Supply Chain Diagnostics to Confront Theory and Practice – Re-Questioning the Core of Supply Chain Management

Günter Prockl

Summary:
This paper illustrates the basic approach, structure and development path of a diagnostic instrument that integrates existing approaches of systemizing, structuring and thus elaboration of the core of supply chain management (SCM). The main purpose of this computer-aided tool is the quick indication of weak spots within supply chain enterprises. But this self diagnostic is not the focus of this paper. More interesting is the side effect of gaining feedback from diagnostics sessions. While answering diagnostic questions, users are confronted in a systematic way with concrete challenges and principles of SCM. Their industries, supply chain stages as well as the answers are documented in standardized data records. So the tool can provide useful data regarding the state of implementation and differences in key challenges for different players in different supply chains. Separate studies on potentials, obstacles and realization of SCM principles as well as existing scientific publications on design principles, interviews with industry experts, and the experiences of the concerned consulting and research institutions have been used as input in the development process of the self diagnostic instrument.

Keywords:
Supply Chain Diagnostics, Boot-Strapping, Principles, Key Challenges, Root Causes

1 The Core of Supply Chain Theory and Realities of Practice

1.1 Supply Chain is Not Supply Chain and Player is Not Player

Since Oliver & Webber (1982) coined the concept and the term, supply chain management has seen rapid advances, especially in recent years, and is now an established concept of the scientific community as well as of most practitioners. It is apostrophized as a kind of meta competence of successful business management, and a great number of literature on concepts, potentials or technical support has been published. Apart from this predominantly popular literature, less work has been finished towards the scientific collection, critical consolidation and systematization of this multitude of models, design recommendations or single principles, thus addressing the question on the emerging nucleus of supply chain management. Though there are some initial and useful taxonomies and systematic collections of supply chain concepts and ideas available as well as initial preliminary results of international Delphi studies[1], the critical and systematic confrontation of theory and practice still seems to be missing.

Additionally, most recommendations and suggested potentials address supply chain management in general. But an increasing number of authors provide convincing arguments for the need of a more differentiated view on what is the right supply chain. Fisher (1997) separates products into functional and innovative products and uses this distinction to argue for two different archetypes of supply chains: the efficient supply chain and the responsive supply chain; each with a different set of specific challenges. Fine (1998) uses product architecture to separate supply chains into modular and integral supply chains. Christopher (1998) differentiates between lean and agile supply chains depending on demand stability. Lee (2002) or Sheffi (2004) combine different views towards more hybrid approaches. All approaches together show that there is no such a thing as the "one perfect supply chain." Theory on supply chain design should reflect this.

Furthermore, players across even the same supply chain may also have different views on what is the right supply chain for them. The supply chain efforts of fast-moving consumer goods are almost exclusively focused on the area downstream from producers to retail. The area upstream has hardly been recognized at all until now (Prockl, 2000: 57). Midsized companies, when asked about the benefits of supply chain management or efficient consumer response, provide answers that are different to those of big players. Studies show that not all supply chain players show the expected results (Heckmann et al., 2003; also Prockl et al., 2004: 32-33).

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[1] See for example http://legacy.csom.umn.edu/AHill/SCMtenR2/

While the basic theoretical core elements of supply chain management may thus emerge gradually, the next question on the differentiation of supply chain management concept towards different supply chain types or different supply chain actors seems almost totally unaddressed. Insights on the weight of different supply chain challenges for different positions in the chain, different chain types or different actors are lacking.

1.2 Need for Hypothesis and Empirical Data from Practice

Keeping these introductory thoughts in mind, the danger of dividing theoretical rigor and practical relevance is once more apparent (Anderson et al., 2001; Nicolai, 2004). If research on supply chain management asks for both rigor and relevance, then attempts to bridge this gap between theoretical rigor and practical relevance seem to demand meeting at least two requirements (see also Weick, 2001: 72, 74; Starkey & Madan, 2001: 3-4). First there is a need for a confrontation of theory and practice in a straightforward as well as systematic way that is itself interesting and helpful for practitioners. Second, practice of supply chain management should neither be seen as a homogeneous whole, nor should theory reflect the idiosyncrasies of individual cases. Instead, the theory needs to be separated for different supply chains including different supply chain echelons and different types of supply chain players.

One opportunity for such an approach, as outlined in this paper, has been provided by a joint project of university researchers together with business consultants to develop a rapid diagnostic toolset for supply chain management. The main aim of the computer-aided instrument is the quick diagnostics and indication of weak spots within enterprises in a supply chain. Such diagnostics sessions can be run by managers of the respective companies themselves or more commonly in first meetings between the companies and the involved researchers and consultants.

However, the diagnostics itself are not the focus of this paper. Yet, within the context of this paper the two requirements of confronting practice with theory as well as gaining empirical feedback from the diagnostics sessions will be addressed. By answering the diagnostics questions, the users provide empirical feedback on exploratively-gained supply chain challenges and principles. By asking for the industry and supply chain stage of the company as well as the standardized documentation of all answers in a data record, the diagnostics instrument can provide useful empirical data regarding the state of implementation and differences in key challenges for different players in different supply chains.

The following two sections describe first the approach used to explore the hypothesis on supply chain management that are incorporated into the diagnostic tool. Then the structure of the tool and the process of a typical diagnostics session are sketched to illustrate how the diagnostic tool can work as a data machine for relevant feedback from practice.

2 Exploring a Set of Hypotheses on Supply Chain Management

2.1 Combining Top-Down and Bottom-Up Approaches – Bootstrapping of Theory and Practical Experience

One of the major challenges of the project was to create a toolset that is based on science as well as practical experience and that is itself interesting, helpful and easy to use. Therefore, from the beginning a strong emphasis had to be put on the basic structure of the tool, allowing it to take different industry specifics into account later. Furthermore, the tool does not target specific measures but tries to provide a more qualitative system of indicators on relevant hot spots in the users' companies or supply chains. To get better indications of such hidden problems without the opportunity to detail questions (as during an interview) on given answers, it seemed more appropriate to encircle problems by providing bundles of different diagnostic questions that address different views of a problem and thus may show some intended redundancy. The elaboration of these question sets and their sound structuring around core issues of supply chain management played one of the most prominent roles within the project. For this task, a combined approach of top-down and bottom-up analysis seemed most appropriate (Figure 1).

- **Top-Down: Driven by Principles**

On the one hand, such a search for indicators on hidden opportunities within supply chains may be based on relevant principles of supply chain management and, respectively, principles of flow systems design. Such principles and recommendations can be found, although they are distributed throughout the relevant literature. The task was then to identify, condense and evaluate such principles and transform them towards diagnostic questions. Additionally, to structure the questions along the supply chain, so-called topics had to be defined that express concisely the conformity or non-conformity to the related principle.

- **Bottom-Up: Driven by Experience**

On the other hand - besides the more theoretical principle-based approach - the search on indicators may also be related to actual problems observed in daily practice and the related typical solutions to tackle those problems. By requisitioning these typical problems regarding their typical underlying root causes, core issues (now in the sense of key challenges that have to be mastered in supply chain management) could be defined.

The single steps of this approach, referred according to a statistical method as "bootstrapping," are sketched below. But before this, the basic paths "top-down" and "bottom-up" are introduced in some more detail.

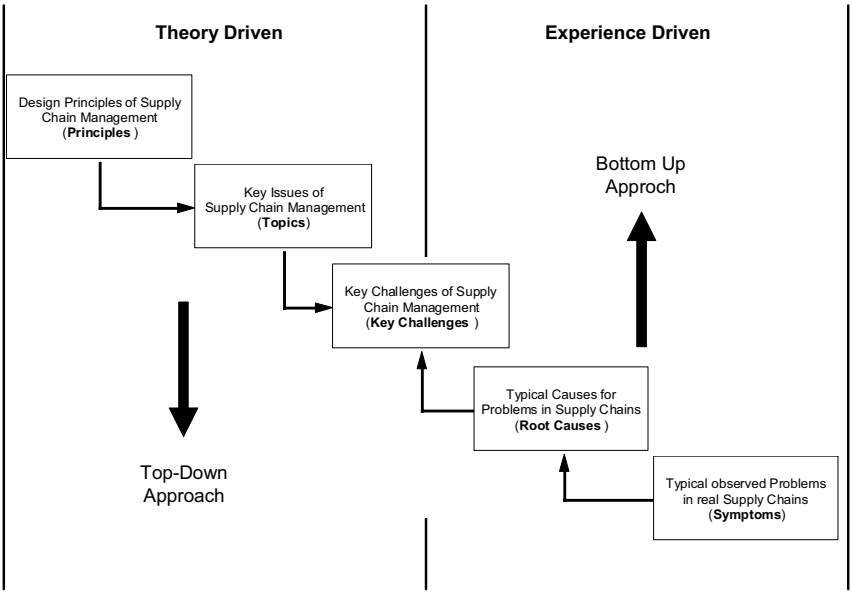

Figure 1: "Bootstrapping" Approach to Combine Theory and Practice

2.2 "Top-Down"- The Good Supply Chain in Theory

Supply chain management gained ample attention in recent years - also as topic of scientific discussion. It seems that the scientific community agrees widely on the basic objectives and the basic levers of supply chain management. Typical, frequently-mentioned objectives include increasing customer value by reducing lead times and reducing costs (Bhattacharya et al., 1996: 39-48; Cavinato, 1991: 10-15; Towill, 1996), and thus finally increasing the success of all companies involved (Stevens, 1989: 3; Cooper et al., 1997: 2; Bechtel & Jayaram, 1997: 16; Christopher, 1998; Klaus, 1998: 23; Kotzab, 2000: 34; Brewer, Speh, 2000: 75). The primary lever is seen as the design and alignment of all activities in the whole supply chain - i.e. across company borders - towards this ultimate goal of customer (consumer) orientation (e.g. Jones & Riley, 1985: 17; Stevens, 1989: 3; Bowersox, 1997: 181-189; Christopher, 1998: 23ff.; Klaus, 1998; Prockl, 2001). Closely related to this is the belief that overall, better coordination of the activities and thus more effectiveness as well as efficiency may be realized by sharing data and joint planning (e.g. Bowersox, 1996: 102) across the total supply chain. In addition to a necessary joint awareness for the objectives of the total supply chain and for the required means to realize these objectives across company borders, the

following major tasks of supply chain management seem to be emerging (Prockl, 2001: 42; Delfmann, 1998: 71; Klaus, 1998: 434ff.; Fine, 1998: 105ff.):

- The active configuration of the supply in terms of breaking down and allocating all the activities, tasks, functions, processes and competencies on to different actors in the chain to exploit competitive edges by advantages of locations, specialization and centralization and goal oriented bundling of core competencies;
- the active design of coordination decisions regarding the transfer, control and communication processes between the allocated actors. The chain must mobilize the actors continuously towards the total objectives as well as integrate the actors who are distributed geographically and organizationally into an altogether "optimal" complex. This integration task is basically done by formal organizational means, the application of (information) technology as well as socially oriented interventions into the organizations' routines;
- the permanent re-alignment of the established structures to secure the advantages and thus the sustainable competitiveness of the supply chain. The design and re-design of the supply chain thus becomes a continuous "meta-core competency" of the companies involved (Prockl, 2001: 43; Fine, 1998: 221). In addition to the configuration/allocation and the coordination/integration, the adaptation/development of the supply chain is the third major task of supply chain management.

But supply chain management also incorporates many older concepts and ideas under the umbrella of a new and handy "language" (Klaus, 1998: 436). This makes it much more difficult to define - beyond these basic ideas - which elements and design recommendations really represent the core of supply chain management and which contribute significantly to companies' success. Prockl (2001) provides one approach by adapting Giddens (1984) structuration theory and trying to characterize the phenomenon of supply chain management via its "structural properties," i.e. the proposed and typical standard solutions and related patterns of action.[2] This work provides about 900 design recommendations for supply chain management from different scientific sources, and arranges it to sets of principles essentially structured around the basic ideas and task of supply chain management (Prockl, 2001). Slightly modified in its structure and supplemented by additional, current sources, this systematic collection of principles and ideas of supply chain management could be used as the theoretical starting point to define step-by-step key issues of supply chain management.

Table 1 shows in excerpts some elements of this work. In the third column, some first proposals of such key issues are presented. These issues are then mirrored on

[2] For the concept of "structural properties" and the basic thoughts of the structuration theory see Prockl (2001: 16-20) and constitutive Giddens (1984).

experiences and requirements of the practitioners (see 2.3 Bottom-Up) and are refined step-by-step to hypothesize on relevant key challenges of supply chain management.[3]

Core Tasks of SCM	Basic Concepts of SCM[4]	Illustration of Some Topics in SCM
Task 1: **Configuration/ Allocation**	▪ Flow oriented differentiation, segmentation ▪ Modularization ▪ Outsourcing ▪ Postponement ▪ Mass customizing ▪ Capacity harmonization	▪ Segmentation of the supply chain according to customer and demand requirements ▪ Category management ▪ Combination of product and service policies; ▪ Make2Order vs. Make2Buy ▪ Network strategy assessment ▪ Strategic decision structures; Joint vision ▪ Supply chain technology strategy ▪ Strategic network planning ▪ (Cross docking, Transshipment) ▪ Encapsulation of related activities (focused factory; modular production) ▪ Modular/integral product architecture; ▪ Proximity, Local sourcing ▪ "Interface" reduction (Single/Modular sourcing) ▪ "Interface" design (System supplier; One-Stop Shopping) ▪ Process ownership and consignation arrangements ▪ Outsourcing of non-core competencies (3PL/4PL) ▪ "Warehouse Postponement" (e.g. Centralization of slow movers etc.) ▪ Postponed manufacturing, Assembly and merging ▪ Postponed transportation (Drop shipments) ▪ Capacity/Stock harmonization; Joint capacity planning; Synchronized production

Table 1: Core Tasks, Basic Concepts and Topics in Supply Chain Management (Part 1)

[3] A similar effort to define the core of supply chain management via sets of principles is currently taken in a Delphi study. See http://legacy.csom.umn.edu/AHill/Scmten/R2.

[4] A deeper discussion of most of these improvement concepts can be found in Prockl (2001: 101ff).

Core Tasks of SCM	Basic Concepts of SCM	Illustration of Some Topics in SCM
Task 2: **Coordination/ Integration**	▪ Compressing/ Speeding of the supply chain ▪ Leveling and capacity adjustments ▪ Early sharing of information and data ▪ Collaboration, Partnering, Trust ▪ Adequate formal organization, esp. contract design ▪ Joint monitoring ▪ Permanent and early error prevention	▪ Cross company planning and control ▪ Technical standards, EDI, CPFR etc. ▪ Process-/operation standards ▪ Information sharing and monitoring ▪ Data integrity (Master Data Alignment) ▪ ERP/SC-Planning software ▪ Integrated real-time processing (Tracking & Tracing) alerting, Event management ▪ Cross functional teams; Ad-hoc teams; Cross training ▪ Collaborative product development (concurrent engineering) ▪ Strength of bonds, Contracts ▪ Aligned measurement systems, Gain sharing, Open book, Incentive systems, Bonus/Penalty ▪ Scorecards, Performance Measuring/Management ▪ Self management/organization, responsibilities ▪ Partnering, Win-Win, Cultural proximity ▪ Commitment within and across the SC ▪ Origin oriented cost accounting ▪ Just in Time, Pull, Replenishment
Task 3: Adaptation/ Development	▪ Development and scalability ▪ Open standards ▪ Agility	▪ Open scalable technologies ▪ Adaptive business processes ▪ Supplier development programs ▪ Benchmarking und technology exchanges

Table 1: Core Tasks, Basic Concepts and Topics in Supply Chain Management (Part 2)

2.3 "Bottom-Up"- The Problems Shown in Practice

The top-down approach formulates in a more or less normative way the objectives, tasks and principles that, when applied, should secure the "good" supply chain. In contrast to this, the bottom-up works form the other side and start with the identification and description of typical weaknesses and problems in practice. By asking systematically for the underlying reasons of these problems, key issues may be defined, but now from the bottom up. Such approaches of detecting problems in individual analysis and the classification of such problems with standard root causes and standard solutions based on past experiences is the core business of the classic consulting companies. Figure 2, taken from a company presentation of Booz Allen Hamilton, clearly illustrates this approach.

Together with additional studies (e.g. Heckmann, 2003; see also Prockl et al., 2004), this preparatory work of the consultants was to identify typical weaknesses, ask for their underlying causes, and group them according to typical root causes for problems that could be included within the project as second starting point – this time from the viewpoint of the practitioners.[5]

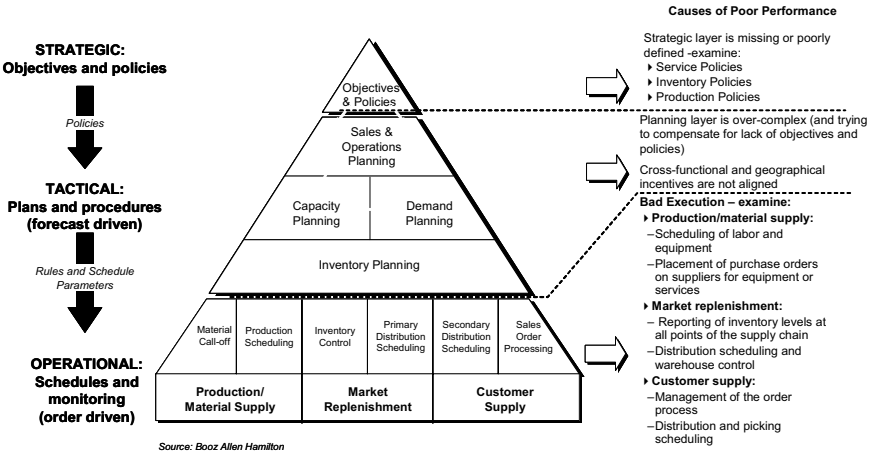

Figure 2: Problems, Typical Causes of Poor Performances and Consulting Issues

2.4 Structuring Principles, Key Challenges, Root Causes and Symptoms

The outlined bootstrapping method was realized in a partly iterative process composed of the basic steps specified in the sections below. These single steps may be further classified into a preparation stage and a realization stage (see Chapter 3). In the preparation stage discussed in this chapter, the identification, collection, grouping and consolidating of the material from the different sources came to the fore. Simple Excel tableaus served as technical support. The following steps were executed:

- **Step One: Defining the Basic Structure and the Relevant Elements**

First, the elements of the both approaches (top-down and bottom-up) were combined into an overall structure, and in some iterations a first matching of the more inductively deduced topics of supply chain management with the deductively investigated root problems of the practitioners were done. The structural link of

[5] For the roles of consultants in academic research see also Robey & Markus (1998).

both directions was realized by sets of hypotheses on what is important and relevant for supply chain management today: these are called the "key challenges".

- **Step Two: Collect and Arrange Material from Primary and Secondary Sources**

The developed framework was filled with further material. In this stage, redundancy and gaps still were accepted consciously. To keep the survey feasible and thorough, the project team agreed to focus on some core industries: "Automotive," "Communications, Media," "Fast Moving Consumer Goods," "Pharmaceuticals" and "Chemicals." But not only these industry sources on design recommendations and on typical problem challenges in supply chain management were investigated. The used material collection and evaluation included own surveys and reports from different projects, publication of organizations like Odette published project reports, supply chain models (e.g. SCOR, ECR, VICS), questionnaires, checklists, and whitepapers.

- **Step Three: Formal Consolidation**

The classifications and groupings were checked formally, and entries with very similar content but differently expressed were consolidated. Some redundancies were eliminated in this stage.

- **Step Four: Asking Industry Experts**

In step four, the preliminary key challenges were listed in the form of hypotheses. Each challenge was then attached to a scale (high, medium, low relevance). Then industry experts were confronted with the hypotheses to generate first rankings and estimations on the relevance of single challenges. This feedback was used for further alignment and consolidation of the key challenges.

- **Step Five: Grouping and Consolidation**

In numerous loops, the material collection was then condensed and thinned out systematically, and the remaining gaps were more tightly focused and filled. To do this, the project team members elaborated their individual proposals. Then in group meetings, the proposals were compared, discussed intensively and aligned. Due to a lot of material referring to chain awareness, this large group was split into three smaller groups so that the following six basic principles could build the backbone of the diagnostics instrument.[6]

- "Create Supply Chain Awareness",
- "Create Demand Transparency across the Chain",
- "Align Supply Chain to Products and Customers",
- "Configure Network (Structure)",
- "Integrate Operations (Process)",
- "Develop Supply Chain (Adaptation)".

[6] See also chapter 2.2, and for the structure of principles, challenges, questions see 3.1.

- **Step Six: Preparation for Programming**

In the last step of the preparation stage, the results were implemented into an access database used as a basis for the succeeding programming - widely independent of operation systems. Within the database, the single elements were identified by a hierarchical number system. Each data record represents a symptom for possible problems already in the form of a question sentence. Each such question is linked with a referring root cause, the key challenges, and additionally to the evaluation in a diagnostics session regarding how it relates to the levels of strategy, tactics and operations, and to five more factor analytical views on "Products and Innovation," "People and Soft Factors," "Technology and Investment," "Organization and Processes," and "Performance Measuring and Monitoring."

3 Gaining Data – Involving the Stakeholders

3.1 Informing, Challenging and Asking

The major intention that the tool is to provide diagnostics has put some requirements on the questionnaire. On the one hand, e.g. the length of a typical supply chain, the different areas involved, or the mix of strategic and operational aspects demand as many questions as possible. Additionally, the questions should be asked as precisely and least-suggestively as possible. On the other hand, the number and the length of the questions should be limited to a minimum, keeping required time to answer the questions low. Along with the programming for these reasons, a lot of effort was put into the wording of the questionnaire.

But even more important than the wording was the creation of a structure that actively involves the user into the data generation process. The user should not get only a promise of a diagnostics and a kind of an evaluation after the end of the session, but should be informed and challenged with the theoretical core of supply chain management during the answering session. Thus, he should ideally learn about supply chain challenges and be kept curious regarding the next questions. As shown in Figure 3, the two important objectives are combined in this approach. Picking the key challenges as a central theme was not only helpful to combine top-down and bottom-up approaches for the development of the tool, but also supported the actual application of the instrument to meet the necessary balance between asking about facts and problems and informing the user and keeping him curious.

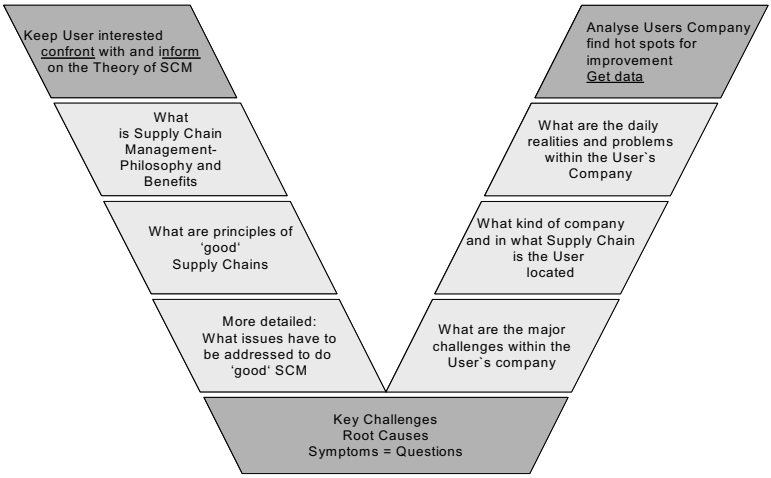

Figure 3: Basic Thoughts on the Structure of the Tool

This idea was implemented into the tool by a catalogue of 90 questions that are grouped around root causes, the root causes around key challenges, and the key challenges around the six basic principles of supply chain management (Figure 4). In the diagnostic sessions, a set of three questions is always related to one root cause and presented simultaneously on one screen. The questions themselves are phrased concisely, but the user additionally gets some text on the same page regarding key actions and common risks related to the root cause, thus explaining the background of the problem that is addressed by the questions in more detail.

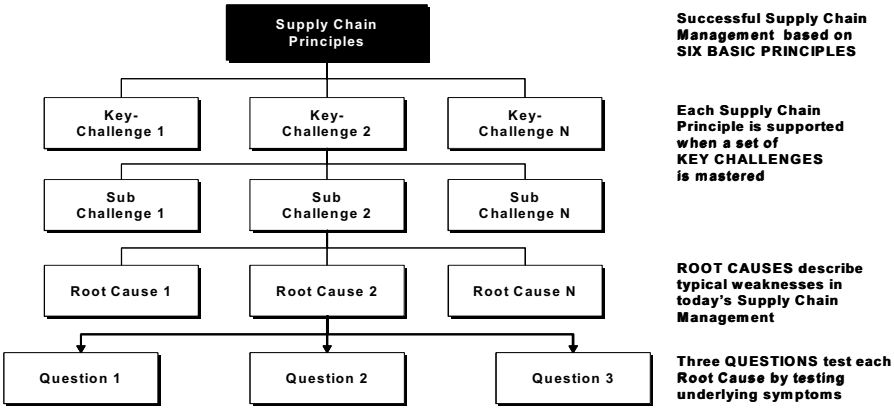

Figure 4: Basic Structure of the Diagnostic Tool

3.2 Basic Structure of a Diagnostic Session

The course of a diagnostics session consists of five basic steps, shown in Figure 5. First step of the diagnostics is the identification of the user. By choosing a name, the user may save his proceedings, with the option to interrupt and resume a diagnostic session later. Also, different users from the same company might run different sessions and compare individual results. In the identification procedure, the user is also encouraged to select his/her supply chain industry and supply chain stage and to provide some more data e.g. size and revenue of the specific company. In non-anonymous sessions e.g. run by the consultants, this information may also be entered by the consultants.

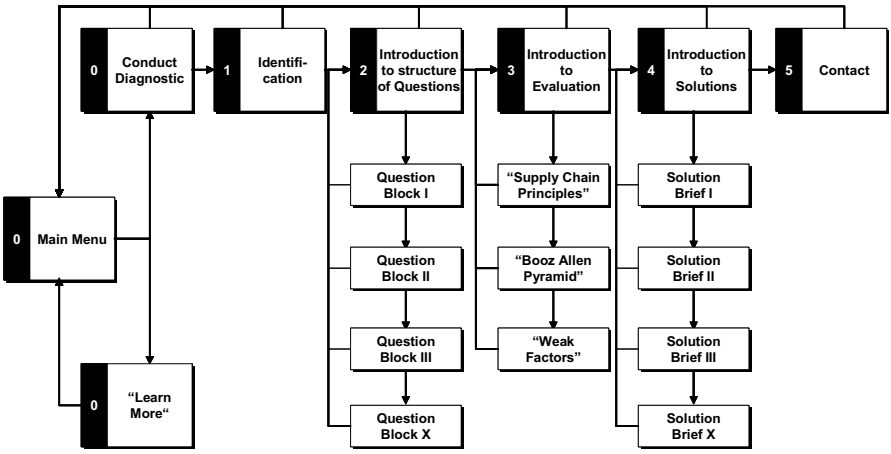

Figure 5: Basic Course of a Diagnostic Session

After identification, the users obtain an overview and introduction regarding the questions and opportunity to answer the single question blocks one after the other or to answer single selected question blocks. The latter might be of specific interest when different users e.g. purchasing, production, sales share the answering task. After answering the questions, the users may proceed to the evaluation. The evaluation of the diagnostics is not the focus of this paper, so only a short outline of the basic functions is given here. There is the opportunity to analyze from three different views. The evaluation of key challenges shows which of these seem mastered by the users' company and which might be at risk. Another view separates into strategic, tactical or operational aspects, and finally, there is the opportunity to check if specific company factors like products, human resources, organization technology or performance monitoring are on track. An introduction to possible solutions and the opportunity to get into contact to the tool providers are the final steps, but not of interest in this paper.

3.3 Using the Data

"The academic's job is to understand how an idiosyncratic individual world comes to be seen as a universal world and how vested interests work to convey this definition of universality." (Weick, 2001: 74). From a more methodological point of view, the tool seems to address the major suggestions for bridging the relevance-rigor gap by supporting not only demanded self-reflection of researchers, but including real reflection from practitioners early on as well (Weick, 1999):

- Not only researchers but also the other stakeholders (Starkey & Madan, 2001) of research, the practitioners, are actively involved in the research process. Thus, by the confrontation of the elaborated theoretical core of supply chain management with the real needs of practice, critical feedback could be generated - not only collected - helping to make this core more robust.
- On the other hand, involvement of practitioners provides direct benefits for this group. The systematic grouping and presentation of important supply chain issues may help practitioners detect gaps and future opportunities and thus enter undeveloped fields beyond the pure reflection of their current typical problems.

Of special interest within the context of this paper is the opportunity to evaluate answers on how different industries and different supply chain stages might provide interesting insights regarding the still-open question on how to differentiate the supply chain for different industries and players. Users directly identify their supply chain industry and stage and provide feedback on their actual hot spots and unsolved problem areas. Later versions of the tool could use this "micro" input to differentiate the challenges step-by-step closer to the needs of different industries or different types of companies. The structural requirements for this are already embedded within the tool.

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