An approach to evaluate a firm's supply chain strategy as a conceptual system

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Abstract

Being able to evaluate an extant supply chain strategy is an obvious prerequisite to any reformulation effort. Yet the literature offers scant advice on how to conduct this evaluation. This paper proposes an approach to evaluate a firm's supply chain strategy as a conceptual system. Four evaluation criteria are proposed: *support* for the firm's strategic objectives, *consistency* among internal elements, *coverage* of areas of interest, and *sufficiency* in fulfilling expectations. A method is proposed to apply these criteria in the evaluation of a supply chain strategy. The approach was tested and refined through two action research projects. Examples are provided.

Keywords: supply chain strategy; conceptual system; strategy evaluation; evaluation criteria; evaluation method

1. INTRODUCTION

Supply chain managers often find themselves in a position where they would like to evaluate the current supply chain strategy of their firms. As supply chain scholars actively engaged with practitioners in the field, we are frequently approached by companies interested in conducting an evaluation of their supply chain strategy. Table 1 provides multiple examples of this, summarized from our own interactions with companies in recent years.

In some cases, the interest in reevaluating the supply chain strategy may have been kindled

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by a specific development, such as new competitors (example #1), a new business strategy (examples #2 and #6) or competitive model (example #5), changes in the business environment (example #4) or in the structure of the supply chain (example #9), among others. In other cases, the motivation is not a particular event, but an interest in retaining a leadership position (examples #3 and #7) or a general awareness that the *status quo* may be improved (example #8).

Example #1: a global business unit from a company in the chemical industry, dedicated to specialty product. Facing *growing competition* from low cost providers in China and increasing costs of raw materials, the VP of supply chain decided it was time to rethink their unit's supply chain strategy.	**Example #2**: a company in the health care industry, competing in both drugs and devices, recently developed a *new business strategy*. They expressed interest in finding whether their current supply chain strategy continues to be adequate, and if not, how it should be adjusted.	**Example #3**: a business unit from a company in the electronics industry, dedicated to computers. Having recently acquired a leading position in certain key markets, the business unit has expressed interest in ensuring they have the right supply chain strategy in place, *to remain leaders*.
Example #4: a U.S. company in the food industry, facing the *challenges of the 'great recession,'* asked for a revision of its supply chain strategy, to be both more efficient and better prepared for the challenges of the future. The first step is to evaluate their current supply chain strategy.	**Example #5**: a business unit from a company in the health care industry, dedicated to distribution. New regulations on the industry required *a change of their competitive model*. This prompted this business unit's head of supply chain to reevaluate their current supply chain strategy.	**Example #6**: a company in the health care industry, specializing in high tech medical devices. Facing challenges brought by fast growth, they hired a new CEO, who launched a *significantly different business strategy* and asked that the supply chain strategy be evaluated and revised to align with the new goals.
Example #7: a global corporation in the chemical industry. Perceiving its *leadership position is threatened* by supply-chain savvy competitors, it decides to develop a global supply chain strategy at the corporate level, requiring the evaluation of existing supply chain strategies at the BU level.	**Example #8**: a U.S. utility company, with a large proprietary fleet. After multiple supply chain initiatives at the operational level, *the attention has moved* to the strategic level. They have manifested interest in evaluating the company's current supply chain strategy, to identify areas for improvement.	**Example #9**: a company in the food industry, with global operations. In recent years, many of their key suppliers have been acquired by a new corporation. Uncertain about the implications, the company is interested in reevaluating their supply chain strategy in light of this *supplier consolidation*.

Table 1: Examples of firms interested in supply chain strategy evaluation

These examples, by no means exhaustive, illustrate the need practitioners often have of being able to evaluate a supply chain strategy. We also find in the literature references to instances when a supply chain strategy should be changed, such as Aitken, *et al.* (2003), which suggests that, to maintain competitiveness, changes to the supply chain strategy may be necessary as a product proceeds through its life cycle. What we have not found in the literature is an approach to conduct the evaluation of a supply chain strategy.

The absence from the literature of a clear and actionable approach to evaluate a supply chain strategy, unfortunate as it may be, is part of a pattern. A quarter of a century after Shapiro and Heskett (1985) described *strategy* as one of the two faces of supply chain management (called at the time 'business logistics,' the other face being *operations*,) supply chain strategy research remains, in general, relatively neglected. As a field, supply chain strategy has fallen behind two other related fields with expansive literature coverage: supply chain operations and business strategy, both of which have an established tradition of evaluation.

In business strategy, for example, evaluation is seen as "an essential step," since "strategy can neither be formulated nor adjusted to changing circumstances without a process of strategy evaluation" (Rumelt, 1996). In the operational side of supply chain management, there are several established "tools for diagnosing potential problems in a supply chain" (Foggin, *et al.*, 2007). In the strategic side of supply chain management, however, there is no established approach for evaluation.

We identify two distinct components to the challenge of evaluating a supply chain strategy. The first is the need to have a well-defined set of criteria that can be used for the evaluation. The second is to have an actionable method to apply these criteria in an evaluation. Neither criteria nor method could be found in the literature.

To bridge this gap, the present paper seeks to propose a set of criteria and a method for the evaluation of a firm's supply chain strategy. Both were developed, tested and refined as part of a wider multi-year research effort on supply chain strategy.

Definitions

Given the "excessive use – and even abuse" (Nollet, *et al.*, 2005) – of the term *strategy*, it becomes necessary to establish a working definition of what is meant in this paper by supply

chain *strategy*, and to clearly differentiate it from the concept of the *supply chain* itself.

A working definition of supply chain strategy

The concept of strategy has been subject to debate in academia for almost half a century (Nollet, *et al.*, 2005), during which period multiple definitions of the term have been proposed. Around the turn of the century, Mintzberg (1994) proposed allowing the term *strategy* at least five meanings: one of these was strategy as a *pattern.* This idea of strategy as *"a pattern of cohesive actions"* (Evered, 1983) has been echoed in the supply chain management literature, where supply chain strategy has been described as *"a pattern of decisions"* related to the supply chain (Narasimhan, *et al.*, 2008), and as a *"set of choices"* made by firms (Lo and Power, 2010). It has also been said the activities of a supply chain are a better indicator of a supply chain strategy than any formal strategy statement (Cigolini, *et al*., 2004).

For the purpose of this paper, the supply chain strategy of a firm is understood as the set of ideas behind the activities, decisions and choices of that firm's supply chain, which serve as logical bridge between the supply chain operations in the field and the business strategy.

Supply chain vs supply chain strategy

Based on Mentzer, *et al.* (2001) we define *supply chain* as a set of entities "directly involved in the upstream and downstream flows of products, services, finances and/or information from a source to a customer." The difference between a *supply chain* and a *supply chain strategy* is the difference between a set of physical entities and a set of ideas. So, for example, when AMR Research publishes its 'Supply Chain Top 25' list, what they are ranking are supply chains (O'Marah, 2010), *not* supply chain strategies.

2. LITERATURE REVIEW

We have not found in the literature a set of criteria purposefully designed for the evaluation

of a supply chain strategy, comparable – for example – to the four "broad criteria" proposed in Rumelt (1996) for the evaluation of a business strategy. Nevertheless, the case could be made that a careful reading of the literature should yield lessons on what constitutes a good supply chain strategy, which could then be adapted to serve as criteria for evaluation. These lessons may be classified in two types: advice based on expert opinion and inferences derived from empirical studies. Although fundamentally different in their claims to knowledge (one is based on opinion and authority, the other on systematic observation), both refer mostly to how a given 'strategy' relates to a supply chain's performance.

Advice based on expert opinion

Expert opinions are ubiquitous in the supply chain management literature. In some instances, they are also largely influential. Some articles from trade publications, such as Fisher's (1997) article on matching the supply chain to demand characteristics, or Lee's (2004) article on the three qualities that differentiate the best supply chains, have become widely-cited *classics* in the field. Although the ideas they advance are presented modestly by their authors as drawn from personal expertise, their intuitive appeal has resulted in wide application and in some cases has triggered a number of scholarly articles that seek to prove or disprove them.

Given such high-profile expert advice, practitioners may be tempted to use it as a foundation to evaluate their own supply chain strategies. Below we argue against such an approach, using as example the most widely cited article in the genre: Fisher (1997). The point is meant, nevertheless, not regarding Fisher's article in particular, but the genre in general.

According to Fisher (1997), products can be characterized as either functional or innovative, and supply chain strategies as either efficient or responsive. Fisher claims that efficient supply chain strategies are a good match for functional products, and responsive supply chain strategies

are a good match for innovative products. He also claims that the opposite combinations would result in bad matches.

During the past decade Fisher's widely-referenced framework has been subjected to multiple empirical tests, with mixed and even contradictory results. Several studies found evidence only for part of Fisher's claims (Li and O'Brien, 2001; Selldin and Olhanger, 2007; Qi, Boyer and Zhao, 2009). Another study by Lo and Power (2010) found their evidence supports none of Fisher's claims. Furthermore, Lo and Power found evidence against the classification of products as either functional or innovative, and of supply chain strategies as either responsive or efficient.

When fundamental doubts can be cast on the empirical validity of the ideas presented in the most widely cited expert-opinion article, it becomes clear that there are perils in basing the evaluation of a specific supply chain strategy solely on insights derived from expert-opinion literature.

Inferences from empirical studies

A different type of articles found in the literature is based not on expert opinion, but on empirical data. Practitioners may be tempted to extrapolate the general lessons found in these empirical studies to the particular problem of evaluating a specific supply chain strategy.

We argue that there are several limitations to using empirical studies as the basis for insights on what makes for a good supply chain strategy. A first limitation is the validity of the empirical data that serves as support for these studies. There is no guarantee of the validity of self-reported answers, such as those obtained in surveys, unless they can be independently verified.

A second limitation is that empirical studies usually focus on a single feature of the supply chain strategy. An example is Frohlich and Westbrook (2001,) which focuses on integration, suggesting it positively impacts the performance of a supply chain; however it says nothing

about factors other than integration. Albeit there is value in knowing that a given feature is desirable in a supply chain strategy, this narrow knowledge is not enough to evaluate the whole of a supply chain strategy.

A third limitation is that, even if the findings of empirical studies are true at an aggregate level, it is unlikely that they hold true for every particular instance. It is not possible to know whether a particular insight will apply to the specific case of a supply chain strategy of a given firm. For example, a survey by Sun, Hsu and Hwang (2009) – based on 243 useable answers – suggests that "a firm within a low demand and low supply environmental uncertainty would find it more profitable to deploy and use an efficient SC strategy rather than a responsive risk-hedging and agile SC strategies." Even if this finding is true for most firms "within a low demand and low supply environmental uncertainty", there is no assurance it will hold true in the case of a particular firm, which is all that matters for a given firm.

A fourth limitation, which applies not only to both empirical and expert-based insights, is that it is not clear how practitioners can act upon these insights to conduct an evaluation. The lack of a mechanism that can be used to apply empirical insights in the actual process of evaluating a supply chain strategy diminishes the value these insights may have as evaluation criteria. In other words, knowing what attributes are desirable in a supply chain strategy is not sufficient unless this knowledge is accompanied by a method to apply it in the evaluation of a supply chain strategy.

Mechanism for evaluation

We have found no actionable method in the specialized literature to conduct the evaluation of a supply chain strategy. The case could be made that methods developed for other purposes could be adapted to the problem of supply chain strategy evaluation. For example, Martinez-

Olvera and Shunk (2006) present "a realignment methodology for the supply chain strategy development." By *realignment* the authors mean the rearrangement of the elements of an existing supply chain strategy, in order to improve customer satisfaction as an output of the supply chain operations.

This method starts from the premise that there are six business models that manufacturing firms may follow, and that for each one of them there is a corresponding preferred supply chain strategy that provides the best alignment. Managers can determine the misalignment of their firm's current supply chain strategy by comparing it to all the six preferred supply chain strategies listed in the framework. The closer the current supply chain strategy is to any of the six preferred strategies, the better the supply chain strategy is considered.

The approach proposed by Martinez-Olvera and Shunk may suffer from oversimplification: the number of business models that supply chains are expected to support may not be infinite, but it is most likely larger than six. Probably aware of the difficulty caused by this oversimplification, in a subsequent paper that develops the methodology further, Martinez-Olvera (2008) suggests as a direction for future research the possibility of including '*hybrid models*' that go beyond the basic six, by combining features from more than one of them. Yet the paper provides no mechanism for evaluating these hybrid models.

3. DEVELOPING A NEW APPROACH

Having found in the extant literature no clear answer to the question of how to evaluate a supply chain strategy, we set out to develop a new approach. This approach includes both a set of criteria and an actionable method for managers to evaluate a firm's supply chain strategy.

A grounded starting point

We start by addressing a fundamental problem: discussing a supply chain strategy in a factual

manner is not an easy task. As Hicks (1999) laments, "it is often the case that high-level discussions of supply chain strategy are completely void of facts." This may be due to the 'elusiveness' of strategy in general (Bakir & Bakir, 2006) and the fact that how to characterize a supply chain strategy remains an open question (Frohlich and Westbrook, 2001.) In addition to the difficulty of characterizing a supply chain strategy, or possibly as a result of it, supply chain strategies are often left tacit. An international survey by Harrison and New (2002) found that more than half of the supply chain strategies in over 250 firms across diverse sectors "were either non-existent, patchily defined with poor definition, or had only some elements defined and lacked detail." Likewise, an analysis by Perez-Franco, Singh and Sheffi (2010) of 20 case studies on supply chain excellence revealed that only 2 made explicit reference to the *supply chain strategy*, compared to 18 that made explicit reference to the *business strategy*.

As a starting point to any factual discussion of the supply chain strategy, it would be useful to make the supply chain strategy explicit and to conceptualize it in a way that lends itself to discussion and evaluation. Building upon the idea that, in general, strategy is revealed by activities (Porter, 1996; Andrews, 1987) and, in particular, supply chain strategy is revealed by supply chain activities (Cigolini, et al., 2004), a method to conceptualize the supply chain strategy of a firm was proposed recently by Perez-Franco, Singh and Sheffi (2010.) This method taps into tacit knowledge (Baumard, 1999; Harrison, 2004; Tsoukas, 2005) about the firm's activities in order to *reveal* its supply chain strategy, and then *captures* it as a conceptual system (Blanchard, 2008), that is to say, as a group of interrelated concepts working together to accomplish a common purpose (Oliver, Andary and Frisch, 2009).

The FSM as starting point

The outcome of the method proposed by Perez-Franco, *et al.* (2010) is called a 'Functional

Strategy Map,' or FSM; it is a conceptual representation of the supply chain strategy as a bridge between operations and business strategy.

The FSM makes use of five categories of concepts, or *layers*, spanning from the specific and operative to the general and strategic. We propose making use of the three middle layers of the FSM for the purpose of evaluating the supply chain strategy (see Figure 1).

These three layers are: (a) the *strategic themes* (STs), which articulate the firm's strategic imperative, clarify and expand the business strategy and relate it to the business environment; (b) the *operational themes* (OTs), which refer to specific activities conducted by the firm; and (c) the *functional themes* (FTs), which represent the ideas behind the operational themes. Taken together, the FTs and OTs capture the essence of the functional strategies of the firm, including the supply chain strategy.

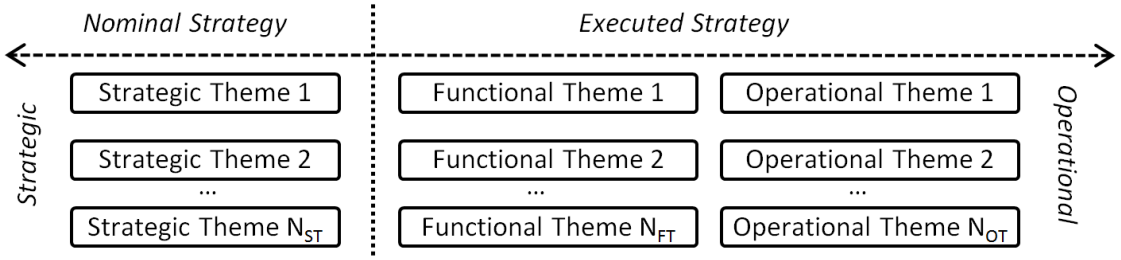

Figure 1: Middle layers of a FSM

Figure 2 provides an example of a FSM, showing only the three middle levels that are used for evaluation. It describes the supply chain strategy of Saflex, a $9B business unit of a specialty chemicals company, with operations in the Europe, Asia and the Americas. The reader is referred to Perez-Franco, Singh and Sheffi (2010) for information on the method to build the FSM.

Unprecedented vs extant system

Since the current supply chain strategy of a firm is – by definition – already in place at the time of evaluation, it is not an "unprecedented system," e.g. one where evaluation precedes operation, but an "extant operational system," e.g. one where changes are done while the system

is in operation.

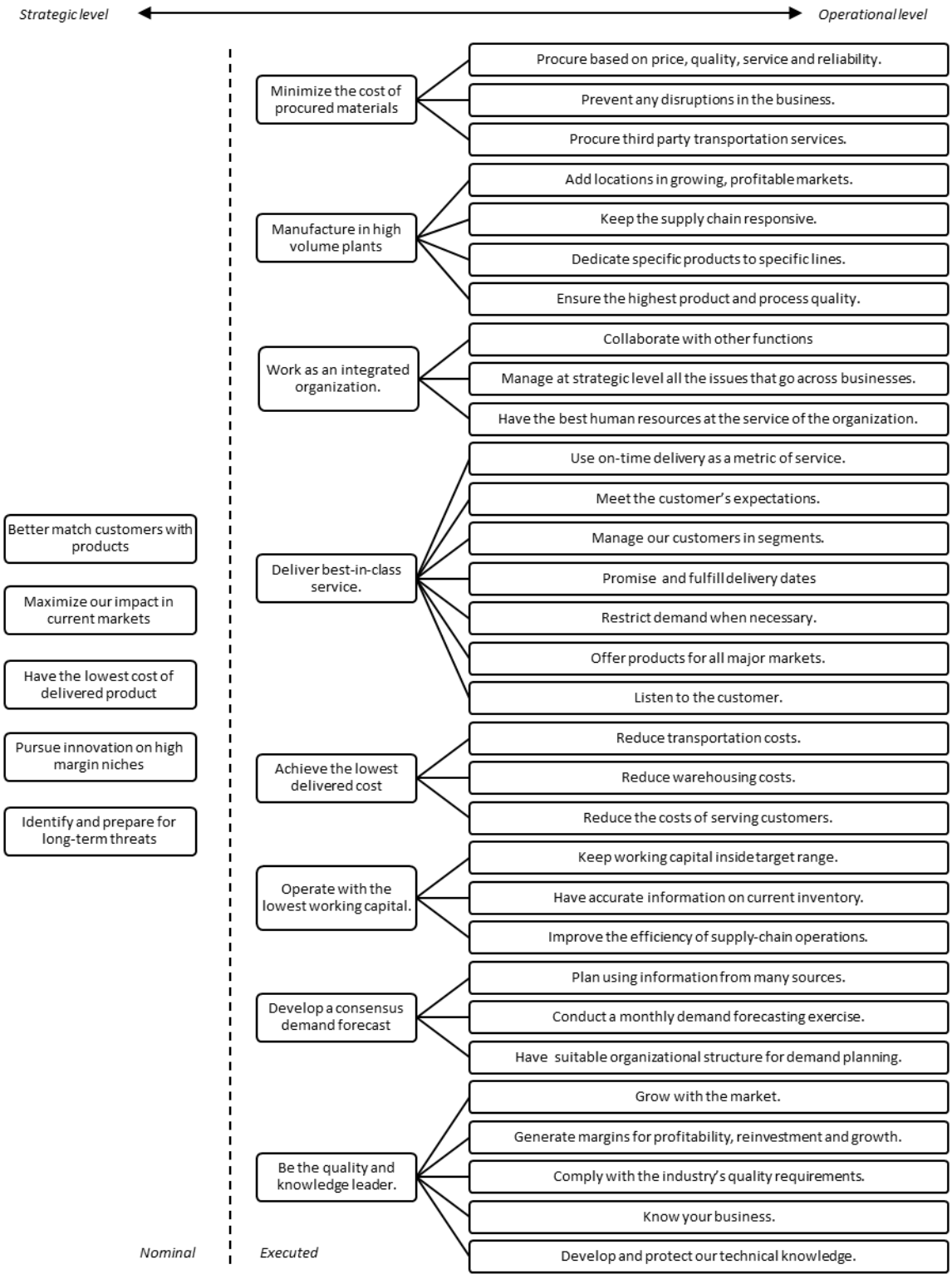

Figure 2: FSM from Saflex (middle layers)

When it comes to extant operational systems, "the objective is generally to improve performance … without disruption of operations," so that "the system in question improves in some way and becomes 'fit for purpose'" (Hitchins, 2007, p.357).

The question then becomes how to evaluate a supply chain strategy in place. There is more in the systems engineering literature about evaluating unprecedented systems than about evaluating extant systems.

Systems evaluation figures most prominently as part of the "design and development activity processes," with the objective of acquiring "a high degree of confidence," as early as possible, "that the system will ultimately perform as intended" (Blanchard, 2008). The literature is less rich concerning the evaluation of an extant system, particularly a conceptual system like the FSM.

An initial set of criteria

Our search for an approach to evaluate a supply chain strategy is two-fold: finding a set of *criteria* to guide the evaluation, and a *mechanism* to actually conduct it. Developing an initial approach, it follows, would require developing an initial set of criteria and an initial evaluation mechanism, which can be tested and refined through projects.

An initial set of criteria to evaluate the supply chain strategy as a conceptual system is suggested by the fact that the FSM evolved from adapting Porter's 'activity-system map' to the problem of supply chain strategy (Perez-Franco, *et al.*, 2010). Porter (1996) argues that an activity-system map "can be useful for examining and strengthening strategic fit," a claim that echoes the objective of improving performance and fitness of an extant system. Porter distinguishes three types of fit: *first order fit* is when activities support the overall strategy; *second order fit* is when activities support each other; *third order fit* refers, in Porter's words, to

an ‘optimization of effort.’ Porter’s ideas of activity-system maps and fitness have been applied to supply chains (i.e. Ayers, 2006).

Having selected an adaptation of Porter’s map, the FSM, as our starting point for an evaluation of the supply chain strategy, we considered whether it was possible to adapt fitness as evaluation criteria. Porter’s *first order fit* can easily be adapted to evaluation of the concepts from the FSM, at two levels: first, it could translate into an assessment of the ability of a given functional theme to support a given strategic theme, which we could call *functional support*; second, it could translate into an assessment of the ability of a given operational theme to support a given functional theme, which we call *operational support*. Porter’s *second order fit* can also easily be adapted to evaluation of the concepts from the FSM. It could translate into an assessment of the support that a functional theme provides to another functional theme, which we could call *inter-functional support*. Porter’s *third order fit* is not so easily adapted into the evaluation of concepts from the FSM. So, as an initial set of criteria, we start with these three: functional, operational and inter-functional support.

An initial evaluation mechanism

We set then to identify an initial mechanism to conduct the evaluation. An engineering design tool known as ‘evaluation matrix,’ with a long tradition in the conceptual design of products as diverse as vehicles and software, caught our attention as a good candidate.

Evaluation matrices are found at the core of Pugh Controlled Convergence, (PuCC) , a method developed by Stuart Pugh and refined over a decade of field work with industry, to narrow down choices in the early stages of a conceptual design (Pugh, 1990.) Frey *et al*. (2007) have quantitatively verified the ability of PuCC to converge on superior designs through the iterative use of evaluation matrices.

As used in PuCC, the ‘evaluation matrix’ has: (a) as vertical headers a list of expectations that will be used to judge the merits of a given design concept, (b) as horizontal headers a series of design concepts to be evaluated, and (c) on each cell of the matrix an assessment of the ability of a given design concept to satisfy a given expectation.

Pugh’s evaluation matrix could be adapted to serve as a mechanism to evaluate the criteria derived from Porter’s first order fit. A first matrix could be built as follows: (a) as vertical headers, use the strategic themes from the FSM, (b) as horizontal headers, use the functional themes from the FSM, and (c) in each cell of the matrix, an assessment of *functional support* provided – in the Pugh tradition – by a team of experts.

Similarly, a second matrix could be built where we use: (a) as vertical headers, the functional themes from the FSM, (b) as horizontal headers, the operational themes from the FSM, and (c) in each cell of the matrix, an assessment of *operational support* provided by a team of experts.

A different type of matrix, widely used for analyzing systems, could be adapted for the evaluation of the criterion derived from Porter’s second order fit. Known as Design Structure Matrix, or DSM (Eppinger, Whitney, Smith, & Gebala, 1994), this tool consists of a matrix representation of dependencies within a system. It uses the same list of components of the system for both the vertical headers and the horizontal headers. The cells in the matrix indicate whether one component of the system depends on another. The DSM is often used for system analysis, and has been adapted to socio-technical systems, including supply chains (Bartolomei, 2007.)

It is possible to adapt the DSM matrix for our evaluation purposes, by using the functional themes from the FSM as both horizontal and vertical headers in a matrix, and inserting in each cell of the matrix an assessment of *inter-functional support* provided by a team of experts.

Testing and refining through projects

The initial approach – criteria and method – described above were tested in desk top-runs, using data from a secondary case study. Encouraged by their potential as tools for evaluating the supply chain strategies, a series of steps was devised for building the empty matrices, collecting the data that would go into them, and then for analyzing the data seeking insights. This method – a primitive version of the one shown in the Appendix – was tested, improved and refined through two action research projects.

Action research is "an informed investigation into a real management issue in an organization by a participating researcher, resulting in an actionable solution to the issue" (Harris, 2007.) Action research "forms a bridge between practitioner understanding and the generation of theoretical knowledge to inform action," through which "knowledge generation and the development of new practices are integrated and theorized" (Somekh, 2008.) Action research projects "can contribute to generating new knowledge" in supply chain management (Muller, 2005) since "they strive to advance both science and practice" (Naslund, 2002.)

First action research project

A first action research project was conducted with Saflex. The project, which was not limited to evaluation, spanned over two years and included the following data collection: (a) 41 open and semi-open interviews with 40 respondents, scheduled for one hour each, on the subject of the firm's activities; (b) Five panel discussions with a team of eight supply chain managers with each panel scheduled for four hours; and (c) a series of four online questionnaires, sent to ten members of the supply chain function, which in total, included 356 questions, 3055 answers and a response rate of 86%.

The main goal of the Saflex action research project was to test, for the first time with a firm,

the emergent approach of using evaluation matrices based on the FSM to appraise a supply chain strategy. Among the lessons from this first project are the following:

- The members of the firm responded positively, and quickly embraced two of the evaluation criteria we had considered, namely *functional support* and *operational support*. Useful insights were derived from the matrices we prepare to explore these criteria. This, along with the team's favorable response, lent validity to the use of *functional support* and *operational support* as evaluation criteria.
- An interesting realization was that evaluating the support of all operational themes to all functional themes was very taxing in terms of effort, due to the large number of possible combinations. Most of those combinations, however, were irrelevant; we found that exploring the support of operational themes to functional themes other than their parents (e.g. those hierarchically related to them in the FSM) produced little or no additional insights.
- The idea of *inter-functional support*, on the other hand, did not resonate with the team. It seemed that, in their opinion, functions were not expected to actively support each other, as much as they were expected not to interfere with each other. The matrix we prepared to explore the inter-functional support also showed a high degree of symmetry along the long diagonal, suggesting that the question was not one of direction-specific support of one functional theme to another, but one of bidirectional compatibility between pairs of functional themes. We came to call this *functional consistency*, and its discussion with the team lead to an exploration of the fundamental trade-offs faced by supply chain planners, as well as how they are being addressed. It is worth noting that one of four "broad criteria" proposed by Rumelt (1996) for the evaluation of a business strategy is also called 'consistency' and is defined as follows: "the strategy should not present mutually

inconsistent goals and policies." This lends validity to the inclusion of *consistency* as an evaluation criterion.

- During the session to validate the FSM, a member of the team asked about an area of interest for the supply chain that was not featured in the map as prominently as he would have expected. This lead to a discussion about which other areas of interest for the supply chain were not featured in the map as prominently as the team would have expected. Several were pointed out. These gaps were described as 'shortcomings in coverage.' Based on this experience, we proposed a new criterion for the evaluation of the supply chain strategy, which we call *coverage*, understood as the ability of the supply chain strategy to address all the areas of interest for the supply chain managers.
- During the session to discuss the evaluation matrices, the point was made by a member of the firm that it was necessary to consider whether the support that was being received by a goal was enough to satisfy it. For example, a strategic theme may be receiving support from a few functional themes, and yet not be fully satisfied as a goal. This idea resonated with the team and suggested yet another criterion for evaluation, which we call *sufficiency*, understood as the extent to which goals are satisfied: *strategic sufficiency* when applied to the satisfaction of strategic themes as goals, and *functional sufficiency* when applied to the satisfaction of functional themes as goals.

Second action research project

A second action research project was conducted with Libica[†], a health-care company with approximately $100B in annual sales. The project spanned over seven months and included the following data collection: (a) 22 open and semi-open interviews with as many respondents,

[†] The name of this company and other sensitive information has been disguised.

scheduled for one hour, on the subject of the firm's activities; (b) three panel discussions with a team of 24 managers from different functions in the firm, each panel scheduled for four hours; (c) three panel discussions with sub-teams of eight managers from different functions in the firm, each panel scheduled for 1 ½ hours, and (d) two online questionnaires sent to two separate sub-groups, which combined accounted for 83 questions sent to 25 individuals, with a total of 1,981 answers and a response rate of 95%.

The purpose of the action research project with Libica was to test the revised evaluation approach. Based on what we learned during the previous project, the evaluation criteria and the method were revised as follows:

- *Functional support* was retained as criterion. The method to evaluate it remained the same.
- *Operational support* was retained as criterion, yet it was redefined so that only support to 'parent' functional themes is evaluated. The evaluation matrix used was simplified accordingly, and this resulted in an important reduction in the time required to complete it.
- *Inter-functional support* was dropped as criterion altogether. Instead, we evaluate for *functional consistency*, considered bidirectional and thus only requiring half of the evaluation matrix (the other half would be its mirror image).
- *Coverage* was added as criterion.
- *Functional sufficiency* and *strategic sufficiency* were added as criteria.

Some lessons from this second project are the following:

- *Functional consistency* was embraced by the team as a criterion. Using it instead of *inter-functional support* results in a reduction in the time and effort required to complete the matrix. Again, we verified that discussing *consistency* brings to light issues regarding fundamental trade-offs.

- *Coverage* seemed to be well accepted by the team as an evaluation criterion. The mechanism used to evaluate it is straightforward: discuss, during the validation of the FSM, what areas of interest are absent from the map. This simple approach was effective in revealing multiple shortcomings in coverage.
- The idea of *sufficiency* as a criterion was quickly embraced by the team. The mechanism we used to identify shortcomings in sufficiency was relatively simple: during the data collection for building the FSM, and the sessions to validate it, notes were made of all comments about areas in which the performance of the supply chain is falling short of expectations. These comments indicate shortcomings in sufficiency.

4. THE SCS EVALUATION APPROACH

Having tested and refined the approach through two action research projects, we proceeded to document the evaluation criteria and method, as follows.

Criteria for evaluation

We propose the following four general criteria to evaluate a firm's supply chain strategy:

a) *Support:* activities should support the goals of the supply chain strategy

b) *Consistency:* components of the supply chain strategy should be compatible

c) *Coverage:* the supply chain strategy should address all important areas

d) *Sufficiency:* the goals should be fully satisfied by the supply chain strategy

When these general criteria are applied to the different levels of the FSM, they result in a total of 10 possible specific criteria (see Figure 3): (1) *Functional support*: the functional themes are expected to support the strategic themes (STs). (2) *Operational support*: the operational themes are expected to support the functional themes. (3) *Strategic consistency:* the strategic themes are expected to be compatible among themselves. (4) *Functional consistency:* the

functional themes are expected to be compatible among themselves. (5) *Operational consistency:* the operational themes are expected to be compatible among themselves. (6) *Strategic coverage:* the strategic themes are expected to address all the areas of interest to the strategy. (7) *Functional coverage:* the functional themes are expected to address all the areas of interest to the functions. (8) *Operational coverage:* the operational themes are expected to address all the areas of interest to the operations. (9) *Strategic sufficiency:* The strategic themes should be satisfied by the functional themes. (10) *Functional sufficiency:* The functional themes should be satisfied by the operational themes.

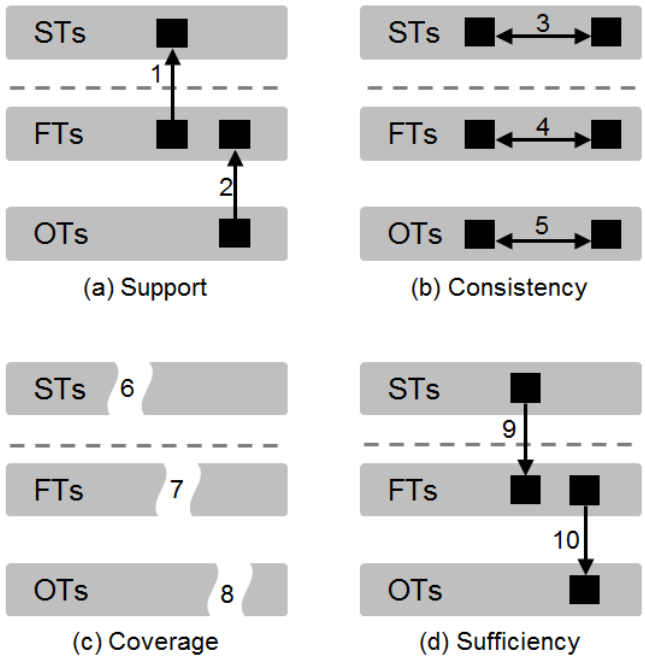

Figure 3: Proposed evaluation criteria

Method for evaluation

Evaluating consistency and support

Consistency and support are evaluated by means of individual assessment of the relationships between the relevant concepts from the FSM, followed by discussion in a panel setting. This is done with the aid of evaluation matrices. For example, evaluating *functional consistency* in a

supply chain strategy is performed by asking individuals to assess the compatibility of each pair of functional themes from the FSM. Likewise, *functional support* in a supply chain strategy is evaluated by asking individuals to assess whether each given functional theme is providing support to each given strategic theme form the FSM. A detailed method on how to prepare, complete and interpret the evaluation matrices for the evaluation of functional support, functional consistency and operational support is provided in the Appendix.

Evaluating coverage

Coverage is evaluated by asking the individuals what areas of interest are not currently being addressed by the supply chain strategy. The answers of individuals are then discussed and expanded in a panel. This can be done for all three levels in the FSM: since the map explicitly shows the areas of interest that are being addressed by the supply chain strategy, those that are absent can easily be identified by a group of experts. So far, our projects have not required any further mechanism. A provision we have found useful is taking extensive notes, while the FSM is being built, of all comments regarding: (a) things the firm could be doing but is not, and (b) areas that seem relevant, for which the firm has no clear established policy. These comments are typically indicative of shortcomings in coverage.

Evaluating sufficiency

Sufficiency is evaluated by asking the individuals what objectives are not currently being satisfied chain strategy. For functional sufficiency, the question revolves around whether functional objectives, as shown in the FSM's functional themes, are satisfied. For strategic sufficiency, the question revolves around whether strategic objectives, represented in the FSM's strategic themes, are satisfied. Answers typically have the form of comments on grievances or shortcomings, ways in which the supply chain is falling short of the expectations. These answers

of individuals are then discussed and expanded in a panel. So far, our projects have not required any further mechanism. However, we expect that KPIs, both strategic and functional, could be useful for the evaluation of sufficiency.

5. ILLUSTRATING THE APPROACH

This section illustrates the proposed approach with examples adapted from our action research projects with Saflex and Libica. Information has been disguised where appropriate.

Consistency and support evaluation

Here we present examples illustrating the process to evaluate consistency and support in a supply chain strategy, following the steps outlined in the Appendix.

Data collection

For data collection, as required by Step 2 in the method shown in the Appendix, a three-part questionnaire is prepared. Part 1 collects data about *functional support*, through questions about support that functional themes provide to strategic themes. What follows is an example from Saflex. In their FSM, the fourth strategic theme (ST_4) is: "*Pursue innovation on high margin niches.*" The third (FT_3) is: *"Work as an integrated organization."* A question in Part 1 of the questionnaire inquires about the support FT_3 provides to ST_5 (we label it $Q1_{3,5}$). It reads: *"Working as an integrated organization helps us to pursue innovation on high margin niches."*

Part 2 collects data about *functional consistency*, through questions about the compatibility between pairs of functional themes. What follows is an example from Libica's questionnaire. In their FSM, the first functional theme (FT_1) is: *"Focus our efforts in efficient distribution."* The second functional theme (FT_2) is: *"Move towards value-added services."* A question in Part 2 of the questionnaire inquires about the compatibility between FT_1 and FT_2 (this question we label $Q2_{1,2}$). It reads: *"Focusing our efforts in efficient distribution is compatible with moving towards*

value-added services."

Finally, Part 3 collects data about *operational support*, through questions about how necessary are the operational themes for their parent functional theme. What follows is an example from Libica's questionnaire. In their FSM, the tenth operational theme (OT_{10}) is: *"Add profitable customers to our customer base."* Its parent in the FSM, the fifth functional theme (FT_5), is: *"Improve profitability through customer and product mix."* A question in Part 3 of the questionnaire inquires about how necessary OT_{10} is for its parent, FT_5 (this question we label $Q3_{10,5}$). It reads: *"Adding profitable customers to our customer base is necessary to improve profitability through customer and product mix."*

In both the case of Saflex and Libica, questionnaires were administered online and the progress of responses was monitored. A week after the questionnaires were delivered, reminders were sent to individuals that had not replied. Response rates were 86% for Saflex and 95% for Libica. Obtaining such high response rates require a strong commitment from team leaders.

	Respondent	**Coding the answers to $Q1_{2,4}$ from Part 1 of Saflex's questionnaire**	Supportive	~ Neutral	Detrimental	Unsure
Individual 1	1	*I am not sure*				✓
Individual 2	2	*It may hurt, but only a little*		✓		
Individual 3	3	*It makes no difference*		✓		
Individual 4	4	*It makes no difference*		✓		
Individual 5	5	*No, it significantly hurts*			✓	
Individual 6	6	*It makes no difference*		✓		
Individual 7	7	*It may hurt, but only a little*		✓		
Individual 8	8	*It may help, but only a little*		✓		
Individual 9	9	*No! It is terrible*			✓	
Individual 10	10	*I am not sure*				✓
		Percentage of respondents	*0%*	*60%*	*20%*	*20%*

Figure 4: Answers to question Q12,4 of Libica's questionnaire, coded

Data analysis

What follows is an example of how to code answers from each part of the questionnaire, following Step 4 from the Appendix. Figure 4 lists the answers that ten respondents provided to question $Q1_{2,4}$ from Part 1 of Libica's questionnaire.

	$Q1_{1,1}$	$Q1_{1,2}$	$Q1_{1,3}$	$Q1_{1,4}$	$Q1_{1,5}$	$Q1_{2,1}$	$Q1_{2,2}$	$Q1_{2,3}$	$Q1_{2,4}$	$Q1_{2,5}$	...
Supportive	*50%*	*60%*	*90%*	*10%*	*40%*	*10%*	*50%*	*70%*	*0%*	*20%*	...
Mostly neutral	*50%*	*40%*	*10%*	*70%*	*60%*	*60%*	*40%*	*10%*	*60%*	*50%*	...
Detrimental	*0%*	*0%*	*0%*	*0%*	*0%*	*10%*	*0%*	*0%*	*20%*	*0%*	...
Unsure	*0%*	*0%*	*0%*	*20%*	*0%*	*20%*	*10%*	*20%*	*20%*	*30%*	...

Figure 5: Summary of answers to first ten answers to Part 1 of Saflex's questionnaire

The same coding process is followed for all other questions in Part 1. The results are then summarized in a table. Figure 5 shows this summary for the first ten questions of Part 1 of Saflex's questionnaire.

	Respondent	**Coding the answers to $Q2_{6,7}$ from Part 2 of Libica's questionnaire**	Incompatibility
Individual 1	1	*It is somewhat compatible*	
Individual 2	2	*It is somewhat compatible*	
Individual 3	3	*It is somewhat incompatible*	✓
Individual 4	4	*I'm not sure about this one*	
Individual 5	5	*I'm not sure about this one*	
Individual 6	6	*It is somewhat incompatible*	✓
Individual 7	7	*It is somewhat incompatible*	✓
Individual 8	8	*It is somewhat compatible*	
Individual 9	9	*Yes, it is totally compatible*	
Individual 10	10	*It is somewhat incompatible*	✓
	11	*No, it is totally incompatible*	✓
	12	*I'm not sure about this one*	
	13	*It is somewhat compatible*	
	Percentage of incompatibilities		*38%*

Figure 6: Answers to question Q26,7 of Libica's questionnaire

Figure 6 lists the answers that respondents provided to question $Q2_{6,7}$ from Part 2 of Libica's

questionnaire.

The same coding process is followed for all other questions in Part 2 of the questionnaire. The results are then summarized in a table. Figure 7 shows this summary for a few questions.

	...	$Q2_{5,12}$	$Q2_{6,7}$	$Q2_{6,8}$	$Q2_{6,9}$	$Q2_{6,10}$	$Q2_{6,11}$	$Q2_{6,12}$	$Q2_{7,8}$	...
Compatible	...	*73%*	*38%*	*27%*	*73%*	*82%*	*100%*	*91%*	*54%*	...
Incompatible	...	*9%*	*38%*	*73%*	*9%*	*18%*	*0%*	*0%*	*38%*	...
Unsure	...	*18%*	*23%*	*0%*	*18%*	*0%*	*0%*	*9%*	*8%*	...

Figure 7: Table with coded answers to Part 2 of Libica's questionnaire

A similar process is used to code answers from Part 3.

Arranging answers in the matrices

Following Step 5 from the Appendix, coded answers are arranged in the evaluation matrices. Figure 8 provides an example of an FT-ST Matrix with 'Supportive' values, from the Saflex project. As threshold value we used 50%. All cells with values equal to or larger than this threshold have been shaded in gray.

	FT1	FT2	FT3	FT4	FT5	FT6	FT7	FT8
ST1	50%	10%	70%	70%	60%	10%	50%	60%
ST2	60%	50%	60%	20%	90%	20%	40%	50%
ST3	90%	70%	80%	10%	89%	40%	70%	0%
ST4	10%	0%	50%	10%	20%	0%	10%	30%
ST5	40%	20%	60%	50%	50%	20%	30%	40%

Figure 8: Saflex's FT-ST Matrix showing the 'Supportive' values

Figure 9 is example of an FT-ST Matrix with 'Detrimental' values, based on the Saflex answers. All cells with values equal to or larger than 50% have been shaded in gray.

	FT1	FT2	FT3	FT4	FT5	FT6	FT7	FT8
ST1	50%	60%	20%	30%	40%	80%	50%	40%
ST2	40%	40%	30%	70%	10%	70%	60%	50%
ST3	10%	10%	20%	30%	0%	60%	30%	70%
ST4	70%	60%	50%	80%	60%	80%	90%	70%
ST5	60%	50%	30%	50%	40%	50%	60%	50%

Figure 9: Saflex's FT-ST Matrix showing the 'Detrimental' values

Figure 10 shows an FT-FT Matrix with 'Incompatible' values from our project with Libica. As threshold value we used 33%. All cells with values equal to or larger than this threshold have been shaded in gray.

	Focus our efforts in efficient distribution	Move towards value-added services	Deliver fast, accurately, safely and reliably	Operate using lean principles	Improve profitability through customer and product mix	Address the direct-to-store and bulk needs of national accounts	Address the delivery and other special needs of workshop customers	Help independent retailers be more competitive	Simplify things for us in our interaction with the customer	Collaborate with our suppliers, but not in all relevant areas	Manage through clear and well communicated objectives	Improve the impact of our workforce
Focus our efforts in efficient distribution												
Move towards value-added services	0%											
Deliver fast, accurately, safely and reliably	0%	27%										
Operate using lean principles	0%	0%	0%									
Improve profitability through customer and product mix	27%	18%	18%	9%								
Address the direct-to-store and bulk needs of national accounts	0%	0%	0%	0%	9%							
Address the delivery and other special needs of workshop customers	9%	0%	9%	0%	15%	38%						
Help independent retailers be more competitive	0%	0%	0%	0%	9%	73%	38%					
Simplify things for us in our interaction with the customer	0%	0%	0%	0%	23%	9%	0%	18%				
Collaborate with our suppliers, but not in all relevant areas	0%	0%	0%	0%	10%	18%	0%	0%	18%			
Manage through clear and well communicated objectives	0%	0%	0%	0%	0%	0%	0%	18%	0%	8%		
Improve the impact of our workforce	8%	0%	0%	0%	9%	0%	0%	15%	0%	9%	0%	

Figure 10: Libica's FT-FT Matrix showing the 'Incompatible' values

Reading the matrices for insights

Following Steps 6 and 7 from the Appendix, the matrices are read for insights. For example, inspection of Saflex's FT-ST Matrix showing the 'Supportive' values (Figure 8), demonstrates

that FT3 is largely supportive of all strategic themes. Likewise, Saflex's FT-ST Matrix showing the 'Detrimental' values (Figure 9), shows that FT6 is largely detrimental to all strategic themes. By inspection, it is clear that all functional themes are largely detrimental to ST4.

Expressing verbally and graphically the most outstanding relationships found in the matrices helps us derive finer-grained insights. For example, consider Libica's FT-FT Matrix of *'Incompatible'* values. As shown in Figure 10, we highlighted five cells, which correspond to five incompatibility relationships: FT6-FT8; FT6-FT7; FT7-FT8; FT1-FT5; FT2-FT3. From Libica's FSM we know the seven functional themes involved are:

- FT1, "Focus our efforts in efficient distribution"
- FT2, "Move towards value-added services"
- FT3, "Deliver fast, accurately, safely and reliably"
- FT5, "Improve profitability through customer and product mix"
- FT6, "Address the direct-to-store and bulk needs of national accounts"
- FT7, "Address the delivery and other special needs of workshops"
- FT8, "Help independent retailers be more competitive"

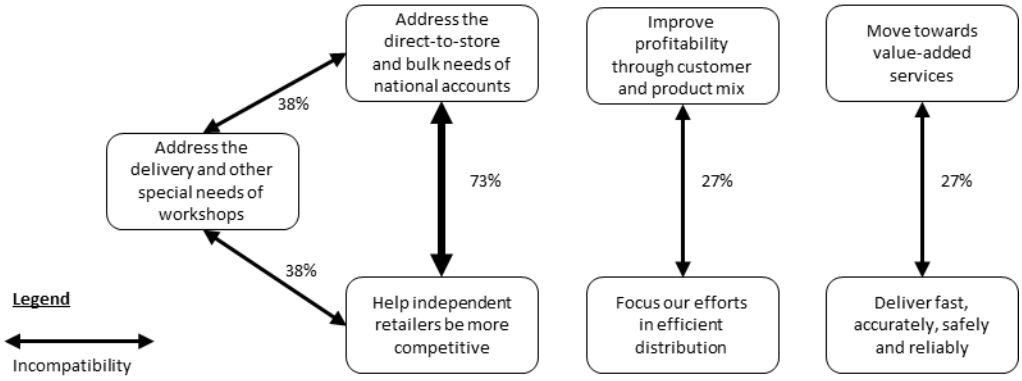

Figure 11: Graphical representation of the incompatibilities among Libica's FTs

We can express each incompatibility relationship verbally. For example, the incompatibility between FT6 and FT8 can be expressed verbally as follows: "Addressing the direct-to-store and bulk needs of national accounts is at least partly incompatible with helping independent retailers be more competitive." We can also express the incompatibilities *graphically*. For example, all

five incompatibilities found in Libica's FT-FT Matrix can be expressed graphically as shown in Figure 11. A conceptual map communicates all five incompatibilities in a clean and concise manner.

Coverage evaluation

Our work with Saflex provides an example of how we can infer coverage issues from comments made during the validation session for the final map. During the session to validate Saflex's FSM, one of the members of the team made a comment: the map seems to be silent about the organizational structure that should govern the supply chain. Should the supply chain team belong to the business unit exclusively, to the corporation exclusively or be a mix of both? So we made a note of "Organizational structure" as an area of interest not properly addressed by the existing supply chain strategy, e.g. a coverage shortcoming.

The Saflex case provides another example. In a session held to discuss the findings of the alignment evaluation, comments made hinted to a missing area. Several members of the group commented that the supply chain would be better off if they could collaborate with suppliers and customers. Given these comments and noticing the FSM had no reference to collaboration, "Collaboration with other supply chain parties" was added as a coverage shortcoming.

The case with Libica provides an example of inferring coverage issues from comments made during the validation of partial maps. Asked to provide individual feedback on the partial maps, three different respondents pointed out that there was a need of collaboration with customers, particularly large national accounts. One respondent suggested "adding a section for collaboration with customers." Another person described it as a need for: "establishing a strategic relationship with national chain customers." A third one also mentioned the same idea. Thus, "Collaboration with customers" was noted as a coverage gap.

Sufficiency evaluation

Let us illustrate how to search the data for sufficiency shortcomings, in the form of 'grievances,' with a few examples taken from an interview with Libica. The respondent described an issue Libica had recently experienced with its largest customer, which we call ACME. The respondent told us that just 'wrapping [their] arms around the issue' had taken four months, and gaining access to ACME's facilities to explore the root causes of the problem took 60 days. The respondent mentioned this as an example of the lack of collaboration between Libica and some major customers, making the point that had there been more of a partnership in place, a solution to the problem would have come faster. Asked what he wished Libica had done differently in the past so that problems like this would be avoided, the respondent said: "I wish that Libica was a more customer-focused organization, from the beginning." Asked to clarify what he meant by "more customer-focused," he replied: "Where we are now is that we have resources that face towards our manufacturers … and then when you look on the customer side, due to the nature of the business … I think we've lost the ability to really understand how our customers make money and how we help them make money." The respondent then went on to describe how they have lost focus of how easy or difficult it is to do business with Libica. "We've been tough to do business with. Our first answer tends to be 'no' when a customer asks for something. We become more difficult to work with, and as we become more difficult to work with, solving problems becomes more difficult. The bigger the problems, the longer they last, the more money gets lost by everybody. That's what I mean by customer-focused."

While extracting data from this interview, we wrote down the following 'grievances':

- Four months to wrap arms around issue of labeling ACME; two months just for access.
- Develop a reputation for being difficult to work with.

- Focus on driving higher margins from suppliers, at the expense of customer satisfaction.
- When customers approach us with ideas, often our first answer is "no."

Then all grievances are consolidated in a list. Table 2 lists the grievances identified while listening to the Libica interviews and sessions. These grievances have been organized thematically. In the table, '*we/us*' refers to Libica.

Grievances on the supply-side
• *We have to give a higher priority to routine operational collaboration with manufacturers:* - *We have to work with manufacturers to resolve problems. Presently, our supply chain guys have no ongoing working relationships with their supply chain guys.* - *We have to give a higher priority to collaboration to 'routinize' orders. Presently, we have 20 people expediting orders. This indicates a problem in the routine ordering procedures.*
Grievances on the demand-side
• *We suffer from a lack of collaboration with largest customer in certain key areas:* - *Collaboration to identify and solve problems is not good with ACME, our largest customer: e.g. it took us 4 months to wrap arms around issue of labeling, 2 months just for gaining access.* • *We have developed a reputation for being hard to work with:* - *When customers approach us with ideas, often our first answer is "no."* • *We have not paid enough attention to customer satisfaction:* - *The speed and completeness of customer serviced deteriorated as existing relationships between CSRs and customers were lost with the CS centralization. The 'pod' of CSRs answering a customer's calls is larger than before.* - *Service level (i.e. order fulfillment) leaves much to be desired.* - *It takes longer to set up a new customer account with us than with others (including smaller regional players.)* • *Our ordering system has to be improved:* - *Lack of backorder capability in the ordering system encourages ghost orders.* - *The customer will most likely have to place the order again. This is extra work for them.* - *The system cannot tell apart new orders from repeat unfulfilled demand. This confounds our demand data.*
Grievances regarding internal affairs
• *Work to be done in gaining trust of employees:* - *Recent surveys found significant distrust of employees towards management.*

Table 2: Summary of grievances from Libica exercise

6. DISCUSSION

Assessing the efficacy of the approach

Since the impacts of a given supply chain strategy are felt over many years, during which a multitude of other factors affect the performance of the firm, it is difficult to verify experimentally the efficacy of this or any other strategy evaluation and setting method. Instead,

we rely on the organization itself, on the feedback from the executives heading the supply chain in the companies we worked with. We submit that evidence in support of our method is found in comments made by the project sponsors.

During the session with Saflex to validate the evaluation findings, the VP of Supply Chain said of these following: “You've hit the nail in the head.” He added: “This is a very good crystallization of things.” On the evaluation report, he said: “The report highlights the key issues. … You managed to find the key conflicts.” Commenting on a 3-way conflict we had found in Saflex’s current supply chain strategy, he commented: “The 3-way conflict is a very, very important item right now.”

Likewise in the Libica, VP of Operations and Supply Chain commented during our final meeting that his reaction to being faced with the 3-way conflict shown on the left hand side of Figure 11 was like an epiphany: “To me, it was like a light bulb went off…,” he said, adding that he realized then that: “We are trying to do everything!... And that was clear from the material.” Here, ‘the material’ refers to the evaluation matrices and the graphs he was shown during the validation session.

A little piece of anecdotal information, in which we take some pride, is that in the case of both firms the sponsors of our project were promoted within months of their project’s completion. The commitment of these sponsors to see the projects through takes particular relevance when we consider that the method being tested was new, that it required a non-negligible commitment of time from a team of senior members, and that these trials were conducted during a time of financial crisis.

Assessing the transportability of the approach

The transportability of the approach was tested with graduate students: a guide, similar to

that shown in sections 4 and 5 and in the Appendix, was provided to graduate students in a masters-level supply chain strategy class in Boston, where 25 students applied the evaluation method to data collected from the Saflex exercise, as part of a project. A second group of 12 students, as part of a supply chain strategy seminar in Bogota, were asked to apply the evaluation method to a case study chosen by them. These students built an evaluation matrix on their own, collected data to complete it and analyzed it to derived insights. They also identified shortcomings in coverage and sufficiency. These results suggest the method is transportable.

A foundation for moving forward

Saflex's VP of Supply Chain told us, before conducting the exercise with us, that he had been looking in the literature for a "roadmap to do" supply chain strategy, but found none. "There are many books about strategy," he said, "but they are basically theory," as opposed to a real-world, actionable "process that we can walk." After our exercise with our method, he commented on the evaluation exercise: "Your system seems to be able to single out and capture the fundamental issues we're struggling with." He added: "I think we have a foundation for moving forward."

External vs internal wisdom

The approach we propose gives members of the firm an opportunity to evaluate their supply chain strategy in their own terms, according to their own understanding and knowledge of their business. It seeks to take full advantage of the *internal wisdom* of the organization, while minimizing the reliance on *external wisdom* taken from the literature. It is, borrowing the concept from anthropology, more of an *'emic'* approach, in that it keeps things in the same terms used by the organization. It avoids bringing into the process any *'etic'*, foreign concepts.

The cost of being true to self

The approach we propose relies heavily on the members of the organization to conduct tasks

that may be –in the words of a participant – *"tedious"*: there is a feeling of repetition in answering the questionnaires, and the respondents may feel the weight of the process heavy on their shoulders. However, this reliance on the team members, which could be the method's most important downside, is also its biggest strength. By following this *'true to self'* approach, we allow the group the opportunity to evaluate their supply chain strategy in their own terms and words, according to their own understanding and based on their own knowledge of their business.

Looking outside from the inside

An interesting and unexpected insight for us was that, even though the evaluation method may come across as 'introspective', it actually led to useful insights about the need for external relationships. While validating the findings of the evaluation with Saflex team, participants would often volunteer mechanisms to improve the situation, along the lines of: "You know, about this problem… if we could improve our collaboration with our suppliers, then we could make this better", or "If we could convince our buyers that it is in their best interest to provide us with accurate information on X, then this situation would improve", etc. Almost every conflict had a flip-side, in the form of an "if" idea involving, very frequently, an improved collaboration with other players of the supply chain.

Thus, an unexpected conclusion from our research, which was originally focused on the internal coherence of a firm's supply chain strategy, is that improving the internal conflicts often requires the strengthening of external relationships, through collaboration and partnership. A similar experience occurred with Libica, where many of the conclusions pointed to the need to improve collaboration with both suppliers and customers. This assuages – at least in part – the concern that the evaluation may result exclusively in internal insights, given that it was made

considering the supply chain strategy as a system of ideas in itself, with no explicit provisions for the external environment.

7. CONCLUSSION

In this paper we have presented an approach to evaluate a firm's supply chain strategy as a conceptual system. The approach uses as its starting point a conceptualization of the supply chain strategy known as a functional strategy map, or FSM. It seeks to free the firm from reliance on *external wisdom*, that is, knowledge derived in other settings that may or may not apply to the firm's circumstances. Instead, it seeks to provide a minimum and intuitively appealing framework for the firm to conduct an evaluation of their supply chain strategy based on the *internal* wisdom of those most familiar with the target supply chain.

The approach we have proposed calls for evaluating the supply chain strategy of a firm along four general criteria. The first is *support*, a requirement that activities support the goals of the functions and the organization. The second criterion is *consistency*, the expectation that components of the supply chain strategy are compatible with each other. The third is *coverage*, which requires that all areas of interest are properly addressed. The fourth criterion is *sufficiency*, the expectation that functional and strategic goals are satisfied.

For each one of these evaluation criteria, we have proposed an evaluation method. The method we propose for evaluating *consistency* and *support* make use of a tool adapted from engineering design, known as ‘evaluation matrices,’ with the goal of exploring the relationships of support and mutual compatibility among relevant concepts taken from the FSM. Insights derived from the matrices are then discussed in a panel. The method we propose for evaluating *coverage* calls for finding gaps between the areas of interest for the firm's supply chain and the areas of activity identified in the FSM. Finally, the method we propose for evaluating *sufficiency*

requires assessing whether the stated objectives of the functions and the organization as a whole are being satisfied. We anticipate KPIs could play a role in the evaluation of sufficiency. This remains an area to be explored in future projects.

Both the proposed criteria and method were tested and refined through two action research projects. The ability of the approach to identify conflicts in the supply chain strategy provides evidence in support of its evaluative power. It revealed trouble areas that were recognized by the firm as verisimilar and relevant, and yet in some cases they were unexpected. The transferability of the method and the criteria was tested by asking students to apply it using documentation as a guide, with satisfactory results. Our deployments of the method in two projects confirmed that insights generated during the evaluation address both internal aspects and external aspects involving trading partners.

Currently we are applying the evaluation approach in two new projects, one in the US and one with a multinational corporation. Additionally, a third party is independently applying the approach to two projects in Latin America. As more replications are conducted, our understanding of the capabilities and limitations of both the criteria and the method are bound to improve. At this point, nevertheless, the method and criteria have shown enough promise to warrant further exploration and refinement, and represent a novel contribution to the literature.

APPENDIX

A detailed method for evaluating consistency and support

Step 1 - Prepare empty matrices based on FSM

We use the FSM as starting point to create three empty evaluation matrices. The purpose of these empty matrices is twofold: first, they serve as a guide regarding what questions to ask, and second, they provide a template which can be used to summarize and arrange the answers.

The first empty matrix to be built is called the FT-ST Matrix. Its purpose is to explore the support that functional themes provide to the strategic themes. In this matrix, the functional themes serve as column headings, while the strategic themes serve as row headings. Let N_{FT} be the number of functional themes and N_{ST} the number of strategic themes found in the FSM, then this will be a N_{FT} x N_{ST} matrix.

The second empty matrix to be built is called the FT-FT Matrix. Its purpose is to explore the compatibility between the functional themes. In this matrix, the functional themes serve as both row and column headings. The FT-FT Matrix is a N_{FT} x N_{FT} matrix. More than half of its cells need not be explored since the matrix is symmetric by definition and the diagonal is trivial. The number of active cells - which include information - in the FT-FT matrix is then $(N_{FT}^2 - N_{FT})/2$.

The last empty matrix is the OT-FT Matrix, which has the purpose of exploring how necessary the operational themes are to their parent functional themes. In this matrix, the individual operational themes serve as column headings, while the functional themes are used as row headings. Letting N_{OT} be the number of operational themes, the OT-FT Matrix is a N_{OT} x N_{FT} matrix. However, since we are only interested in exploring how necessary an operational them is for its parent functional theme, cells that do not belong to a child-parent pair ("non-active" cells) need not be explored.

Step 2 – Create a questionnaire based on the matrices

In step 2 the analyst has to prepare a three parts questionnaire.. Each empty matrix created in Step 1 serves as basis for generating one part of the questionnaire. In turn, each active cell in these matrices serves as basis for a question.

For each cell in the FT-ST Matrix we prepare a question, asking about the support that the functional theme heading the cell's column provides to the strategic theme heading the cell's row.

A total of N_{FT} x N_{ST} questions are written; a sample layout is shown in Figure 12.

FT-ST Matrix		Functional Themes			
		1	2	3	4
Strategic Themes	1	$Q1_{1,1}$	$Q1_{2,1}$	$Q1_{3,1}$	$Q1_{4,1}$
	2	$Q1_{1,2}$	$Q1_{2,2}$	$Q1_{3,2}$	$Q1_{4,2}$
	3	$Q1_{1,3}$	$Q1_{2,3}$	$Q1_{3,3}$	$Q1_{4,3}$
	4	$Q1_{1,4}$	$Q1_{2,4}$	$Q1_{3,4}$	$Q1_{4,4}$

Figure 12: Sample question layout in ST-FT Matrix for Part 1 of the questionnaire

The wording for the questions is as follows: for cell (i,j) the question reads "[Functional Theme i] helps our goal of [Strategic theme j]". The respondent is offered a series of answer choices in the form of a Likert scale (Brill, 2008):

- *Yes! It is crucial*
- *Yes, it significantly helps*
- *It may help, but only a little*
- *It makes no difference*
- *It may hurt, but only a little*
- *No, it significantly hurts*
- *No! It is terrible*
- *I am not sure*

For each active cell in the FT-FT Matrix we prepare a question. The question asks about the compatibility between two functional themes, the one heading the cell's column and the one heading the cell's row. A sample layout is shown in Figure 13.

FT-FT Matrix		Functional Themes			
		1	2	3	4
Functional Themes	1				
	2	$Q2_{1,2}$			
	3	$Q2_{1,3}$	$Q2_{2,3}$		
	4	$Q2_{1,4}$	$Q2_{2,4}$	$Q2_{3,4}$	

Figure 13: Sample question layout in FT-FT Matrix for Part 2 of the questionnaire

The wording for the questions is as follows: for cell (i,j), where i>j, the question reads "[Functional Theme i] is compatible with [Strategic theme j]". The respondent is offered these answer choices:

- *Yes, they are totally compatible*
- *They are somewhat compatible*
- *They are somewhat incompatible*
- *No, they are totally incompatible*
- *I'm not sure*

For each active cell in the OT-FT Matrix we prepare a question asking how necessary the operational theme heading the cell's column is to the functional theme heading the cell's row. A sample layout is as shown in Figure 14.

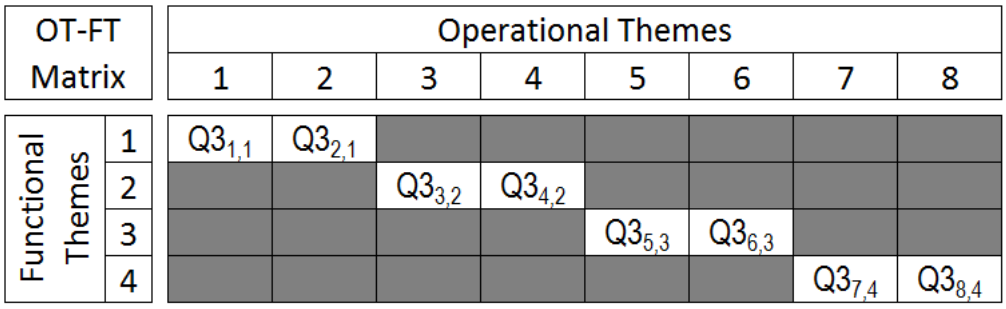

Figure 14: Sample question layout in OT-FT Matrix for Part 3 of the questionnaire

The wording for the questions is as follows: for cell (i,j) the question reads "[Functional Theme i] is necessary for [Strategic theme j]". The respondent is offered answer choices in the form of a Likert scale:

- *Yes, it is necessary*
- *It may help, but only a little*
- *It makes no difference*
- *It may hurt, but only a little*
- *No, it is detrimental*
- *I'm not sure*

Step 3 – Administer the questionnaires to respondents

The questionnaire assembled in Step 2 is administered to a group of respondents, chosen

from the different areas relevant to supply chain activities. Respondents are asked to answer all three parts of the questionnaire individually to ensure the anonymity of the answers and to promote creative thinking (Taylor, Berry and Block, 1958).

Step 4 - Code the answers into a values

The answers provided by individual respondents to the questionnaire are coded in order to be analyzed. This section presents a recommended approach to the basic coding of the data.

An approach that has proven useful to code the data obtained from Part 1 of the questionnaire is to calculate the percentage of the respondents who described the relationship between an FT and an ST as *'Supportive'* (e.g. those who replied either *"Yes! It is crucial"* or *"Yes, it significantly helps"*). Calculate also the percentage who described it as *'Detrimental '* (replying *"No, it significantly hurts"* or *"No! It is terrible"*). Calculate the percentage who described it as *'Mostly neutral'* (namely, those who replied *"It makes no difference," "It may help, but only a little," or "It may hurt, but only a little"*). Finally, calculate the percentage that was '*Unsure'* (replying *"I am not sure"*). An example of this is provided in the main text (see Figure 5.)

A similar approach works for coding the data obtained from Part 2. For each question, calculate the percentage of respondents who describe the relationship between a pair of FTs as *'Compatible'* (replying *"Yes, they are totally compatible"* or *"They are somewhat compatible"*). Calculate the percentage who described it as *'Incompatible'* (replying *"No, they are totally incompatible"* or *"They are somewhat incompatible"*). Finally, calculate the percentage that was '*Unsure'*. An example of this is provided in the main text (see Figure 7.)

The same approach is useful to code data obtained from Part 3 of the questionnaire. Calculate the percentage of the respondents who describe an OT as being *'Necessary'* for its parent FT (replying *"Yes, it is necessary"*), those who described it as being *'Detrimental'* (replying *"No, it is*

detrimental"), and those who described it as being *'Mostly neutral'* (replying either *"It makes no difference," "It may help, but only a little,"* or *"It may hurt, but only a little"*). Calculate also those who were *'Unsure.'*

Step 5 – Arrange values into matrices

The values calculated in Step 4 are arranged into a series of matrices, built using as template the empty matrices from Step 1.

The four types of values calculated from Part 1 answers will be arranged in four separate matrices, using as template the empty FT-ST Matrix. Each value is put in the cell that corresponds to the question whence it was calculated. Two examples are provided in the main body.

Likewise, the three types of values calculated from Part 2 answers will be arranged in three matrices, using as template the empty FT-FT Matrix. Each value is put in the cell that corresponds to its question. An example is provided in the main body.

Finally, the same is done for the four types of values calculated from Part 3 answers. They will be arranged in four matrices, using as template the empty OT-FT Matrix, putting each value in the cell that corresponds to its question.

Step 6 - Identify the top values in each matrix

To facilitate reading the matrices prepared in Step 5, highlight the largest values they contain. For each matrix, select a threshold value and highlight the cells that contain values equal or larger than the threshold. Since no threshold value applies in all instances, the recommendation is to try out different thresholds values. We have used 50%, 33% and 25% as thresholds, to highlight values that indicate when at least half, a third or a quarter of respondents, respectively, answered in a given way. Main body provides an example.

Step 7 – Derive insights from the analyzed matrices

There are several ways to derive insights from the matrices. A simple approach is by inspection. Another approach is to express, both verbally and graphically, the relationships that correspond to the highlighted values in each matrix. Verbally, each relationship can be expressed using a statement of the form: *"X% of respondents expressed that Y supports Z;" "X% of respondents expressed Y is detrimental for Z;"* or *"X% of respondents expressed there is an incompatibility between Y and Z,"* etc. Graphically, several relationships can be expressed using a conceptual diagram, where concepts are depicted as boxes, with lines connecting them to illustrate relationships of incompatibility, support, detriment, etc. Examples are provided in the main text.

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