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Lessons learned from methodological triangulation in management research

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Abstract

Purpose – The purpose of this paper is to leverage the lessons learned from three published studies on volume flexibility in the capital goods industry to demonstrate the effective use of methodological triangulation in operations management research.

Design/methodology/approach – The paper uses lessons learned from three published studies to address several issues that researchers encounter when using methodological triangulation. It also develops a coherent framework for developing a research strategy that uses methodological triangulation.

Findings – In demonstrating the use of triangulation, the paper documents several tradeoffs that researchers face including: outlining a triangulation strategy; considering the strengths and weaknesses of different data sources; assessing convergent, complementary divergent and meta inference; and paying attention to errors of inference during the triangulation process.

Research limitations/implications – As with every research method, methodological triangulation has limitations that can be amplified by method specific issues and assumptions related to across-method generalization and inference.

Practical implications – Provides a detailed example of why and how researchers make critical decisions on the appropriate use of methodological triangulation.

Originality/value – This work will assist future researchers who use triangulation to better position their work and to make informed choices that ultimately lead to more complete theories. This work would also be on interest to practitioners interested in keeping up with academic literature.

Keywords Operations management, Research methods, Management research

Paper type Research paper

Introduction

Triangulation combines several research methodologies to study the same phenomenon (Denzin, 1970). Complementary methods are deployed under the assumption that weaknesses inherent in one approach will be counterbalanced via strengths in another. This paper presents several lessons learned in the course of completing a triangulated study of volume flexibility in the capital goods industry. The fundamental tenet of triangulation is the application of several method-appropriate strategies for assessing the phenomenon. Thus, several different questions can be asked about the same phenomenon and the appropriate method used for each question. Often the purpose of triangulation in specific contexts is to obtain confirmation of findings through convergence of different perspectives. The point at which the perspectives converge is seen to represent reality.

The primary objective of this paper is to exemplify the use of methodological triangulation and articulate alternatives and tradeoffs that will assist future

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researchers who attempt triangulation. Here, we focus on triangulation for three reasons. First, we want to communicate a coherent framework for developing a research strategy that uses methodological triangulation. This will assist future researchers who use triangulation to better position their work and make informed choices during the conduct of the study that can ultimately lead to more complete theories. Second, we use lessons learned from three published studies to address several issues that researchers encounter when using methodological triangulation. This effort also supports the growing but under-represented body of empirical research particularly in the operations management literature (Scudder and Hill, 1998). Third, we show how triangulation can also be used to replicate prior research and make valuable contributions to management research (Amundson, 1998).

Types of triangulation

The triangulation metaphor is taken from navigation and military strategy, which "use multiple reference points to locate an object's exact position" (Clark, 1951). Originally used in social sciences and psychology (Smith, 1975), several management studies have now used triangulation to resolve difficulties in interpretation and theory building. Since the early efforts of Denzin (1970), triangulation studies have gone beyond the initial focus on eliminating weaknesses in any one method. There are five basic types of triangulation. First, data triangulation strengthens research findings by using multiple ways to collect and analyze data involving time, space, and persons. Second, investigator triangulation consists of the use of multiple, rather than single observers. Third, multiple triangulation refers to the situation where the researcher combines in one investigation multiple observers, theoretical perspectives, sources of data, and methodologies. Fourth, theory triangulation consists of using more than one theoretical scheme in the interpretation of the phenomenon. Fifth, methodological triangulation involves using more than one quantitative or qualitative data sources or methods in a single of research (Jick, 1979).

There are three rationales frequently given for using methodological triangulation. The first is completeness, which recognizes that following McGrath (1982), any single research method chosen will have inherent flaws, and the choice of that method will limit the conclusions that can be drawn. It is therefore essential to obtain corroborating evidence from using a variety of methods that can be classified generally as either qualitative or quantitative. Quantitative and qualitative methods complement each other, providing richness or detail that would be unavailable from one method alone. The second rationale is contingency, which is driven by the need for insights into how and why a particular strategy is chosen. For example, qualitative research is often used when a phenomenon is very complex or poorly understood. Such contingent choices of methodology are often dictated by newness – discovery of environmental attributes that give rise to the phenomenon are necessary before we can quantify (and measure) such attributes. Interviews with managers, critical incident analysis, document reviews, and an interpretive mode of assessment can orient researchers to the nuances of how and why, for example, different strategies and tactics are deployed. The results may suggest hypotheses to be tested by quantitative methods. Qualitative investigation can also help organize quantitative data that have already been gathered or suggest new ways of approaching the phenomenon. The third rationale for triangulation is confirmation. Triangulation should improve the ability of researchers to draw conclusions from their studies and might result in a more robust and generalizable set of findings (Knafl and Breitmayer, 1989). Traditional criteria like

reliability and validity are replaced by the level of symmetry between alternative methods used. By combining multiple data sources, alternate observers, distinctively different theories, alternate methods, and varying empirics, the researcher hopes to overcome the intrinsic biases arising from single method, single-observer, and single-theory studies.

Unlike other efforts in the general management literature, the use of triangulation in operations management research has been limited. Many researchers using the quantitative survey-based approaches have argued for rigorous field studies (qualitative approaches) before conducting the survey thereby implying triangulation. In general, such triangulated efforts can be found in several areas of operations management research including well known streams of research in the area of operations strategy (the Harvard studies), world class manufacturing (the Minnesota studies), customer contact, cellular manufacturing and other empirical but primarily quantitative or qualitative efforts.

Methodological triangulation using three published studies

We rely on three published studies (see Table I) to present our triangulated findings and lessons learned in methodological triangulation. Each of these studies focused on volume flexibility, which is defined as "the extent of change and the degree of fluctuation in aggregate output levels, which the system can accommodate without incurring high transition penalties or large changes in performance outcomes" (Koste and Malhotra, 1999). It is noteworthy that while the three studies have been published, the reflective synthesis presented in this paper has not been previously presented. Therefore, in order to avoid repetition, we make every effort to point the reader to the detailed information contained in the three completed studies. However, in order to guide the reader through this analysis, we summarize each of the studies below.

The first and second studies (Jack and Raturi, 2002) were complementary and were published as a single paper. The first study used three in-depth case studies to examine the detailed context and background of the drivers, and sources of volume flexibility. While all three firms were in the capital goods industry, one was a small computer equipment manufacturer, another was a producer of industrial air filtration systems, and the third was a manufacturer of industrial screeners and separators. We found that in all three firms, there was significant concern among managers for gaining competitiveness through volume flexibility. We also found that there were several avenues for developing a volume flexible response and that deployment of these tactics was dependent on the availability of resources and systems.

Since all three case study firms used different approaches and derived differential benefits, it was challenging to relate the sources of volume flexibility to performance. Therefore, in the second study (Jack and Raturi, 2002), we built on our findings from the case studies and then surveyed a broad sample of operations managers in order to understand their perceptions about the sources of volume flexibility and their impact on performance. Thus, our second study focused on responses from a survey of 140 operations managers who were primarily responsible for developing systems and infrastructure for generating a volume flexible response. We analyzed the survey data using structural equation modeling that validated the positive linkages between the sources of volume flexibility and firm performance. Our critical finding suggested that short- and long-term sources of volume flexibility have a positive, albeit differential, impact on a firm's performance.

	Study 1	Study 2	Study 3
Published papers	Jack and Raturi (2002)	Jack and Raturi (2002)	Jack and Raturi (2004)
Context and setting	We found no studies that use qualitative methods to understand how and why firms develop a volume flexibility strategy.	While several studies have used surveys to measure managerial perceptions about volume flexibility, none of these identify the sources of volume flexibility and link them to firm performance.	While previous studies have used quantitative methods to measure volume flexibility, none of these measures simultaneously consider the three components suggested by deGroote (1994): environmental uncertainty, responses to uncertainty, and performance outcome.
Objectives	To understand the context and background of the drivers and sources of volume flexibility	To understand the impact of the sources of volume flexibility on firm performance	To develop process-based measures of volume flexibility and compare them in small and large firms
Research Design	Case study	Survey research	Cross-sectional secondary data analysis
Data sources	Three firms in the capital goods industry computer parts manufacturer air filtration manufacturer and industrial screeners manufacturer	Survey responses from 750 operations managers in mid-western USA	Twenty years of data on 550 firms in 29 capital goods industries (SICs 3510-3590)
Hypotheses and propositions	Eleven propositions that identify the drivers and sources of volume flexibility	Ten hypotheses that identify the sources of volume flexibility and link them to firm performance	Five hypotheses that measure and compare process-based measures of volume flexibility in small and large firms
Analytical methods	Use Eisenhardt's (1985) methodology for case study design and analysis	Item analysis, factor analysis, ANOVA, regression analysis, and structural equation modeling	Regression analysis
Validity established	Internal validity	Internal validity, external validity, construct validity, and statistical conclusion validity	Internal validity, external validity, and statistical conclusion validity
Results	Internal sources include: equipment and capacity buffers, inventory buffers, and workforce flexibility External sources include: outsourcing arrangements, supply and distribution networks, strategic alliances	Internal sources and external sources have a positive impact on a firm's volume flexibility capability Short-term and long-term sources have a positive impact on a firm's VF capability	Output of large firms fluctuate more than that of small firms Small firms use their inventory more efficiently than large firms in responding to demand fluctuations

Table I.
Summary of three triangulated studies on volume flexibility

(Continued)

	Study 1	Study 2	Study 3
	Short-term include: internal sources Long-term sources include: external sources and adjustments to internal sources.	VF capability has a positive impact on firm performance.	Small firms use their process technology more efficiently to respond to demand fluctuations Small firms use a combination of inventory buffers and process technology more efficiently to respond to demand fluctuations When we incorporate profitability directly in to the volume flexibility measure, large firms are more volume flexible.
Conclusions	Small firms rely less heavily on external and long-term sources of volume flexibility than large firms do.	Large firms are ultimately more volume flexible because they use their resources and influence to secure more sources of volume flexibility than small firm do.	While small firms may be more efficient, large firms are ultimately more volume flexible because they are able to fluctuate their output more profitably than small firm can.

Table I.

In our third study (Jack and Raturi, 2004), we used 20 years of financial performance data from 550 firms in 29 capital goods industries to test the effectiveness of alternative sources of volume flexibility. In this study, we developed four measures of volume flexibility using the principle that a volume flexible firm can handle similar levels of uncertainty (as measured by sales variability) with smaller fluctuations in inputs (as measured by variability in cost of goods sold and variability in inventory levels). Our findings suggest that although small firms may be more volume flexible, they have difficulty benefiting from this capability. Two critical conclusions from these studies are that the ability to be volume flexible does create long-term strategic value for a firm and that these firms can benefit by adopting a methodical process for establishing the needs and sources of volume flexibility.

Lessons learned from methodological triangulation

Based on our three studies of volume flexibility in the capital goods industry, there are five lessons to be learned from the use of methodological triangulation. These lessons provide insights into the strengths, weaknesses, and tradeoffs involved in using a triangulated approach (secondary data, case studies, and field survey) to measure volume flexibility and relate it to firm performance. In conducting these three related studies, we started with the premise that the multi-method approach would grant us significant advantages of validity inference and generalizability. The lessons focus on how researchers can achieve the following benefits in their research strategy:

- completeness by using methods with complementary strengths and non-overlapping weaknesses;

- confirmation, consistency, and interpretive agreement by using convergent, complementary, and meta inference; and
- contingencies by paying attention to divergent inferences, inference, operational and population transferability, and common error types.

Lesson 1: Develop a strategy for triangulation

Methodological triangulation can be conducted in many different ways. However, the first task is for researchers to develop an appropriate strategy that can leverage the many facets of triangulation. As such, several probing questions need to be asked and answered at the outset as follows:

- Are multiple methods used at any stage of research? The issue of using multiple methods and picking these methods consciously to benefit theory development (as opposed to opportunistic choices) is central to triangulation. In our project, we consciously chose case method and survey research; the use of secondary data analysis (study 3) was somewhat opportunistic since COMPUSTAT readily provided the kind of secondary data we were seeking to validate the impact of volume flexibility on performance.
- Are the methods used similar? We relied on qualitative and quantitative approaches with primary data and quantitative assessments on secondary data. Alternatively, we could have used a multi-method study with primarily qualitative or quantitative data. A case approach with the firm as the unit of analysis and an ethnographic study focusing on the choices of a manager when faced with a volume flexibility decision were also considered.
- Are the methods separable? Our unit of analysis was a firm; and our focus was not to compare differences in results across methods (as would be true in methodological triangulation). Thus, we treated all three methods as independent and separable with some commonalities in the hypotheses considered in each method. It was our conjecture that case study would give us better answers to the drivers and sources of volume flexibility; survey research would allow us to asses the relationship of these variables to perceived performance. Finally, secondary data would allow us to validate the relationship between volume flexibility and actual performance.
- Is there any data conversion across methods? No conversions of data (qualitizing or quantizing the data) were considered in any study; we were working with new measures and constructs and felt that such attempts would be worthwhile only after we established the mono-method validity.
- Is the data collected at different levels? We considered a single unit of analysis in all three studies – the firm or the organization. An interesting mixed level extension to this work would be to assess the interpretation of volume flexibility at the firm level and triangulate it with the specific managerial decisions made by individuals to enhance volume flexibility.
- Are the methods used in parallel? The parallelism of the methods was based primarily on our need to complete the studies within a specific time frame. The studies were sequential to some extent with a one-way impact from qualitative methods (case study) to quantitative methods (survey); however, we recognized

the value of establishing iterative cycles to redefine research questions and hypotheses and emphasized concurrency in the methods.

- Is the integration of methods reciprocal? This is not applicable since we used concurrent design; however, this would be a critical issue in sequential triangulation since the extent of reciprocity would have a significant impact on completeness and convergence.
- Is any method primary or has dominance? We considered primacy of the methods and concluded that we would treat the findings from each method as equivalent. Later we discuss how this creates some problems in making valid conclusions when there is non-convergence in two methods.

Lesson 2: Choose methods with complementary strengths and non-overlapping weaknesses

In methodological triangulation, a researcher must make every attempt to choose methods that deliver robust theory at the end. This means that the methods should complement each other's strengths and subvert the other's weakness. This suggests that ideally, the research question(s) should drive the selected research methodology. While this may sound basic and clichéd, we believe that this is a foundational question that the researcher should address early on. For example, in our quest to find answers to several questions related to volume flexibility, we quickly discovered that no one quantitative or qualitative method could reliably provide the needed answers. Since our research objective was to build and validate theory on volume flexibility, we focused on three basic questions about the volume flexibility construct: What?, How?, and Why?.

Figure 1 summarizes the objectives, data sources, and analytical methods of the three approaches. First, the case studies were designed to address the questions

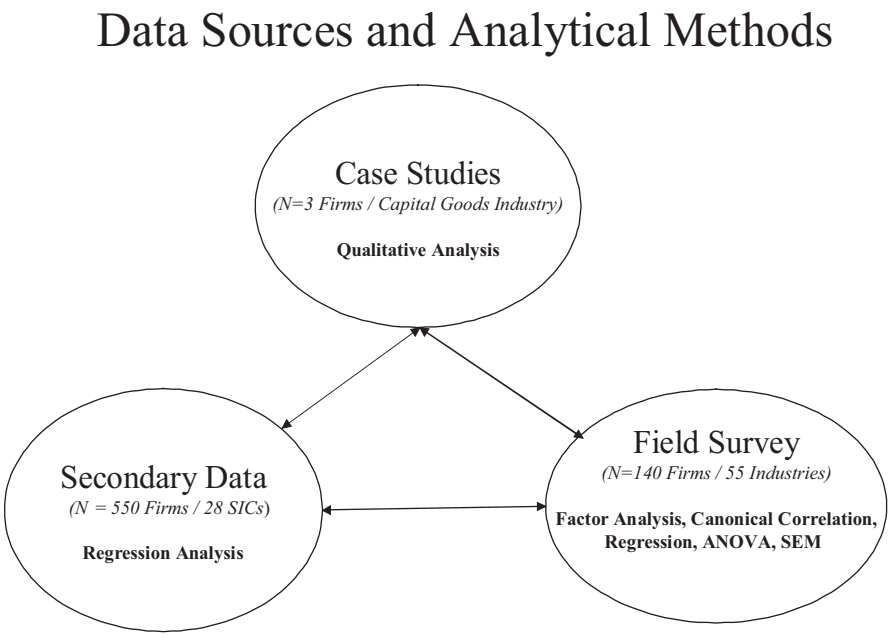

Figure 1.
Triangulated studies, data sources, and analytical methods

(How? and Why?) by focusing on the drivers and sources of volume flexibility within the firms. For example, a typical question that we asked was: Why are firms driven to adopt a volume flexibility strategy and how do they achieve it? In this study, we relied on qualitative primary data from three different firms. In the second study (field survey), we addressed the (What?) question and assessed the manager's view of volume flexibility in response to demand uncertainty. For example, in the field survey a typical question that we focused on was: What is the relationship between volume flexibility and performance? In this study, we developed a field survey instrument influenced by our findings from the case study and then collected and analyzed field survey data from 140 managers about their perceptions. Finally, the third study provides answers to the theory testing question (Who?, Where?, and When?). For example, a basic question that we investigated was: are small firms more volume flexible than large firms are? And if so, When? and Where? For this effort, we used a secondary data source (20 years of data on 550 firms from the COMPUSTAT database).

Lesson 3: Carefully consider validity when selecting the underlying research methods

Researchers should attempt to establish different types of validity when using methodological triangulation. In our case, we established four different types of validity by using these three research methods. Our unit of analysis was a firm; and our focus was not to compare differences in results across methods (as would be true in a conversion mixed method triangulation). We treated all three methods as independent and separable with some commonalities in the hypotheses considered in each method. It was our conjecture that case study would give us better answers to the drivers and sources of volume flexibility; survey research would allow us to comprehend the relationship of these variables to managerial perceptions about their firm's performance. Finally, the use of secondary data enabled us to achieve statistical conclusion validity in testing the relationship between volume flexibility and actual firm performance.

Lesson 4: Recognize that methodological issues can limit the generalizability of results

Research design and data sample selection heavily influenced the conduct, analysis, and ultimately, the generalizability of results in a triangulated study. The generalizability of our results may be limited by the three issues related to the transferability of our results. First, both data and method of analysis may limit the amount of inference transferability. For example, one could argue that the three different samples investigated in each of these studies ultimately had limited population transferability because they addressed different types of firms in the capital goods industry. However, one could also argue that we achieved operational transferability with regard to other methods of observing the volume flexibility phenomenon or measuring the attributes. Our observations in study 1 and 2, for example, created the conditions for defining a measure for volume flexibility in study 3. We observed through literature and our case study that the notion of volume flexibility must be imbedded in the process. This led to the creation of process based measures in study 3. Finally, even though, we use different measures of performance in study 2 and 3 (self-report vs direct observation), we achieve ecological transferability as we do find some convergence between the results obtained relating volume flexibility to performance across small and large firms.

Lesson 5: Build rich theories by leveraging four types of inference from triangulation

Triangulation is useful in providing four kinds of inference. First, we may observe similarities across the studies that are mutually reinforcing (complementary inference). Second, we may observe that these similarities allow us to solidify a proposition or a theory (convergent inference). Third, we observe radical differences across the studies, leading to serendipitous learning or theory development (divergent inference). Finally, triangulation allows us to step back and reflect on the general findings to generate higher level theories or frameworks (meta inference). Each of these is discussed with reference to our research on volume flexibility.

Complementary inference

While case studies can yield interesting propositions about the research question, a related field survey can be used effectively to collect perceptual data from managers and also to test the relationships imbedded in these propositions. The field survey addresses the (What?) question in our study. We use the survey primarily to assess the manager's perceptions of the use of volume flexibility in response to demand uncertainty. Thus, the field survey builds on the case study data on the sources of volume flexibility and focuses specifically on "What sources of volume flexibility are more likely to improve firm performance?" The parallelism of the methods was based primarily on our need to complete the studies within a specific time frame. The studies were sequential to some extent with a one-way impact from qualitative methods (case study) to quantitative methods (survey); however, we recognized the value of establishing iterative cycles to redefine research questions and hypotheses and emphasized concurrency in the methods. Despite these concerns, our triangulated results provide strong support for the hypotheses that volume flexibility has a positive impact on both financial and delivery performance. This result is consistent with the resource-based view that there are firm effects on strategies and performance outcomes in the same industry (Wernerfelt, 1984).

Convergent inference

Analyzing, interpreting, and developing triangulated findings can be a very difficult task. The underlying problem is that each research method along with the chosen data collection method presents its unique challenges and tradeoffs. Striving for convergent inference between the underlying results is one way to resolve differences between triangulated results. In our project, the three methods support the hypothesis that the sources of volume flexibility are different in large and small firms. For example, in our analysis of the secondary COMPUSTAT data, our process-based measures suggest that small firms are more efficient in using their inventory buffers and slack production capacity as sources of volume flexibility. Using regression analysis on the secondary data, we achieved statistical conclusion validity for volume flexibility metrics between small and large firms.

Divergent inference

Divergent inference refers to dissonance or inconsistency between two strands of a mixed methods study. It is due to this dissonance that methodological triangulation can provide interesting results (Kaplan and Duchon, 1988). Our findings also suggest that there is a significant difference in the options that large and small firms use as their long-term sources of volume flexibility. For example, one results of the field survey

shows that small firms rely less on the use of inventory buffers and slack capacity resources than the larger firm do. For example, linking volume flexibility strategies to firm performance can yield interesting results because the three research methods measure performance differently. First, the rich context and background that was documented in the case study suggest that volume flexibility has a positive impact on performance, as evidenced by the three firms in the case study. Second, the finding that volume flexibility has a positive impact on performance was also corroborated in the field survey where the results from the regression analysis suggest that volume flexibility has a positive impact on financial performance.

However, while the first two studies provide consistent results, the third study using secondary data analysis paints a somewhat different picture. On our process-based measures, we find that small firms are more effective in being able to deal with a larger variation in sales using a smaller deviation in inventory levels and costs of goods sold. This volume flexibility capability, however, does not translate into any competitive advantage for the small firm – they are much less profitable than large firms are. Our process-based measure that incorporates profitability suggests that large firms are able to change their output levels more profitably than small firms can. Thus, our research paints an incomplete picture of the volume flexibility capability – performance linkage across small and large firms. One explanation for this may rest with how small and large firms treat flexibility – it seems that small firms tend to use flexibility to absorb uncertainty in a reactive manner. On the other hand, large firms use flexibility to contain, mitigate, and remove uncertainty in a proactive way. We conjecture, therefore, a deep pockets hypothesis (Jack and Raturi, 2004) to fill this void in our explanations – we have not measured other factors, such as the deeper pockets of larger firms that allow them to survive fluctuation in sales more profitably than small firms.

Meta inference

Meta inference refers to the integration of inferences obtained through qualitative and quantitative studies in a mixed methods design. A triangulated study should provide insight and a multi-dimensional perspective into the research question. The first step in integration of the findings across the three studies was to specify the alternate sources of volume flexibility (see Figure 2). We find a number of workforce management practices generate flexibility in the short term. However, through the survey, we find that the external sources of volume flexibility are deployed more heavily and more effectively in large firms. This is a consolation, as now we are better able to explain our inconsistent result from secondary data analysis; small firms have lower variation in costs and inventories in response to the same level of sales variation but are yet ineffective in delivering a profitable volume flexible response. We find that large firms have a much wider array of alternatives to respond to demand variations: better forecasting and scheduling systems, more leverage over suppliers, more partnership arrangements and strategic alliances with suppliers, and better control over market mechanisms such as pricing and demand management. Large firms rely less on short-term and (probably more costly) alternatives as temporary workers, capacity buffers, inventory and overtime.

The meta-inference process from the three methods used in our research allows us to posit a framework of relationships between drivers, sources, measures, and impact of volume flexibility. These linkages are shown in Figure 2. The link between the drivers and sources of volume flexibility are dashed lines because they represent

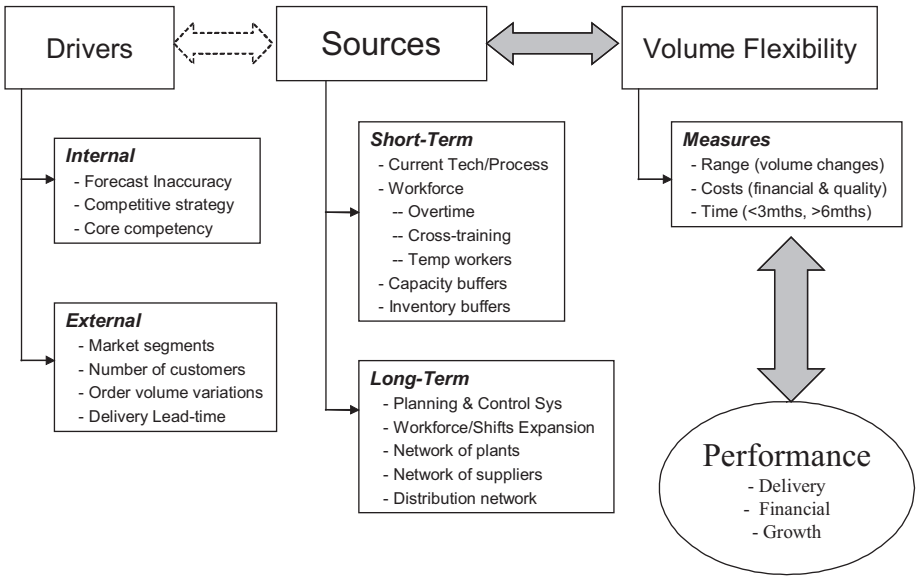

Figure 2.
A framework for volume flexibility

propositions that were supported in the case studies but they were not validated in our field survey. However, the other linkages were both supported in the case studies and validated in the field survey and through secondary data analysis, as we described earlier.

Summary

In this paper, we walk the reader through a triangulation journey and inform them on the alternatives, tradeoffs and pitfalls in the process. We document several forms of triangulation and document a path approach to specifying the strategic parameters of a triangulated study. This summary informs researchers who are undertaking triangulation on a strategic approach to their research problem and the tradeoffs involved therein. We then outline several issues that surface when making inference from multiple methods, using the volume flexibility research as an example. These include issues related to different kinds of inference (convergent, complementary, divergent, and meta inference) as well as alternative caveats in making generalizations. We show, with an example, the process of meta inference and development of a framework through triangulation. Finally, we point out several errors that might still reduce the impact of research conclusions during triangulation.

As with every research method, triangulation has limitations that can be amplified by the chosen methodologies and the selected data sources. There are two sets of limitations to any triangulation: method specific issues and assumptions related to across-method generalization and inference. Method-specific assumptions in our three studies may lead to error in making conclusions for that study. For example, the secondary data was limited to publicly traded firms. To the extent that our sample of

550 firms was drawn from a population of publicly traded firms, our results may be limited to this population of firms. Our case studies were limited to an opportunity sample of three small manufacturing firms. The field survey was also based on a sample which may have response bias (our response rate was approximately 19 per cent). We hope that through triangulation, method specific errors introduced into our research have less impact in biasing our findings one way or another. It is also noteworthy that since these multi-method studies can become very large and difficult to package succinctly, researchers should also plan their choices of publication outlets very carefully.

However, that is not to say that triangulation itself is not prone to error as other researchers have aptly shown (Massey, 1999). Our triangulated findings (e.g. relationships between volume flexibility and performance) are not absolutely truth statements but subject to falsification in the same way that every good theory is. We are not claiming sanctity of any method in our research – we are observing phenomena with multiple methods to ground the theory development process in different versions of an existing reality.

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