gallen and affiliated institutions. The integrated conceptual framework was adapted on the basis of the principles of system theory and cybernetics, combined with knowledge about specific structures and the management requirements of family-run agricultural enterprises (**Figure 5**). The framework consists of three main components: the internal organizational and management unit of the enterprise (1), the stakeholders involved (2), and the four spheres of the enterprise environment (3). Both the management unit and the stakeholders with direct interest in the activities of the enterprise are assigned to the inner part of the framework (white boxes), while the four spheres of technology, economy, ecosystem, and society belong to the surrounding environment affecting the enterprise from outside (gray frame). The interactions among elements inside the enterprise are depicted with black circular arrows, while interactions of these elements with those belonging to the environmental spheres are depicted with gray arrows.

The candidate's contribution to the article

The candidate had primary responsibility for the preparation of the article. This involved conducting a literature review, theory description, composing the framework model, and drafting of the manuscript. The co-authors Vera Bitsch and Klaus Menrad both critically revised several drafts of the manuscript and made valuable contributions to improve the manuscript in terms of its technical and linguistic accuracy. The manuscript was double-blind peer reviewed by three reviewers and edited in the period between August 8, 2015 and June 22, 2016.

Publication citation

Gabriel, A., Bitsch, V., & Menrad K. (2016). Conceptual framework for system analysis of family-run agricultural enterprises. *Journal of Small Business and Entrepreneurship* 28(4):325–344.

3. Article #2: Feasibility-oriented application of system analysis in SMEs - the cybernetic approach of VSM applied to horticultural retail companies in Germany

Article abstract

Many approaches of business analysis focus on single disciplines or specific problems but ignore complex and dynamic interrelations between small and medium-sized enterprises (SMEs), their stakeholders, and their business environment. In order to meet these challenges, the system analysis tool Vester Sensitivity Model® (VSM) is applied on a reference company representative of the German horticultural retail sector. Based on the principles of system theory and (bio-) cybernetics, the VSM system building tool uses net thinking, heuristics, and a participatory approach to illustrate and evaluate the systemic role of relevant key variables, and their interrelations in the example company. In this article, the analytical steps of the VSM are applied up to the finalized effect system model of the reference company. As an innovative aspect, the article emphasizes how the multilevel process of the system analysis can be put into practice more effectively by using interactive media tools to enable the required communication and consensus by the participating stakeholder panel. Elements such as the manager's ability of strategic planning, the organizational climate, and the company's image were uncovered as critical, but also stabilizing key factors for such companies. Although the study focuses on the specific situation of German horticultural retail companies as the research subject, the suggested procedure of integrated knowledge generation is transferrable to any business, industry branch, and country. Especially scholars, advisors, and business analysts working in the field of SME management can use the concept to evaluate such systems in the overall context of the companies under investigation.

Keywords: participatory approach; retail companies; small and medium-sized enterprises; system theory; Vester sensitivity model

Central results presented in Article #2

Table 3 Tabular output of system variables and cybernetic classification by means of cross-impact matrix including the quotient- and product values assessed by the consensus impact matrix (see Gabriel, Bitsch, & Menrad, 2017, Tab. 4, p. 163)

active <---------> reactive	quotient value	**critical <---------> inert**	product value
Highly active		**Highly critical**	
Lack of economic skills and knowledge	2.93	---	
Sense of markets and customers	2.75	**Critical**	
Manager’s production skills	2.64	Strategic planning	2592
Suitable location	2.50	**Slightly critical**	
Active		Long-term continuity	1764
Optimal size of sales area	1.93	Optimal structure of employee base	1680
Barriers through regulation and legislation	1.92	Customer-oriented marketing	1617
Effects of societal changes	1.68	In-house production	1617
Slightly active		Company’s image	1512
Limited willingness to cooperate	1.55	Profitability	1496
Financial flexibility	1.50	Corporate communication	1479
In-house production	1.48	Organizational climate	1400
Optimal task allocation	1.47	**Neutral**	
Optimal structure of employee base	1.37	Degree of assortment competency	1332
Neutral		Implemented company philosophy	1330
Social and environmental responsibility	1.26	Optimal task allocation	1320
Standardization of work processes	1.26	Customer satisfaction	1232
Strategic planning	1.13	Internal communication	1225
Use of advanced technologies	1.11	Highly competitive market	1184
Degree of assortment competency	1.03	Active pricing policy	1160
Shortage of skilled labor	1.00	Productivity	1008
Internal communication	1.00	Shop attractiveness	962
Relationships with suppliers	0.96	**Slightly inert**	
Implemented company philosophy	0.92	Standardization of work processes	918
Highly competitive market	0.86	Shortage of skilled labor	900
Customers’ appreciation of hort. products	0.84	Use of advanced technologies	868
Profitability	0.77	Customers’ appreciation of hort. products	864
Slightly reactive		Effects of societal changes	814
Active pricing policy	0.72	Qualification to train apprentices	777
Shop attractiveness	0.70	Relationships with suppliers	756
Conflicts between family and work	0.69	Limited willingness to cooperate	748
Customer-oriented marketing	0.67	Conflicts between family and work	704
Customer satisfaction	0.64	Sense of markets and customers	704
Reactive		Social and environmental responsibility	667
Productivity	0.57	Suitable location	640
Corporate communication	0.57	Financial flexibility	600
Qualification to train apprentices	0.57	**Inert**	
Organizational climate	0.56	Lack of economic skills and knowledge	574
Company’s image	0.48	Manager’s production skills	518
Long-term continuity	0.44	Optimal size of sales area	378
Highly reactive		Barriers through regulation and legislation	325
---		**Highly inert**	

In addition to the system grid, the VSM software provides a tabular output of the system variables classified according to their role in the system (**Table 3**) as results of working step 5. Active system elements are thought to have major impacts on several other system variables (high quotient value and high product-value). Several active variables refer to management skills (e.g., *lack of economic skills and knowledge*, *sense of markets and customers*, and *manager’s production skills*), or conditions external to the company itself (e.g., *suitable location*, *effects of societal changes*). Assignment to the category of reactive elements implies that a variable is thought to have a low impact on the system as a whole, while being strongly influenced by several other variables within the system. Reactive variables serve as indicators of the system state. In the case of HRCs, highly reactive variables were determined to be e.g., *long-term continuity*, *company's image*, and *organizational climate*. Clearly, *long-term continuity* of HRCs and *productivity* are both indicators of management, and can hardly be changed by direct interventions.

Critical elements are those thought to have strong impacts on many other variables, while at the same time being highly affected by changes in other variables. Thus, the *strategic planning* ability of the manager is influenced by a number of factors that determine the scope of strategic actions. In addition, good strategic management skills have positive long-term effects on multiple business fields in HRCs. Due to their nature, orientation, and range of services and products offered, HRCs strongly depend on interactions with customers. Therefore, *customer-oriented marketing*, *company's image*, and *corporate communication* are additional critical variables in the HRC system. The system analysis revealed a number of inert variables that are weakly inter-linked with the system. Inert system elements are affected little by changes in the overall system, and stay unchanged or react with time delays. For example, *manager's production skills* and *economic skills and knowledge* are affected only after a delay when managerial efforts are applied to improve knowledge in these fields. In some cases, inert variables imply hidden risks, when they have strong selective impacts on critical elements in the system (e.g., risk of *suboptimal structure of employee base* caused by long-time *shortage of skilled labor* on the job market).

The candidate's contribution to the article

The candidate had primary responsibility for the implementation of the thesis project and the preparation of this article. The candidate conceived of and organized the data acquisition methods used as part of the application of the VSM method, acquired the expert panel, organized the workshops, and analyzed the intermediate results after each of the working steps. The co-authors Vera Bitsch and Klaus Menrad helped with the organization of the acquisition of data and gave professional feedback to the intermediate results. The candidate was mainly responsible for the preparation of the manuscript. The co-authors Vera Bitsch and Klaus Menrad both critically revised the manuscript and gave valuable input, in particular with regard to the discussion and implications of the analysis results. The manuscript was double-blind peer reviewed by three reviewers and edited in the period between March 3 and June 2, 2016.

Publication citation

Gabriel, A., Bitsch, V., & Menrad K. (2017). Feasibility-oriented application of system analysis in SMEs – the cybernetic approach of VSM applied to horticultural retail companies in Germany. *Systemic Practice and Action Research* 30(2):145–172.

4. Article #3: Systemic consideration of areas of sustainability in HRCs

Article abstract

Small-sized horticultural retail companies constitute an interface between the horticultural plant production sector and the final consumers. In Germany, managers of these companies are confronted with increasing awareness of their customers for sustainable products and corporate social responsibility. The multitude options to implement strategies to forward sustainable processes and products often intensify managers' uncertainty concerning feasibility and profitability of sustainability-related measures in their company. The article shows the process of systemic modeling of a reference HRC applying the method "Vester Sensitivity Model®" (VSM) on a reference horticultural retail company (HRC). A selected expert panel contributes to identify 35 internal and external system variables. After several consecutive steps of analysis, the systemic role of each of the system variable was identified, and relevant areas of sustainability were extracted from the set of variables. An impact analysis of the identified areas of sustainability revealed their effective strength on other internal and external system elements of the HRC model. Results of the system analysis point out that for a successful implementation of sustainability-related strategies, it is mandatory to integrate them into the general management of these companies. Further, managers of HRC have to consider available resources (staff, professional competencies), and the individual business environment, when they tend to sustainability measures. The first-time application of the VSM method on horticultural retail companies in Germany provides an additional opportunity for practitioners and researchers for an in-depth understanding of areas of sustainability in these companies.

Keywords: horticultural retail companies; sustainability; system analysis; business management (JEL-Codes: L81, Q12)

Central results presented in Article #3

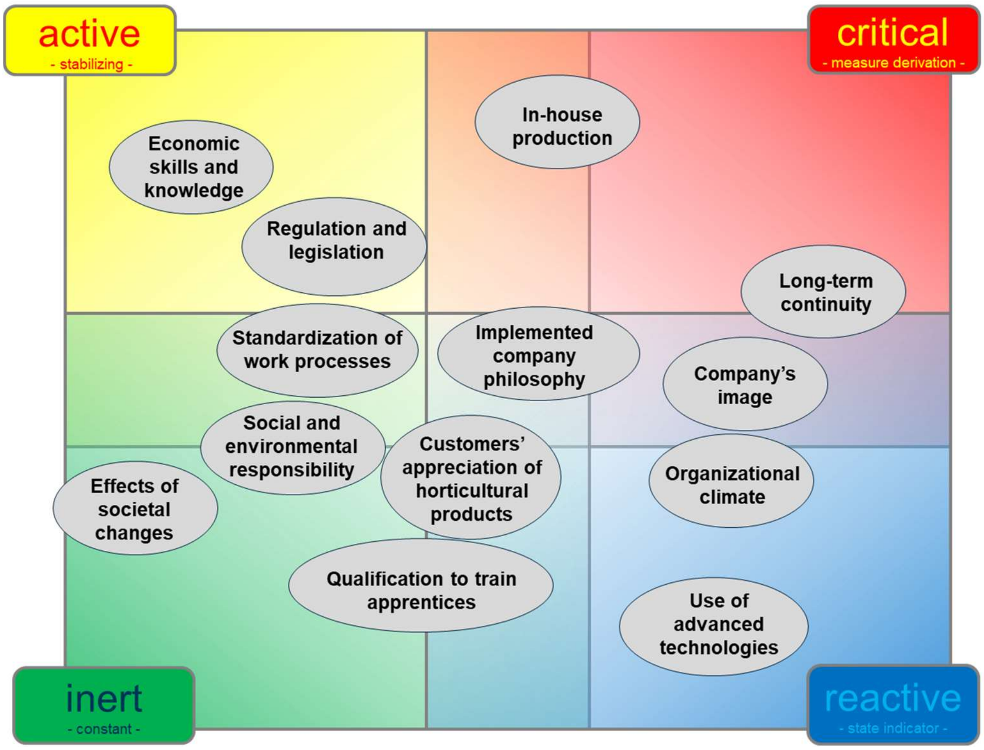

Figure 6 Role portfolio: systemic character of variables in respect of areas of sustainability in HRCs (see Gabriel, & Bitsch, 2017, Fig. 2, p. 253)

Similar to the tabular output of system variables and the cybernetic classification presented in the impact matrix, the location of a specific variable within the system grid (active, reactive, critical, inert) provides initial evidence about system behavior and the impact of that particular variable on the system as a whole. Depending on the product and quotient of the active and passive sum (AS, PS) in the impact matrix, the position of each individual variable in the system grid provides information about its role in the system (**Figure 6**). Critical and active roles of variables such as *long-term continuity*, *in-house production*, and *regulation and legislation* were identified as influential business areas when implementing sustainability-related strategies.

The candidate's contribution to the article

The candidate was the main author of the manuscript and was always mainly responsible for the analysis of the areas of sustainability extracted from the HRC effect system generated in the course of the application of VSM. Co-author Vera Bitsch contributed with her specific experience in the field of sustainability management in SMEs (with contributions to the literature review, and improvement of the discussion and implications), and helped review and revise the manuscript before submission. The manuscript was double-blind peer reviewed and edited in the period between May 5 and August 2, 2016.

Publication citation

Gabriel, A., & Bitsch, V. (2016). Systemanalytische Betrachtung der Bedeutung einzelner Nachhaltigkeitsfelder in Einzelhandelsgärtnereien. In: Dirksmeyer, W., Schulte, M., & Theuvsen, L. (Eds.): Aktuelle Forschung in der Gartenbauökonomie. Tagungsband zum 2. Symposium für Ökonomie im Gartenbau. Thünen Report 44, Johann Heinrich von Thünen-Institut: Braunschweig, pp. 241–260.[8]

[8] Available online: https://www.thuenen.de/media/publikationen/thuenen-report/Thuenen_Report_44.pdf

5. Article #4: Impacts of succession in family business

- a systemic approach for understanding dynamic effects in horticultural retail companies in Germany

Article abstract

While many studies in family business research focus on mono-causal impacts of succession, this study employed a systemic approach to analyze dynamic effects of intra-family succession on multiple business areas in family-run companies. A system analysis using a participatory approach was conducted for a reference family-run company operating in the horticultural retail sector in Germany. The Vester Sensitivity Model®, supplemented with principles from system thinking, was used to identify key variables related to intra-family succession. Expert input and analysis of variable co-occurrence revealed key variables associated with succession such as *strategic planning*, *productivity* and *financial flexibility*. Dynamic interactions among various business areas were identified by simulating interventions in succession trajectories. In particular, key variables such as *conflicts between family and work* and *organizational climate* turned out to be highly sensitive to changes during a succession process. The concept and design of this system analysis tool will allow practitioners such as company managers and business consultants to better understand complex interrelations within companies, and provide additional guidance with regard to critical events like business transfer. The present study uses system thinking to analyze succession and its dynamic and time-lagged impacts on affected business areas in family-run companies for the first time. Repeated application of the systemic approach presented here to real-world business cases will gradually improve the tool and the quality of information it provides.

Keywords: family-run companies; participatory approach; succession; system thinking

Central results presented in Article #4

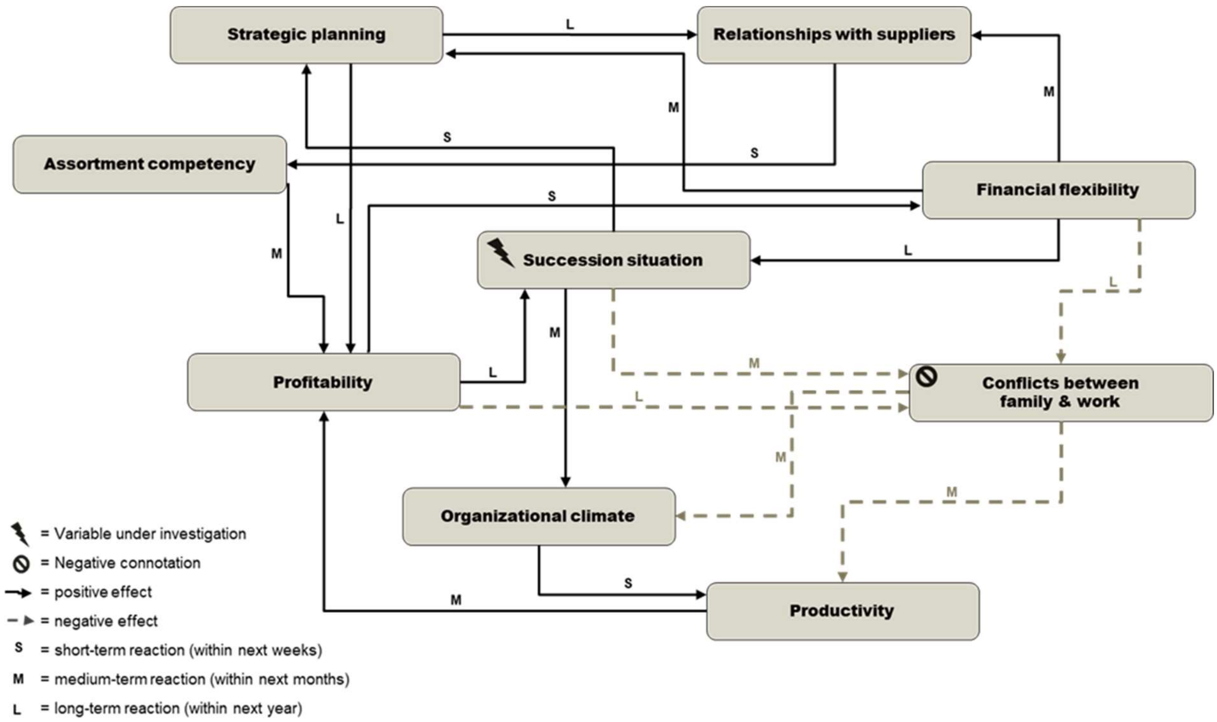

Figure 7 The cause-effect relationships of the key variables in the partial scenario *succession situation* (figure used in Gabriel, & Bitsch (2018, Fig.3))

The experts in the scenario workshop delineated the direction, intensity, and reaction periods of the cause-effect relationships between the linked key variables in the partial scenario (**Figure 7**). To categorize the reaction periods, the experts distinguished between short-term (S), medium-term (M), and long-term reaction effects (L). For example, the key variable *profitability* was thought to have a positive short-term effect on *financial flexibility*, and attenuating long-term effects on *conflicts between family and work*. Similarly, while the *strategic planning* ability is expected to be positively affected by the *succession situation* in the short-term, effects on succession from interactions with *financial flexibility* are not seen until at least a year later (long-term). The experts' assessments of the in total 18 pairs of cause-effect relationships were then used to conduct policy tests and dynamic simulations.

The candidate's contribution to the article

The candidate had primary responsibility for the preparation of the article. This involved theoretical analysis, the literature review according to the topic of succession in family enterprises, data collection (organization of workshops and other working steps with the expert panel), data analysis, and drafting of the manuscript. The co-author Vera Bitsch revised the draft in several rounds and contributed valuable input for the manuscript's enhancement in terms of content-related questions and discussion of the results of the analysis. Co-author Vera Bitsch revised several drafts of the manuscript and made valuable contributions to improve the technical and linguistic quality of the manuscript. The manuscript was double-blind peer reviewed by four reviewers and edited in the period between January 24 and June 30, 2018.

Publication citation

Gabriel, A., & Bitsch, V. (2018) Impacts of succession in family business – a systemic approach for understanding dynamic effects in horticultural retail companies in Germany. *Journal of Small Business and Enterprise Development. Manuscript accepted for publication 'Open Access' on 30 June 2018. https://doi.org/10.1108/JSBED-01-2018-0030.*

6. Integration of the results

The four articles include the conceptual framework (Article #1), the methodological process of the system analysis applied to the reference company (Article #2), and the implementation of the method with regard to concrete questions in HRC management such as sustainability areas (Article #3) and succession planning (Article #4). This chapter starts with a description of completion of the procedural steps of VSM in the final evaluation of the cybernetic state of the reference HRC (VSM working step 9). Afterwards, the empirical results of the analysis are combined with the initial structure of the conceptual framework constructed for family-run agricultural enterprises to identify focal points of the HRC system model.

6.1 Completion of the steps of VSM: The Cybernetic evaluation of the HRC system

The cybernetic evaluation of the HRC system state completes the nine analytical steps of VSM. According to the requirements specified by Vester, this final step serves as an instrument of control, which accompanies the modelling procedure, and supports the derivation of appropriate strategies for the future management of the system being analyzed. Depending on the research question, it can support the transition from results of the system analysis to final decision-making (Salevsky, & Müller, 2016:195).

Following Vester, the final evaluation of the system model is based on eight principles of bio-cybernetics by which the system is checked with regard to its composition, behavior, and state of maturity (Malik, 2012:90; Vester, 1988:409). Independent from the type of system analyzed, the cybernetic evaluation indicates the system's long-term viability, and resilience in the course of significant changes or interventions (Huang et al., 2009:120). The eight principles are derived from a "successful and resilient orientation model: nature" (Harrer, 2010:2). Vester described these bio-cybernetic principles in particular in the VSM handbook (Vester, 2001), and added useful adaptations for the implementation of this final working step in different fields of application.

The software tool supports the comparison of the initial state of the system with the altered status after interventions have been implemented in the system (Malik, 2012:152). Most research projects and theses using VSM to analyze specific case studies forego this “before/after-comparison” (e.g., Brexendorf, 2012; Freisl, 2012; Hübner, 2007:21; Burkhard, 2006). These studies aim first of all at the description of systems to understand their complexity, but neglect the analysis of impacts of implemented strategies on these systems.

In the case of the presented system analysis of HRCs, the cybernetic evaluation is supplemented with further findings deduced from the previous analytical steps of VSM that provide specific indications of the cybernetic state of the system (see also Freisl, 2011:211f). In the following subsections, the concluding cybernetic evaluation of the HRC system model is explained by **a)** the feedback loop analysis and the evaluation of variables’ systemic roles, **b)** the cybernetic evaluation of the set of variables, and **c)** discussion of the eight bio-cybernetic principles applied to the system model according to Vester’s specifications (Vester, 2001).

6.1.1 Feedback loop analysis of the effect system and variables’ systemic roles

The feedback loop analysis of the HRC effect system covers the degree of linkage within the complete system model, and its feedback loop structures.[9] It allows conclusions on the cybernetic state and viability of the system analyzed. The degree of linkage is an evaluation criterion for the stability of a modeled system, quantified by the ratio of the number of direct-linked interactions and the total number of system variables (Brexendorf, 2012:275). The HRC effect system includes more than 100 direct cause-effect-relations with ‘high impact’ rates as elaborated in the impact matrix generated in working step 4.[10] The total of 35 system variables of the final HRC effect system resulted in a degree of linkage value of V = 109/35 = 3.1. This value can be rated as within the range of “optimum of system vitality” according to Vester

[9] The final HRC effect system is attached in the appendix of this present thesis

[10] For a detailed description of the final impact matrix see Article #2 (Gabriel et al., 2017:161–163).

(Malik, 2008:104; Vester, 1990:87). A high degree of linkage enhances the level of system resilience, while a low degree of linkage signifies a less efficient system, and represents a potential threat of stagnation (Freisl, 2011:58).

A further cybernetic characterization of the system is the composition of its loop structures characterized by both sign and length of the loop chains occurring in the effect system. A good balance of positive and negative loops suggests a balanced level of controllability of the system. The modelled HRC effect system is built on 510 feedback loops in total, whereby 281 have a positive (sum of signs positive, destabilizing character) and 229 have a negative sign (sum of signs negative, stabilizing character). In general, systems with an exceeding surplus of positive feedback loops “run the risk of system overshoot” (Chan, & Huang, 2004:134). The slightly smaller number of loops with negative signs as opposed to loops with positive signs in the effect system indicates a moderate level of steadiness of the analyzed HRC system.

In working step 5, the systemic character of each of the system variables was determined (see description at page 31). The product and quotient of the sum of intensity values in the rows of the impact matrix and in its columns are used to determine the position of each variable in the system grid.[11] The awareness of the variables’ systemic role can be used to evaluate the cybernetic structure of the system as a whole. A frequency analysis of the system variables involved in the feedback loops revealed the variables *profitability* (critical), *strategic planning* (critical), *relationships with suppliers* (inert), *long-term continuity* of the company (critical, reactive), *organizational climate* (critical, reactive), and *financial flexibility* (slightly active, slightly inert) as the most interactive elements in the effect system (**Table 4**).

[11] See Article #2 (Gabriel et al., 2017:155) and Article #3 (Gabriel, & Bitsch, 2016:253–255) for detailed description of states of systemic character; a system grid is exemplary illustrated in **Figure 6** in this present thesis (see page 48).

Table 4 Variables' most frequent loop occurrences in the HRC effect system (absolute number of loop involvements)

Involvement in all loops (total = 510)	Involvement in negative loops (total = 229)	Involvement in positive loops (total = 281)
Profitability (364)	*Profitability* (169)	*Profitability* (195)
Strategic planning (265)	*Relationships to suppliers* (156)	*Strategic planning* (147)
Relationships with suppliers (229)	*Assortment competency* (125)	*Long-term continuity* (131)
Long-term continuity (220)	*Strategic planning* (118)	*Financial flexibility* (125)
Organizational climate (208)	*Company's image* (113)	*Productivity* (111)
Financial flexibility (200)	*Organizational climate* (100)	*Organizational climate* (108)
Company's image (186)	*Customer satisfaction* (99)	*Customer satisfaction* (87)
Customer satisfaction (186)	*Highly competitive market* (96)	*Internal communication* (82)
Productivity (173)	*Long-term continuity* (89)	*Optimal task allocation* (79)
Assortment competency (154)	*Willingness to cooperation* (75)	*Financial flexibility* (75)

Critical variables such as *profitability* trigger multiple rapid effects in the overall system when they undergo large changes. Reactive variables such as *long-time continuity*, *customer satisfaction*, and *productivity* are highly sensitive to general modifications in the system. Even though inert variables such as *financial flexibility* and *relationships with suppliers* are involved in a high number of loops, they remain constant over long periods even when other variables in the system change.

In conclusion, the constellation of multiple critical variables highly involved in positive feedback loops exemplifies a certain degree of instability for the HRC system. Nonetheless, critical variables such as *strategic planning* and *profitability* show evident potential for intense dynamic impacts, and should be considered as effective leverages in managing the development of the HRC system.

6.1.2 The intrinsic character of the system variables in the criteria matrix

Further information about the state of maturity of the system as a whole can be derived from the cybernetic states of each of the variables involved in the system. The cybernetic evaluation of the set of variables (working step 3) required a well-balanced assignment of the variables to the seven life sectors of socio-technical systems and the assignment of the system variables to the eleven system-relevant states of physical categories in the criteria matrix.[12] Another benefit of this working step is the evaluation of the system's intrinsic character by the allocation of the system variables to the life sectors and system-relevant state categories. A large number of the variables included in the HRC model was dedicated to the life sectors 'system participants' and 'human well-being'. This result emphasizes the strong significance of human resources in the HRC system. Thus, the cybernetic evaluation in the criteria matrix revealed that HRCs are strongly affected by the people involved, and their specific skills and wellbeing. Formal and structural life sectors such as 'rules and norms', 'space utilization', and 'infrastructure' are represented relatively moderately.

The allocation of multiple variables to the physical category 'information' implies the importance of communication structures in HRCs. The HRC system includes a high number of variables with potential for the categories 'internal impact', and 'openness of the system, through output'. This allocation of the variables indicates that the HRC system itself is primarily controllable from inside the company, e.g., through variables that characterize management skills and behavior, employee structure, and operative management strategies. The dominance of variables inside the company leads to the conclusion that there are a variety of control options for the managers of those companies to initiate successful development (e.g., through strategic management, staff development, or specific marketing measures). In total, the composition of the variables identified for the HRC model suggests that the system is highly controllable from the inside, and less vulnerable to external influences.

[12] The assignment of the 35 system variables to the 18 life sectors and categories are shown in detail in Article #2 (Gabriel et al., 2017:157–161)

6.1.3 Bio-cybernetic evaluation of the HRC system model

The final working step of VSM considers eight bio-cybernetic rules primarily derived from the self-regulating behavior of natural systems. These fundamental rules – transferred to any kind of system – reflect the potential of viability and self-regulation.[13] A qualitative assessment of the HRC system concerning the eight bio-cybernetic rules contributes to an explanation of the cybernetic state of the HRC system as a whole.

Rule 1. Negative feedback loops dominate over positive ones

This first rule emphasizes the importance of a system's ability to remain stable when facing disruptive influences. Prevalence of negative feedback loops over positive loops in the effect system improves the steadiness and resilience of a system. The presence of 281 positive loops and 229 negative loops in the HRC system analyzed has already been discussed in the description of the feedback loop analysis. This imbalance in favor of positive loops shows a slight degree of instability in the HRC system, and represents a certain degree of danger with regard to "tipping" of the system. Regarding the cybernetic characters of the most frequently occurring variables in the feedback loops, critical variables such as *strategic planning*, *long-term continuity*, *company's image* and *profitability* are often represented in both negative and positive loops. Thus, the direct threat of destabilizing effects through those variables is weakened. *Financial flexibility* and *productivity*, and also *corporate communication* as a critical variable occur frequently in positive loops, and therefore, could develop into weak spots that threaten the stability of the system as whole.

Rule 2. Function of the system is independent of quantitative growth

A resilient system is not necessarily dependent on growth, but rather, has the capacity for restructuring in order to move from one stable state to the next (Bogner et al., 2014:171). Vester

[13] The eight bio-cybernetic principles are explained in detail in the VSM Handbook with added examples for business organizations in Vester (2001)

equates this rule in the context of business management with system characteristics that indicate a capacity for further development, e.g., innovation potential, decentralized structures, and independence from conditions external to the company (Vester 1988: 409). Highly active external elements such as (*barriers through) regulation and legislation* and *effects of societal changes* can help to stabilize the system following major changes, such as an increase in company size. The low degree of allocation of variables to the life sectors 'space utilization' and 'infrastructure' in the criteria matrix implies minor significance of such limitations in HRCs. Limits to growth are rather the *optimal structure of the employee base*, *shortage of skilled labor* and *management skills*, all of which have an active role in the HRC system.

Rule 3. The system operates in a function-oriented, not product-oriented manner

This rule is based on the principle that product requirements vary according to a specific time (e.g., means of transportation), but required functions that fulfill basic needs persist permanently (e.g., mobility). Thus, it is important for systems to develop distinct function-oriented structures. Small business companies such as HRCs benefit from flat hierarchies and flexible organization structures, which allow rapid adaption to changes in consumer demands. The active status of *sense of markets* and *customer satisfaction*, and the close contact to the final consumer in the retail sector enhance the function-orientation of the HRC system. Only a small number of variables are assigned to the physical category 'matter' in the criteria matrix and to the life sector 'infrastructure'. The majority of variables are assigned to the categories 'information' and 'flow quantity' which attests to the predominance of interaction functions in the HRC system.

Rule 4. High system potential through exploiting existing forces (jiu-jitsu-principle)

The fourth bio-cybernetic rule emphasizes the fact that systems run more effectively when they do not employ energy to solve problems or overcome opponents, but rather utilize existing forces to improve such situations (Vester, 2001). In the case of the analyzed HRC, well-developed relationships with external stakeholders and competitors holding similar interests encourage synergetic effects (close *relationships with suppliers*, high number of regular customers, and a distinct *degree of social and environmental responsibility*). *Highly competitive markets* are often perceived as inhibiting influence by HRC managers, but are more appropriately seen as driving forces. Flat hierarchies and a minimum of required infrastructure in this type of business favor flexible reactions to new challenges.

Rule 5. Multiple use of products, processes, and organizational structures

Resilient systems are characterized by a high degree of reusability of resources to minimize energy consumption and costs (Vester 1988: 409). Multiple uses of individual system elements can be supported by direct information exchange, optimal use of production resources, wide-ranging skills of the employees, or competitive production in combination with effective corporate communication. Regarding the results of the system description, not all respective variables were rated sufficiently in this context by the expert panel. The challenges of *shortage of skilled labor* and low rates of *standardization of working processes* reduce the possibilities for positive effects through multiple uses of resources.

Rule 6. Recycling efficiencies in interactions of input and output processes

This rule targets the ecological effectiveness of systems. Recycling and interconnected processes increase the viability of a system, and reduce waste and system outflow. With respect to businesses, the rule refers to recycling of unsold products, and an optimal range of the raw materials used in production and sales. This can also be encouraged by effective internal and external information flows. The high number of variables assigned to the 'information' category in the criteria matrix indicates intensive information transfer in the HRC system. Generally, the

HRC system includes a large number of variables related to areas of corporate sustainability.[14] Especially variables such as *social and environmental responsibility*, *in-house production* of plants, *standardization of work processes* and the *use of advanced technologies* show great potential as resource-saving business practices.

Rule 7. Symbiosis - Reciprocal use through exchange and harmonious interactions

This bio-cybernetic rule emphasizes the advantages of small-scale structures, cooperation, and diversity for the viability of systems. There is an increase in effectiveness when several different system elements share the same resources, or support one another. In small businesses, the ties between the different management sub-units (e.g., administration, production unit, corporate communication, sales) are very close as they are mainly within the responsibility areas of only a few stakeholders (e.g., HRC manager family, employees with delegated tasks). Vester characterizes this rule further with symbiotic effects through feedback from company-external stakeholders (Vester, 2001). The direct exchange of the HRCs with their customers (*sense of markets and customers*, *customers' appreciation of horticultural products*) fosters symbiotic effects between internal and external stakeholders of HRCs. As an opposite effect, the identified (active) variable *limited willingness to corporate* of the HRC manager with competitors and colleagues does not lead to additional benefits through symbiotic relationships.

Rule 8. Biological design of products, procedures and forms of organizations

The eighth bio-cybernetic rule refers to the conscious endeavors of decision-makers to use feedback from the environment to refine products and business organization according to the changing needs of people and nature. Vester defines this as "evolutionary management" (see also Steinbrecher, 1990:9). Managers of progressive business enterprises realize that corporate compliance with environmental and social requirements are not only publicly demanded

[14] The identification of areas of sustainability in the HRC effect system is a central objective in Article #3 (Gabriel, & Bitsch, 2017:252)

necessities, but also can result in innovative products and improved working structures, and facilitate creativity and personal development. In general, the business purpose of HRCs – production and marketing of flowers and plants – seem to confirm the fulfillment of this rule. Whether innovations, creativity, and personal development are advanced according to the needs of people and nature is mainly the responsibility of the respective manager and is dependent on his/her existing skills and attitudes.

The qualitative evaluation of the HRC system on the basis of the bio-cybernetic rules revealed a moderate systemic state of maturity of the HRC system. A substantial proportion of the eight rules can be seen as at least partially fulfilled. The balanced state of the HRC system shows a certain robustness, e.g., against "external disturbances", and - to some extent - volatilities in the environment, in which it is operating (Salevsky, & Müller, 2016:207). However, potential vulnerability of the HRC system lies mainly in internal capacities and skills, structures, and human-related interactions of the company's stakeholders. Still, the critical roles of system elements such as *strategic planning*, *profitability*, *corporate communication*, *long-term continuity*, and *optimal structure of employee base* indicate an appropriate level of controllability of the system from the inside, triggered by managerial interventions.

6.2 Incorporation of situational knowledge about the HRC system model into the initial theoretical framework

Article #1 introduced the conceptual framework for system analysis of family-run agricultural companies. This article brought the integrating principles of system theory and cybernetics into the disciplinary context of business management of agricultural companies. The conceptual framework of family-run agricultural companies was derived from several established concepts, and adapted to the situation of family-run companies in the sector of agricultural production in Germany.[15] Articles #2 to #4 covered the system analysis of a reference HRC operating in a specific subfield of the agricultural sector. By using the VSM method, situational knowledge was generated through input from an expert panel. The developed conceptual framework for the agricultural sector served as a general frame for the empirical implementation of the system analysis.

In order to draw final conclusions, the structure and identified elements of the analyzed HRC system were incorporated into the initial conceptual framework. The 35 identified system variables were allocated to the different dimensions and interacting links within the framework (**Figure 8**). The dedicated variables were additionally labelled with their individual systemic character (indicated by their systemic state between critical/inert and active/reactive). The HRC system variables were then distributed to the three main dimensions of the framework (spheres of environment, organization unit and management, company stakeholders). The four spheres of environment (economy, ecosystem, technology, and society) included mainly active and inert variables (e.g., *barriers through regulation and legislation*; *highly competitive market*), and variables that directly affect the management and other stakeholders involved (e.g., *use of advanced technologies*, *customers' appreciation of horticultural products*).

[15] Combination of various already existing systemic management concepts is recommended when they support the optimal adaption of the framework (Ulrich, 2001a:59). The compilation of the specific framework is described in detail in Article #1 (Gabriel et al., 2016:337–339), and illustrated in **Figure 5** in the present thesis (page 41).

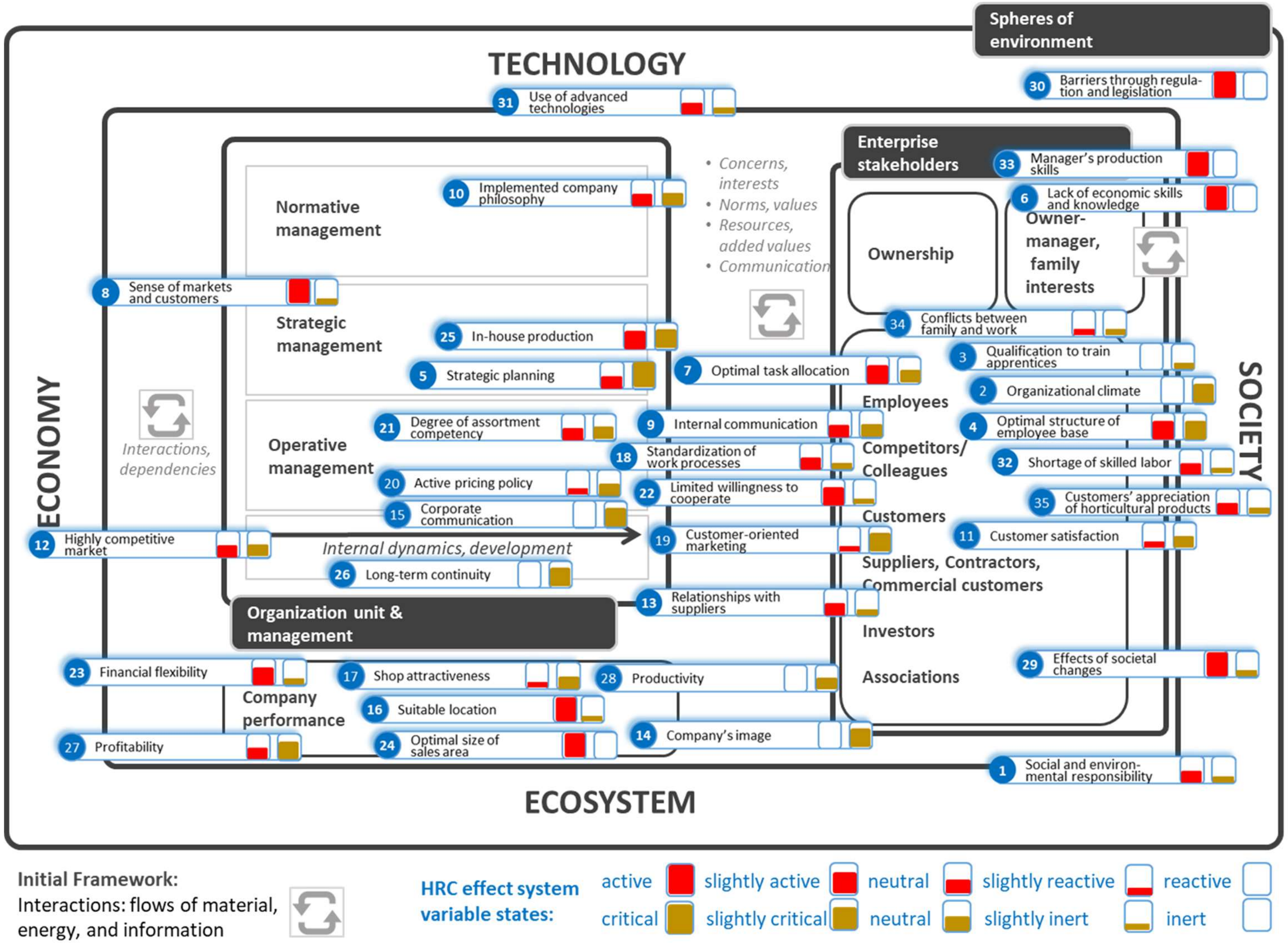

Figure 8 Incorporation of HRC system variables into the conceptual framework of agricultural companies

The second dimension of the framework, the organizational unit and management is structured into three management levels and the dynamic of time and development according to the St. Gallen management concept (Bleicher 2004). The three levels of management (normative, strategic, and operative) include aspects of company structure, activities and behavior (Schwaninger, 2001:1214). The normative level defines the general policy of the company management (represented by *implemented company philosophy*). Strategic management regulates the development and design of the enterprise. The HRC system model includes the critical variables *in-house production*, and *strategic planning* of the company management at this level. The *sense of markets and customers* turned out to be an active element of strategic management that highly affects the overall system and its development.

A number of reactive variables represent the operative management level of the HRC system model. This implies that operative measures in HRCs (e.g., *active pricing policy*, *degree of assortment competency*, and *corporate communication*) result mainly from previous strategic decisions. Reactive, but critical is the aspect *long-term continuity* of the company, which characterizes the dynamics and temporal development of the system. Regarding company performance and structure[16], a *suitable location* of the sales outlet, and the *optimal size of sales area* are highly active prerequisites for the analyzed reference HRC. The variable *financial flexibility*, which is interlinked with the external economy sphere, holds an active role in the system. Increasing financial possibilities have multiple impacts on several business areas and the development of the company.

[16] In contrary to the conceptual framework presented in Article #1 (Gabriel et al., 2016:336–338), variables describing company performance and structure are separated from the management and organizational unit, and summarized in a "company performance unit" for the reason of a more comprehensible presentation of the results in this summary.

The third dimension of the conceptual framework considers the perspectives of the various stakeholders involved in the company. Inside socio-technical systems, several involved individuals and various stakeholder perspectives are included that must be incorporated into the conceptual framework: the owner family (initially differentiated between ownership and family involvement in management of the business), employees, customers, suppliers, investors, and others.

In contrast to larger and non-family-managed companies, the "coincidence of family and business interests" gives rise to a unique set of challenges in family businesses (Davis, 1983; cited in Motwani, Levenburg, & Schwarz, 2006:472). The generally accepted framing of interlocking spheres of business, ownership and family relationships (Gersick et al., 1997; Tagiuri, & Davis, 1996) implies additional interpersonal and emotional components that should be considered. Aspects of ownership in a family-run company, such as non-employed family members and external investors were not considered by the experts, due to the specific situation of the reference HRC. As important factor of family interaction, *conflicts between family and work* was identified as a slightly reactive and inert system element in the conceptual framework.

Professional qualifications of the manager (family) such as *manager's production skills* and *(lack of) economic skills and knowledge* are highly active variables in the HRC system. Various variables describing the interaction between HRC stakeholder groups (e.g., employees and customers) show a critical systemic character especially in this kind of small business company acting at the retail sector (e.g., *optimal structure of employee base*, *organizational climate*, *customer satisfaction*, and *customer oriented marketing*).

The system variables that make up the HRC effect system fit very well into the initial framework for family-run agricultural enterprises. The clustering of a large number of critical and active elements in certain business areas indicates important priorities in HRCs (notably:

strategic and operative management, company performance, interactions through communication, and employee-related issues). A moderate number of variables assigned to the external spheres implies a lower degree of external vulnerability for these kinds of small business companies. This insight into the HRC system state of maturity confirms the results of the cybernetic evaluations conducted along the various working steps of VSM (see chapter 6.1). However, before adapting the conceptual framework to the requirements of HRCs, the demonstrated disparity between external impacts and inside controllability should be corroborated in further applications of system analysis in real-world companies.

7. Discussion and conclusions

The first-time application of the VSM method to family-run companies in the horticultural retail sector helps to describe and understand the complexity of the management of these companies. The developed concept of business analysis following the principles of system theory, cybernetics, and a participatory approach supports managers and decision-makers in small business in better analyzing business management. The following chapter discusses the applicability of the used systemic approach to the type of companies analyzed here, and the transferability of the concept to real-world companies in small business. Finally, implications of the findings of the analyzed case of the reference HRC for general business research and the specific management problems of (family-run) companies acting in this business sector are discussed.

7.1 The added value of applying systemic approaches in business analysis

The literature used to inform the present thesis includes a large number of German-speaking studies and scholarly literature in the context of system theory and systemic approaches in business analysis. There have been many enhancements in managerial system approaches made in German-speaking countries, in particular at the St. Gallen School of Management in Switzerland. Christ (2006:53) distinguishes these system-oriented management approaches from similar American management theories. While both approaches employ pragmatic and application-oriented perspectives, there are shortcomings in American management theories, such as the limitation of the focus mainly to aspects of human resource management, and a certain lack of scientific foundation (Ulrich, 2001b:88). The following sections discuss the advantages and constraints of the systemic approach in (small) business management, and associated methods such as VSM.

7.1.1 System approaches versus non-systemic approaches to business analysis

A variety of established analytical approaches enable effective decisions to help solve single problems in business management, but show deficiencies in systematic structuring of complex and multidisciplinary interactions within companies (Högl, 1996:17). Schwaninger (1997:109) posits that there is evidence of superiority of system over non-systemic approaches when dealing with complex issues. Opinions on this assertion differ among experts of management theory and business economics concerning the implementation of system approaches in business practice. Schwaninger (2001:1218) appreciates the enhancements brought about by the use of systemic approaches, especially as “non-systemic approaches usually fail to take account of the nature of socio-cultural interrelations inherent in the organizations with which they are dealing” (Schwaninger, 1997:109). Non-systemic methods mostly focus on economic aspects, maximizing profits, or the interests of only one group of stakeholders (Schwaninger, 2009:224). Thus, system approaches are able to include cross-linked perspectives of stakeholders involved in an integrated analysis that goes beyond disciplinary boundaries (Malik, 2008:64). Taking the example of the modeled HRC system, it was possible to evaluate interrelations between indicators of company performance, social interaction, and structural conditions.

Proponents of non-systemic approaches criticize the superficial and inefficient transfer of system-theoretical and cybernetic principles from natural systems (ecological, biological, human) to enterprises or similar socio-technical organizations. Von der Oelsnitz (1994) deprecates the limited generation of knowledge through systemic approaches, and criticizes the lack of empirical controllability of the results of such analyses. Other points of critique focus on the insufficient analogy between system models and reality caused by conceptual and methodological errors (e.g., unclear determination of survival aims, lack of empirical verifiability of models) (Von der Oelsnitz, 1994:17ff.). Further criticisms address the demanding input generation for the modeling process, and the unfamiliar format of results for practitioners and decision-makers that still lack suitable forms of presentation (Ossimitz, 2000:52). In order to address these difficulties, advanced solutions and software products for conducting system analysis of business management were implemented in the present thesis project to enhance practicability and to help present the knowledge gained more clearly. In the present thesis project, the first-time application of innovative instruments such as the interactive online-platform, including opportunities for interaction and discussion among the project participants, provided additional opportunities for presenting intermediate results and understanding project outputs. These additional options facilitate the decision for business analysts in favor of a systemic approach with its benefits for analyzing complex systems.

Principe (1994:39f) builds on de Rosnay (1979) and substantiates the importance of systemic approaches in order to analyze complex systems in their totality, complexity, and dynamics. A comparison with conventional analytic approaches of business analysis reveals that only systemic approaches are able to cope with both non-linearity of interdependencies, and dynamic effects in temporal processes. Even non-systemic approaches for analyzing companies that employ multivariate mathematical methods (e.g., regression analyses, and structural equation models) presume linearity of interrelations, and require reliable quantitative data. As indicated in the introduction of the present thesis (see page 12), the application of quantitative multivariate methods to complex research subjects quickly reaches its limits, and can lead to unreliable results. Thus, systemic approaches that follow the principles of system theory help cope with methodical challenges such as data gaps, non-linearity of data, and non-quantitative information. This is possible due to the fact that systemic approaches tend to neglect the precision of details in favor of the benefit of capturing the global perspective, and understanding system behavior (Principe, 1994:40).

Despite the differences between the two general types of approaches to analyzing business management, a general recommendation is not to replace one by the other, but rather to benefit from combining both. There is an increasing attitude in management theory that a synthesis of the two approaches leads to effective solutions for problems in real-world management (Schwaninger, 2004a:426). Thus, non-systemic methods for analyzing business management can be supplemented with methods of system analysis and system modeling tools such as VSM (Malik, 2008:34). Decision-makers in small businesses such as agricultural companies are able to identify the overall effects of managerial decisions, external interventions, as well as time lag implications of induced changes through the use of systemic approaches (Schiere et al., 2004).

7.1.2 Pros and cons of the VSM method

The method developed by Vester is based on his research on (bio-) cybernetics and system thinking, and thus, relies on a very early stage of system modelling. Developers of new methods of system analysis are continually improving them to minimize methodological constraints, and logical deficits. Advanced software solutions[17] for modeling systems are characterized by improved handling of data processing, and show a higher degree of flexibility in the process of

[17] e.g., iModeler (Consideo GmbH), GAMMA (Unicon Management Development GmbH)

system model development (Sailer, 2012:169). However, VSM was chosen as the method of system analysis for the present thesis project due to its capability for providing a transparent overview of the computing processes along each of the working steps. Especially the innovative use of interactive media tools in the working steps of the VSM method demanded accurate knowledge about the analytical processes of the software. For example, the central analysis of the cause-effect relationships of the system variables in the impact matrix (working step 4) was transparent during the data entry, the building of the consensus values, and the subsequent evaluation of the results.

Nevertheless, vulnerabilities of the method are well-known among users of VSM. During the application of VSM in the present thesis project, methodical weaknesses were carefully taken into consideration, e.g., through the continual feedback from the experts in the panel on the intermediate results via the interactive project platform. Furthermore, the cumbersome and rigid presentation of results of the software was circumvented by the graphical revision of the results in Excel, SPSS or PowerPoint (e.g., presentation of the partial scenario, and simulation profiles).

One frequently mentioned weakness of the VSM method is the mandatory requirement to adjust the variables to an equivalent level of abstraction in the process of variable description (working step 2). This increases the risk of an overestimation of single variables in the variable set (Sailer, 2012:167), along with an unreasonable weighting of a variable in its systemic role (Dörner, 2008; Neumann, 2015:20). The introduced option of using the glossary function on the online platform encouraged active exchange among the experts with regard to each variable, and a further refinement of the variable definitions. This allowed a general understanding of the variables to be achieved at any point in the work process.

A further criticism of the VSM method is the insufficient justification of the final set of variables by means of the eighteen life sectors, and cybernetic criteria in the criteria matrix (working step 3). Vester exclusively focused on verifying the variable set by using the cybernetic testing, but neglected a critical evaluation of the terminological consistency of the variables themselves (Grimm, & Neumann, 2010:11). The use of interactive discussion facilities for the experts on the project online-platform enabled a permanent adaption of the system variables and their definitions during the process of the system description.

Another methodical weakness of VSM is the possibility of the “division by zero” of variables in the calculation of the impact matrix in working step 4. Each variable’s systemic role arises out of the quotient and product of the added values of the cause-effect relationships between each pair of variables. Following this approach, a variable that is not influenced by any of the other system variables (e.g., environmental parameters), can show an ineffective quotient between active sum and passive sum, or an unexplainable evaluation of the product value (Grimm, & Neumann, 2010). Although this case did not occur in the analysis of the HRC system, this weak point of the method is evident, and should be kept in mind in its future application. The occurrence of a “zero” in the denominator would be an indication of a variable with a lack of linkages to the system, and thus, insufficient system relevance.

The experience with VSM in this present thesis project revealed the somewhat outdated software with regard to the analyzing processes and result presentation (see also Hübner, 2007:49). The application of VSM was relatively time-consuming, and the generated results had to be graphically enhanced for better understanding.

Despite the drawbacks to the application of VSM, the method is characterized by specific features that differ from similar instruments of system analysis. In particular, VSM explicitly considers the openness of the system to its environment, which is beneficial in first-time modeling of organizations for which no previous studies or literature are available. While other methods of system analysis concentrate only on the subject of investigation and its closely connected components, VSM is unique in its method of “considering the larger system” (Vester, 1988:403). Furthermore, the inclusion of a bio-cybernetic view of the system being analyzed is a unique attribute of VSM that is manifested in several steps throughout the working process (e.g., criteria matrix, bio-cybernetic evaluation). Therewith, Vester transfers basic principles of natural systems onto socio-technical systems such as company or business organizations to push for a high cybernetic state of maturity in order to increase resilience and viability (Freisl 2011:59).

7.1.3 Optimizing the participatory approach for knowledge generation

VSM takes advantage of heuristics to bring together diverse experiences from different practitioners (e.g., managers, employees, advisors), and scholars (Vester, 2007). It allows the integration of various assessments within a given context. The efficiency of the participatory approach is “not a function of the techniques alone but is strongly influenced by the mentality of the people implementing it” (Schlange, & Jüttner, 1997:785). The quality of the results of the analysis depends on the knowledge co-generation accomplished through the inclusion of the multiple and diverse perspectives of the people involved. Their motivated collaboration in the analysis progress makes it possible to integrate the diversity of their life-world perceptions (Pohl, & Hirsch Hadorn, 2008:114).

Methods of integrated business analysis supported by stakeholder participation are approaches that include the objectives of all perspectives involved, and can lead to effective decision-support (Kropff, Bouma, & Jones, 2001). Decision-makers in companies such as family-run HRCs (e.g., HRC managers, consultants in the horticultural sector) who gain knowledge from the use of integrated business analysis are able to expand their insights through including the perspectives of, e.g., family members, suppliers, employees, market experts, and other stakeholders.

The effectiveness of participatory approaches in business analysis depends on the achievement of a consensus based on the real-world knowledge of the practitioners involved (expert panel), as well as the correct implementation of each step of the applied method (see also Pohl, & Hirsch Hadorn, 2008). Thus, the participants' input processes and their interactions must be carefully monitored and guided to ensure that the output meets the requirements of the analysis method. It is the analyst's responsibility to ensure that these requirements are met for the respective method not only correctly, but also most effectively.

Vester emphasized that the VSM working process is a continuous feedback discussion between participants in order to achieve appropriate results. A number of studies using the VSM method to analyze complex issues in business contexts have confirmed that, in most cases, extensive effort was necessary to achieve reliable results (e.g., Wolf, Persson, & Jelse, 2012; Burkhard, 2006). Depending on the complexity of the problems being analyzed, the context, and the number of stakeholder groups involved, a substantial number of workshops is often required to complete the analytical process. Wolf, Persson & Jelse (2012) who used the VSM method to analyze logistics between companies in international supply chains, documented in total seven workshop days, which were complemented with several additional meetings with the study clients. Hübner (2007) reported that twelve meetings and workshops were necessary to finalize a systemic study of an integrated river basin management project. The multi-stage procedure of VSM can easily lead to a decline in the motivation of the participants and a subsequent loss in information quality during the modeling process. The innovative concept used in the present thesis project help accomplish the multilevel process of the system analysis more effectively by introducing interactive media tools to facilitate required communication with and among the panel participants. The online-platform with interactive user functions and a number of online tasks decreased the efforts required to organize joint communication and reduced the amount of time required for the participants involved.

However, such additional instruments cannot completely replace the face-to-face meetings required for effective use of the method. Therefore, the project included three workshops.

In the first two workshops the experts got to know each other and became familiar with the subsequent tasks in the project. The third scenario workshop conducted with a select group of the expert panel (working steps 7 and 8), enabled intensive discussion, and delivered collaborative results on the subject of succession. The balanced combination of face-to-face meetings with time- and effort-reducing interactive online functions had a positive effect on the quality of the results of this thesis project.

7.1.4 Transferability of the systemic approach

The systemic approach presented here - demonstrated on a theoretical reference company - can be applied to analyze and simulate real-world companies as well. For the thesis project, a reference company was preferred as the initial subject of investigation, because a sufficient number of experts could be included in this first-time application of the method to the horticultural sector. In most real-world HRCs the number of stakeholders involved is limited. However, the recursive approach of VSM allows for backward adjustment of the analytical steps and adaption to the specific situations of real-world companies facing various challenges in their business sector.

The inclusion of relevant non-economic indicators such as ‘family atmosphere’, ‘employee communication’, and ‘intensity of business relationships’ together with quantifiable data on company performance provides an additional asset to analyzing company structures and specific management tasks. Managers, consultants, and business analysts that transfer the analytic concepts of VSM to real-world HRCs contribute to the further development of the method while generating and spreading real-world knowledge in the field of their business. Continuous learning through repeated application of system analysis to real-world business cases will gradually improve the quality of both knowledge production in business research, and decision-making in the companies analyzed.

Further applications of the approach at the single-company level offer the opportunity for comprehensive comparison of different companies, and will help generate knowledge on the sector as a whole. However, despite similarities between companies in the horticultural retail sector, a uniform classification of HRCs is challenging, as they show a high degree of heterogeneity in sales structure and service orientation. This variety results in additional challenges in a systematic comparison of several companies, and must be considered in any application of the systemic approach to multiple companies simultaneously. The size of the retail sales floor and the range of products and services they offer vary widely, as does the proportion of the three main fields of activity in which they operate - plant production, retail sales, and supplemental services such as grave maintenance and garden care. Reasons for this diversity include different trajectories of company development over time, and diverse levels of social and economic integration into the local community. The conceptual framework generated in this present thesis sets the framework for the system-oriented modeling of companies in the agricultural sector. It can be used as a "map for orientation" (Rüegg-Stürm, 2004:65) for future efforts, and can be adapted to the situation of real-world cases (Principe, 1994).

Regarding the horticultural production sector in Germany, companies have thus far been compared largely only in terms of their economic performance in an analysis which is conducted using central panel data from the Center of Business Management.[18] Additional applications of the system approach used here at the single-company level in the horticultural sector offers the option of conducting more extensive comparison of companies, despite their heterogeneity in structure, size, and economic orientation.

[18] For information about the comparison system on horticultural companies in Germany, see https://www.zbg.uni-hannover.de/zbgbvg.html

7.2 Implications for management practice in small business

The present thesis project applied a system analysis to companies in the horticultural retail sector for the first time using the method of VSM in the field of small business. The innovative implementation of the approach described here also strongly emphasized the further conceptualization and methodological improvement of system analysis of HRCs. In the course of the application of VSM on the reference company, new findings were obtained that describe the HRC system, interpret the interactions of business areas and stakeholders involved, and help to evaluate the system state. The next section discusses general implications for management practice and research that can be drawn from the results of the system analysis with a focus on the specific management questions considered in Article #3 and Article #4 of this thesis.

7.2.1 Findings for business research and company management

Practitioners and analysts who are in charge of analyzing small companies can use the adapted methodological procedure applied in this thesis project as a blueprint for knowledge generation in a broad stakeholder dialogue. Although the thesis project focused on the specific situation of HRCs in the agricultural sector in Germany, the suggested procedure of integrated knowledge generation following the analytical steps of VSM can be transferred to other businesses, industries, and companies in other economically developed countries.

However, the conceptual framework described here should first be reviewed and adapted in the process of conducting a system analysis in terms of the relevance of the individual framework components, their specific structure, and the type of interactions they have with environmental spheres (Principe, 1994:195). For instance, a small-sized craft business may focus less on the ecosystem sphere and more on social and technological developments. Even after the incorporation of situational knowledge gained through the system analysis of the reference HRC into the initial framework generated for family-run companies in the agricultural sector, specific adjustments to the framework are likely to be necessary. When analysts consider making adaptations to the conceptual framework in the process of analyzing companies in their own specific business areas, they will benefit from concepts generated in the course of previous similar cases.

Integration of the empirical results of the HRC analysis into the initial conceptual framework constructed for family-run agricultural enterprises demonstrated the need for adjustments to the framework. For example, aspects of ownership were found to be of negligible importance for the reference HRC, while they have been shown to play a significant role in family-run companies in other business sectors (Chua, Chrisman, & Sharma, 1999). Also, the importance of innovation capacities was not identified as a crucial key variable for the development of HRCs. Innovation activities of companies are typical examples of complex decision processes with a long-term perspective that are characterized by interactions amongst a large number of actors located within and outside of the enterprises themselves (Edquist, 1997). The success of innovation processes in the agricultural sector relies, in particular, on the effective functioning of a collaborative network with efficient information flows, social interactions, and permanent learning (Knickel et al., 2009). The results obtained from the HRC model provide little evidence that adoption of technical innovations (as manifested in the variable *use of advanced technologies*) is a critical driver for the development and long-term existence of these companies. This outcome should be further explored in future applications of the system approach in agricultural sector companies with different key application areas. According to the results obtained from the analysis conducted in the present thesis, the low degree of importance of technical innovations for companies similar to the reference HRC differs considerably from more production-oriented companies in the agricultural sector (see e.g., Pierpaoli et al., 2013; König et al., 2012).

The effect system of the reference HRC, generated in the VSM working procedures, demonstrated a relatively high "networking rate", with more than 100 direct cause-effect relationships. This high rate indicates a strong interrelationship among structures and processes both within the company, and between the company and its external environment. The interpretation of the systemic character of individual variables in the effect system enables conclusions to be drawn about their function in the system as a whole. Application of this procedure with regard to the HRC system analyzed here revealed elements such as the manager's ability to conduct *strategic planning*, the *organizational climate*, and the *company's image* to be both critical variables and stabilizers of the HRC system. Variables such as a sufficient *financial flexibility*, and respect for the *long-term continuity of the company* by the next management generation form the foundation for the continued development of HRCs. Diverse managerial competencies, such as economic skills and market sense, as well as capabilities in production skills and personnel management are also considered to be important (active) system elements that have multiple impacts on the effect system and on the performance of small companies (see also Mitchelmore, & Rowley, 2010).

A high level of company performance in a particular area (e.g., *profitability*, *corporate communication*) can have a critical influence on other business areas within the company, and the interaction with the environment in which the company operates. The results of the system modeling conducted here confirm the importance of business performance in terms of its effects on the company manager's family (see also Pieper, & Klein, 2007), decision processes (see also Bokelmann, 1987), and competitiveness (see also, Singh, Garg, & Deshmukh, 2008).

7.2.2 Systemic relationships in particular management issues

Generation of the effect system of the reference company in working step 6 allowed the model to be broken down into partial scenarios (working step 7) to investigate specific management problems of the company as case studies. Scenario analysis and dynamic simulations supported greater understanding of the dynamic impacts of managerial interventions or changes in other business areas, and the system as a whole. Article #3 and Article #4 included in-depth analysis of specific management issues such as the importance of sustainability in HRCs and the impacts of the succession situation in those family-run companies.

The importance of sustainability in HRCs

Although the final comparison of the variables with the initially generated conceptual framework showed little interaction with external spheres in the social and environmental context, sustainability is a topic with increasing impact on diverse business areas in HRCs. Small retail companies form a direct interface between production and final consumers, and therefore, have a specific responsibility for sustainable corporate governance. The horticultural sector with its "natural" products and its specific social position in the regional society (as employer, instructor, business partner, knowledge mediator, etc.) is confronted in many ways with requirements for sustainability. In Germany, managers of HRCs face increasing consumer awareness and preferences for pesticide-free and environmentally friendly production of products, and also need to demonstrate their social responsibility to the local community. Strategies for more sustainable production of horticultural products – whether mandatory or voluntary – are diverse in developed countries, although there are considerable uncertainties among HRC managers about the feasibility and profitability of sustainability-related measures (Dennis et al., 2010:1236).

Regardless of the basic motives for implementing sustainability-related strategies in their businesses, managers of HRCs must understand the consequences of implementing sustainability on other business areas in their companies. Article #3 analyzed potential areas of sustainability in HRC in a systemic context. such as *long-term continuity*, *in-house production*, *implemented company philosophy*, and *regulation and legislation* (all identified areas of sustainability are shown in **Figure 6** on page 48). Subsequently, relevant variables of the HRC effect system with substantive relationships to sustainability were identified. Results showed strong interactions between areas of sustainability and day-to-day business management (e.g., *company profitability*, *strategic planning*, *economic skills and knowledge*), and the core activities of HRCs (e.g., *assortment competency*, *in-house production*, *production skills*).

Results of the analysis of sustainability-related variables in HRCs further revealed the importance of sufficient available resources in the company to increase the chance of successful adoption of sustainability-related measures in HRCs. The generally small companies operating in this sector often lack the financial and structural prerequisites for implementing larger sustainability-related measures such as certified production or even for complete transition to organic production. Results of the system analysis indicate, for example, close interlinkages between sustainability-related variables and issues related to staffing (*optimal structure of employee base*, *organizational climate*, and *optimal tasks allocation*). Adequate qualification levels and active engagement of employees are decisive for implementing sustainability in small businesses (Salimzadeh, Courvisanos, & Reveendranath, 2013). As the sector currently suffers from a shortage of skilled labor and difficulties finding junior staff (Kretschmer, 2009), preconditions for implementing sustainability-related strategies are rather unfavorable.

In contrast, the generally straightforward structures present in small business provide opportunities for flexible and quick application of simple sustainability-related measures (Moore, & Mandring, 2009). The manifold close linkages of the identified areas of sustainability to variables related to the company manager showed that successful implementation of sustainability-related strategies depends strongly on the attitudes and personal skills of the managers themselves. As smaller companies generally have no stand-alone “sustainability unit”, the company managers’ involvement and strategic skills are responsible for the implementation of sustainability-related measures (see also Hutchinson, & Chaston, 1995).

The results of the system analysis of areas of sustainability in the reference HRC indicate that a long-term perspective of the company must be ensured to implement sustainability measures. Investing in sustainability-related measures should not be attempted in order to free the company from economic distress, but rather, to advance corporate goals. An important implication for decision-makers in this consumer-oriented sector is that efforts to improve company reputation through the implementation of credible and future-oriented sustainability strategies can have a greater effect on the company in the long term, than on short-term cost reductions or short-term increases in sales.

Impacts of the succession situation in family-run HRCs

Succession has become one of the most studied topics in family business research (Short et al., 2016), with a strong focus on intra-family succession (e.g., Daspit et al., 2016). Many studies in the family business literature emphasize the significance of different impacts of business transfer depending on the type of company analyzed, family situation, and on regional and cultural differences (e.g., Molly, Laveren, & Deloof, 2010; De Massis, Chua, & Chrisman, 2008; Venter, Boshoff, & Maas, 2006; Wang et al., 2004; Lauterbach, Vu, & Weisberg, 1999).

Methods based on system theory are particularly suitable for research in small businesses (Kim et al., 2014) and in family businesses (Frank et al., 2010). In German family businesses, a sizable share of managers is nearing retirement in the coming years, most of whom prefer intra-family succession (Freiling and Grossmann, 2014). Thus, analyzing the integrated effects of intra-family succession on various business areas of a company is becoming increasingly important for managers, institutions supporting succession and business consultants (Klein, 2000).

The case study of succession in family-run companies presented in Article #4 was built on the effect system of the HRC elaborated in Article #2. It analyzed succession, and its dynamic and time-lagged impacts on affected business areas in family-run companies. Identification of close links between succession and various other business areas, such as *strategic planning*, *conflicts between family and work*, and *organizational climate*, provided integrated insights into potential future effects of either an uncertain succession situation, or a succession, which is already in the process of implementation.

The scenario analysis showed that the lack of a known successor affects the performance of the company in the period before the predecessor plans to step down. In situations where the succession situation remains unclear, long-term impacts on *profitability* and *productivity* of the company were also apparent. The analysis of interactions among the scenario variables showed intense cause-effect-relationships between the *succession situation* of the company and *financial flexibility*. The partial scenario also included the perspective of the employees as an important internal stakeholder group. *Organizational climate* emerged as a central and dynamic key variable. A functional relationship with the successor strengthens employees' motivation to work, and reduces work-related 'complaints', 'employee fluctuation', and 'number of sick days'.

Regarding the succession situation in family-run companies, the family business literature broadly discusses the importance of family cohesion, and the interaction of the family, ownership and management spheres (Bozer et. al, 2017; Gersick et al., 1997). Intra-family conflicts ultimately create a high risk of business failure (Freiling and Grossmann, 2014; Paul, 1996), or even the disintegration of the family (Flören, 2002). The scenario analysis uncovered *conflicts between family and work* as additional interpersonal issues of high relevance to the succession situation. The simulations showed that when the succession process was complete, *conflicts between work and family* began to decrease. A long-term improvement in the family atmosphere was the result of the dynamic interactions of the scenario variables.

However, aspects of ownership, such as non-employed family members and external investors were not considered by the expert panel, due to the specific situation of the reference HRC. Although retaining leadership of the business in the family through a successful intra-family business transfer can result in positive reputational benefits in family-run companies (Sharma et al., 2004), *customer satisfaction* did not turn out to be a relevant key factor in the succession scenario. In general, for companies in the retail sector, customers are a substantial stakeholder group affecting economic efficiency. The experts participating in the scenario workshop were able to reach agreement on the selection of all of the key variables with the exception of the variable *customer satisfaction*. While the experts agreed that *customer satisfaction* initially had a strong causal relationship with *long-term continuity* of the company, they argued that the causal relationship with the more narrowly defined target variable *succession situation* in the scenario was insufficient for inclusion in the succession scenario. In conclusion, the diverse set of key variables they identified as having close links to the succession situation demonstrates that systemic approaches may be better able to handle the integration of multiple business areas in the analysis of this critical phase in the company life cycle.

7.2.3 Final remarks for the horticultural sector

The findings of the system analysis presented in this thesis are not sufficient to draw industry-wide conclusions, as they are limited to the specific reference HRC. The results of the analysis of the reference HRC were strongly influenced by the input of the participating expert panel. As argued in chapter 1.3 (see page 26) the quality of the modeling process strongly depends on the completeness of the perspectives considered and the level of knowledge of the participating stakeholders. Application of the method to real-world companies with stakeholders personally affected by a particular situation (HRC manager, family members, employees, consultants, etc.) will lead to more tangible results in the context of the investigation of an individual problem. In general, applying the working steps of VSM to other cases in the horticultural sector requires the input of experts with knowledge pertinent to those particular cases to allow them to identify the aspects that are especially relevant for a particular company.

However, methods such as VSM that are based on a systemic approach can enrich the toolbox of scholars, business analysts, and consultants acting in the horticultural retail sector. They help generate integrated knowledge regarding the development of family-run companies like HRCs. The application of system thinking and the participatory approach supported by VSM and similar methods of system analysis enables a multi-perspective view of such complex organizational systems, and provides a better understanding of dynamic behavioral patterns through managerial interventions or changes in family-run HRCs.

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9. Publication and submission record

The present thesis is submitted as a cumulative thesis, based on four publications

Gabriel, A., & Bitsch, V. (2018) Impacts of succession in family business – a systemic approach for understanding dynamic effects in horticultural retail companies in Germany. *Journal of Small Business and Enterprise Development. Manuscript accepted for publication. (June 30 2018). https://doi.org/10.1108/JSBED-01-2018-0030*

Gabriel, A., Bitsch, V., & Menrad K. (2017). Feasibility-oriented application of system analysis in SMEs – the cybernetic approach of VSM applied to horticultural retail companies in Germany. *Systemic Practice and Action Research* 30(2):145–172.

Gabriel, A., Bitsch, V., & Menrad K. (2016). Conceptual framework for system analysis of family-run agricultural enterprises. *Journal of Small Business and Entrepreneurship* 28(4):325–344.

Gabriel, A., & Bitsch, V. (2016). Systemanalytische Betrachtung der Bedeutung einzelner Nachhaltigkeitsfelder in Einzelhandelsgärtnereien. In: Dirksmeyer, W., Schulte, M., & Theuvsen, L. (Eds.): Aktuelle Forschung in der Gartenbauökonomie. Tagungsband zum 2. Symposium für Ökonomie im Gartenbau. Thünen Report 44, Johann Heinrich von Thünen-Institut: Braunschweig, pp. 241–260.

Additional publications and presentations related to the present thesis

Gabriel, A. & Bitsch V. (2018): Weiterentwicklung der ganzheitlichen Unternehmensanalyse nach dem Systemkonzept unter Anwendung eines partizipativen Ansatzes am Beispiel von Einzelhandelsgärtnereien. Oral presentation at the 52th Deutsche Gartenbauwissenschaftliche Tagung, 28 February-3 March 2018 in Geisenheim.

Gabriel, A., & Bitsch V. (2015): Heuristical approach for a system description of SMEs in Hortibusiness. Poster presentation at the 1st HEZagrar PhD Symposium, 21 April 2015 in Freising.

Gabriel, A., & Bitsch V. (2014): Konzeptentwicklung für eine Systemanalyse im gärtnerischen Einzelhandel auf Unternehmensebene. In Schriften der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaus e.V. (2014): Wie viel Markt und wie viel Regulierung braucht eine nachhaltige Agrarentwicklung. Band 49. Landwirtschaftsverlag GmbH: Münster-Hiltrup, pp. 373–374.

Gabriel, A., & Bitsch V. (2014). System analysis of small horticultural retail companies. Oral presentation at the 29th International Horticultural Congress, 17-22 August 2014 in Brisbane, Australia.

Appendices

Appendix 1

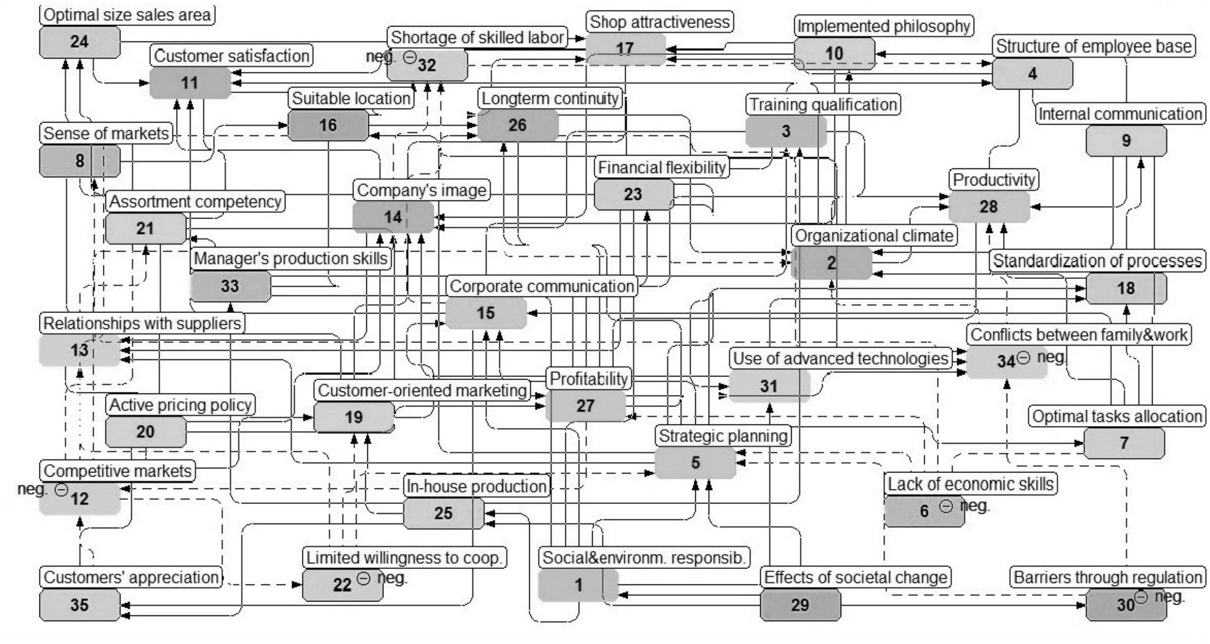

Figure 9 HRC effect system; source: Gabriel, Bitsch, & Menrad (2017:171)

Appendix 2

Table 5 System variable definitions; source: Gabriel, Bitsch, & Menrad (2017:169f)
*Negative variable connotation

No.	Variables	Consensus definitions (abbreviated)
1.	Social and environmental responsibility	Degree of responsibility for the environment and the use of natural resources; consideration of the company’s functions in the society and local economy
2.	Organizational climate	Members’ subjective experience of their company, focusing on interpersonal relationships and communication; manifesting in job satisfaction and job performance
3.	Qualification to train apprentices	Training the next generation, in particular when skilled labor is scarce; training becomes more specialized and more focused on commercial skills
4.	Optimal structure of employee base	Structure and composition of a company’s workforce, its organization, and dynamics; including development, turnover, and loyalty
5.	Strategic planning	Aspect of management’s skill set; long-term objectives and measures considering the company’s environment
6.	Lack of economic skills and knowledge*	Aspect of management’s skill set; competence in economics and organization (e.g., marketing, finance)
7.	Optimal tasks allocation	Aspect of management’s skill set; effective transfer of competencies and responsibilities to subordinates; supplemented by consulting with external experts
8.	Sense of markets and customers	Aspect of management’s skill set, practical knowledge and observation of markets, customers, and trends; timely reaction to change
9.	Internal communication	Communication skills; necessary for information exchange, task allocation, and effective delegation; not limited to management
10.	Implemented company philosophy	Vision and long-term orientation; basis for mission, culture, and strategy; consisting of explicitly documented guidelines and implicitly communicated attitudes
11.	Customer satisfaction	Fulfilling customers’ expectations regarding products and services; stimulates customer loyalty and recommendations (word-to-mouth)

12.	Highly competitive market*	Competitiveness of the local market; intensified competition due to market entry of new distributors and changes in consumer preferences
13.	Relationships with suppliers	Selection and treatment of suppliers; organizational collaboration with suppliers; reliability and consistent quality foster lasting partnerships
14.	Company's image	Images, ideas, feelings, and experiences of external stakeholders
15.	Corporate communication	PR, marketing, customer acquisition and retention; advertising efficiency; conduct of employees and management during customer contact
16.	Suitable location	Easy to reach, visible, and close to target customers
17.	Shop attractiveness	Specific products and services, flair (e.g., cleanness, design, product displays), and customer comfort (e.g., parking lots, opening times, in-shop-coffee bar)
18.	Standardization of work processes	Established processes for sales and service (e.g., standardized complaint management); information systems for products and customers
19.	Customer-oriented marketing	Aspect of management's skill set, fine-tuning of specific marketing strategies to target customer base and generate new customers
20.	Active pricing policy	Positioning in the market and overall price level; customer specific price strategies and target pricing (e.g., discount systems)
21.	Assortment competency	Range and depth of products and services; differentiation, value added, and seasonality
22.	Limited willingness to cooperate*	Cooperation of legally and economically independent partners; horizontally (e.g., joint purchasing, plant swap) or vertically with suppliers or resellers (e.g., joint advertising)
23.	Financial flexibility	Room for strategic investments (includes credit line); liquidity in day-to-day business
24.	Optimal size of sales area	Suitable size for target market, turnover, and assortment
25.	In-house production	Scope of locally produced plants; authenticity and quality
26.	Long-term continuity	Maintenance and development of assets for the next generation; succession plan
27.	Profitability	Ratio between profit and capital (credit, equity) in production and sales
28.	Productivity	Ratio between output and input (human, area, resources); efficiency of work processes
29.	Effects of societal changes	General changes in buying behavior and shopping habits; societal and consumer trends
30.	Barriers through regulation and legislation*	Governmental and private regulatory conditions; taxation, certification, and documentation obligations
31.	Use of advanced technologies	Using innovations to improve efficiency of production and sales processes (e.g., energy saving, digital cash systems); willingness to adopt new technologies
32.	Shortage of skilled labor*	Retrograde image of skilled crafts and trades, in general, also gardener profession; low wages; effects of shrinking workforce on horticultural educational system
33.	Manager's production skills	Horticultural competencies (e.g., ability to judge plant quality); effective process planning in production and sale
34.	Conflicts between family and work*	Aspect in family-run HRCs; lack a clear distinction of family life and business resulting in financial, physical, psychological, or time strain in family businesses
35.	Customers' appreciation of horticultural products	Consumers' and municipalities' esteem of horticultural products and services; cultural value of "green", short-time trends, and long-term attitudes