Development of a Design and Evaluation Framework for Supplier Cities

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*Abstract:*

For companies pursuing opportunities by expanding manufacturing to new markets, one major challenge is unavoidable: identifying and developing capable, local suppliers. In developing markets suppliers often lack the cutting edge technology, processes, and management methodologies driving the world's best businesses. The ability to identify and develop, relocate or build suppliers with World-Class capability becomes a competitive advantage. This thesis discusses the state of the art in Industrial Conglomerations (including Industrial Clusters and Supplier Cities) as well as their benefits and limitations. To analyze the potential opportunity for manufacturing firms considering supplier cities, we have developed a technical, operational, and financial framework for considering the opportunity and making key decisions about structure, location, and included processes. The framework includes a discussion regarding process selection based on an analysis of critical technical issues at each manufacturing step. This analysis considers the relationship of process capability to overall product performance and ultimately to product competitiveness. In an attempt to help justify the effort of the host company in establishing a Supplier City, we include a discussion of the cost model we developed to quantify the benefits associated with supply chain expense, learning curve effects, and the expense of developing suppliers located in Supplier City versus those located elsewhere. We further discuss the legal, political, social and environment risks of Supplier City and guidelines for stakeholder focused management of local, regional and national governments, party officials, and NGO's. Finally, we include a case study in which we apply our framework to The Timken Company's China operations. We discuss their specific case and our recommendations.

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# Chapter 1: Introduction

## *Inception*

This work began as a study of the viability and usefulness of creating a Supplier City for Timken China. The project centered on an internship for the Global Entrepreneurship Lab (15.389) class at MIT's Sloan School of Management and included a team of four Leaders For Manufacturing (http://lfm.mit.edu) fellows: Sabrina Chang, Jason Mellein, Chris Porter, and Daniel Shockley. The original project produced two documents: a white paper and a presentation aimed at Timken China's corporate leadership. Sabrina Chang and Chris Porter were invaluable members of the team, working tirelessly, providing key insights, and contributing strongly to the aforementioned artifacts. For their contributions we are extremely grateful. Further development of the analysis, post-project, of Industrial Conglomerations, Process Selection techniques, and Cultural, Country, Risk, Spill-over, and other aspects was conducted by the authors of this thesis.

## *Problem Summary and Justification*

Since the beginning of the industrial revolution in the United States and Europe, one manufacturing decision has been the focus of many manufacturing strategies - whether to do work in house, or outsource processes and components. In today's manufacturing environment with short product and technology life cycles and extreme competition in both the marketplace and the capital markets, many companies have outsourced an increasing portion of the manufacturing of the products that they sell. In many cases these decisions have had a tremendous impact on the short-term and long-term success of companies. In some cases outsourcing has led to explosive and sustained success allowing companies to focus on activities such as creative development (e.g. Nike and Apple), and in others the decision led to erosion of market power and eventual dissolution or renewal (e.g. IBM and Intel/Windows).

In today's global economy companies expand into new markets to tap a larger pool of customers, as well to develop a larger manufacturing base. These activities are critical to many companies' sustained viability. At present, many multi-national companies are struggling to replicate the supply capability to which they have become accustomed in developed countries in each new countries of operation. This dynamic forces them to re-evaluate their outsourcing decision as well as invest tremendous amounts of human capital

resources in developing capability in new suppliers and relocating old ones. In some cases, the most attractive option can be to establish a higher degree of vertical integration. Many companies are looking for ways to get the advantages of vertical integration accompanied by the competitiveness of a properly though out outsourcing strategy - what we will call Virtual Vertical Integration.

Supplier Cities, Industrial Districts, and Clusters are examples of what we have termed Industrial Conglomerations. An Industrial Conglomeration (IC) is a collection of firms in close geographic proximity with complementarities and synergistic effects with some aspect of the locale and, in many cases, between the firms themselves. In a Supplier City, a host company invites a selected array of suppliers to co-locate in close geographic proximity to the host in order to improve the supply chain and logistics performance of the overall enterprise. This type of conglomeration represents the highest degree of structural coherence of both corporate and physical relationships in any of the IC's due to shared investment in resources and/or infrastructure, the physical contiguity of the participants, and the highly structured and intricately designed nature of inter-corporate physical relationship (e.g. component delivery via dedicated systems). Our subject company, Timken, is considering the development of a Supplier City in a developing region to leverage such effects and asked us to examine the concept in detail vis-à-vis the location specific aspects of their operations.

We believe there is great value to companies, industries, countries, and locales in having a formal understanding of the different types of Industrial Conglomerations and the relevant forces and issues that shape their development and affect their success or failure. Industrial Conglomerations can positively affect competitive advantage at the firm, industry, and country level as well as generate economic growth and innovation. Understanding how to design and develop a conglomeration and avoid the pitfalls in doing so can greatly benefit firms, industries, and countries. For some industries the strategic implementation of a Supplier City can become a competitive weapon providing the efficiency of vertical integration with the flexibility of an outsourced supply chain.

## *Overview of Main Results*

In this work, we complete a review of existing definitions for the different types of Industrial Conglomeration incorporating existing sources and literature and introduced the Conglomeration Curve. This curve allows for the comparison of many existing Industrial

Conglomerations and brings together multiple academic works on the topic. In addition, we demonstrate the numerous benefits that come from the organization of a Supplier City by a host company and assert that a successful Supplier City implementation can have the result of a sustainable competitive advantage. To support this objective, we establish a framework for Supplier City evaluation and development. This tool helps companies identify whether or not there is an opportunity for them to develop a Supplier City, what processes and partners should be included in the Supplier City and how they should structure the relationships to distribute newly created value. The application of the framework will guide a company on a quest for a superior supply chain by directing the consideration of the myriad of important dimensions of each Supplier City implementation. In addition, we document a number of tools that can be used in to assess potential Supplier City options, benefits and opportunities. Finally, we present an analysis, within the context of the developed framework for the implementation of a Supplier City by Timken, China. The content of this work will assist companies in their evaluation of Supplier City opportunities and will help them to develop competitive strength through supply chain superiority.

# Chapter 2: Review of Industrial Conglomerations

In our research, we uncovered a number of different terms and structures to describe a geographic conglomeration of companies but no underlying framework to give a clear understanding of how the different types are related to and different from each other. The abundance of different names and characterizations for conglomerations, along with this lack of a framework for understanding the "design space", occasionally created confusion within our project team, between the team and Timken, and between the authors of this thesis. After some consideration, an underlying order began to appear to us and we developed a framework for relating and characterizing different types of conglomerations. In this section we present the framework, its rationale, and give a detailed description of the various types of industrial conglomeration.

## *Overview*

The patterns of inception, development, risk, and benefit of industrial conglomerations is a complex subject in an informal stage of development. They vary in the degree of organization of inter-company relationships and geographic-positional structure. They also vary in what drives the creation of the conglomeration. On the one end of the spectrum there are conglomerations created for a specific purpose by a single organization with non-competitive partners (suppliers and, possibly buyers); and on the other end, there are conglomerations of companies involved in 'coopetition' who reap benefits from geographic proximity mainly through secondary effects. Secondary effects of the conglomerations themselves vary broadly depending on the environmental, social, and regulatory context of the conglomeration, the industry involved, and the specific distribution of companies across the overall value chain. While conglomerations of various types, sizes, and characteristics have grown, developed, and occasionally failed around the world for the past few decades there is little formal understanding of the distinguishing characteristics of the various types, the competitive advantages they render to stakeholders, or the nature of their development processes and how to encourage or shape them.

The different types of conglomerations vary in their degree of coherence of corporate relationships and physical relationships. On one end you may have a large number of firms located in geographic proximity but with no formal, designed, or mutually dependent relationships between them and physically arranged in a random way. On the other end, the

organizations may have a very high degree of mutual dependence and structure to their corporate relationship and may be physically connected to each other to facilitate the exchange of goods. The following chart illustrates the spectrum of conglomerations along two axes: 1) Coherence of Corporate Relationships; 2) Coherence of Physical Relationships.

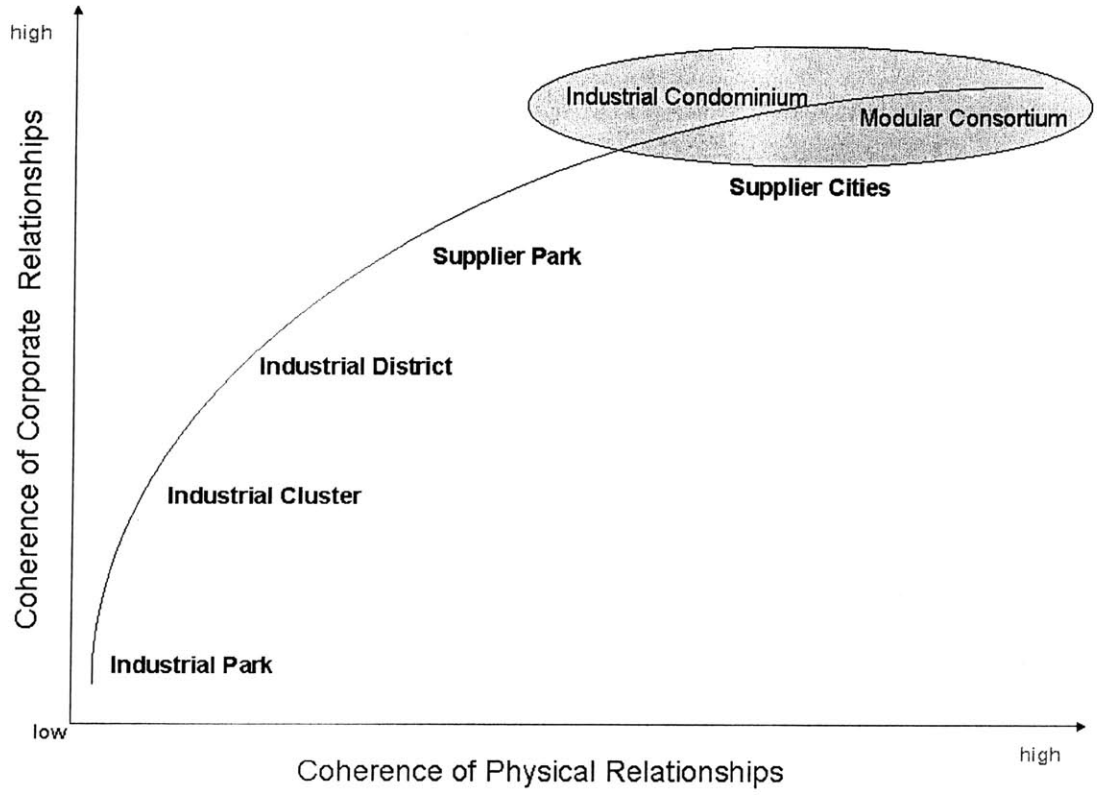


*Figure 1: Level of Coherence of Industrial Conglomerations*

## Industrial Parks

An Industrial Park is an area usually located some distance from a city center, designed and zoned for businesses and/or manufacturing and associated activities.[5,33,36] Industrial parks are usually located close to transport facilities, especially where more than one transport modalities coincide: highways, railroads, airports, and navigable rivers.

An Industrial Park has very loose constraints on the scope of industry that may develop within it. Broadly divergent, unrelated industries may be represented by companies in an Industrial Park. Taken together with suppliers, partners, customers, and service providers who may create a presence within the Industrial Park to serve other related companies already there, and the possible industrial diversity is great. The average structural coherence of both corporate and physical relationships between any two organizations in an Industrial Park is very low.

## Industrial Clusters / Agglomerations

Michael E. Porter defines "Clusters" as "geographic concentrations of interconnected companies and institutions in a particular field."[26] For the sake of semantic continuity between the various types of conglomeration discussed in this thesis, we here introduce the term "Industrial Cluster" as a synonym for Cluster. Industrial Clusters, like Industrial Parks, are comprised of multiple industries, but the industries are more closely linked and interdependent. Further, the distribution of companies across the value chain for a given industry may be smaller than in Industrial Parks but is greater than the conglomeration types listed below and may include equipment manufacturers, channels, and soft services. Industrial Clusters are critical masses of organizations that, together, have distinctly greater success in a particular field than any other locality. Industrial Clusters appear to focus on multiple, but related industries. As noted by Porter, Silicon Valley and Hollywood are the world's most famous clusters. The average structural coherence of both corporate and physical relationships between any two organizations in an Industrial Cluster is somewhat higher than in an Industrial Park due to linkages between the represented industries.

An example of an Industrial Cluster is the California wine cluster which includes 680 commercial wineries and several thousand independent grape growers[26]. This agglomeration further includes suppliers of wine-making equipment, barrels, bottles, caps and corks, labels, public relations and advertising, and specialized publications. This cluster does not have the wine industry as its single focus. The hospitality business plays a large and somewhat independent part, providing food, lodging, and tourism services for people traveling to the area. While they are synergistically related to the wineries, they do not provide services directly to the wineries or in support of the wineries primary business of producing wine. Instead this two foci system creates a convenient method of out-reach and marketing for the wineries while providing a business opportunity for the hospitality industry. Academic involvement is provided by the viticulture and enology program at University of

California, Davis, and the Wine Institute. This conglomeration is not centered on any specific commercial winery. Instead there are a multitude of players at every stage in the value chain (equipment, growers, wineries, academics, etc) all within close geographic proximity with a somewhat low average structural coherence between firms.

## Industrial Districts

"Industrial Districts are geographically defined production systems characterized by a large number of small and medium-sized firms that are involved in various stages of the production process in a particular industry." [1]. Industrial Districts have a narrower industrial scope than Industrial Clusters in that they tend to have a single focus on a specific industry, such as textiles. The firms present still engage in a broad set of activities across the value chain, but all focus on production relevant to a specific industry. Legal/Contractual relationships between firms tend to be more informal and flexible while geographically/physically, there is not much difference from Industrial Clusters. The average structural coherence of both corporate and physical relationships between any two organizations in an Industrial District is somewhat higher than in an Industrial Cluster due to the fact the district is dedicated to a single industry.

Textiles Industrial Districts in Italy have developed a sort of division of labor among the firms that promotes district-wide flexibility and productivity. They often specialize in a single phase of the production process. Firms are able to aggregate orders across multiple customers within the district helping them to invest more aggressively in capital equipment and amortize the costs quickly. Studies comparing district based and non-district based textile firms in Italy show higher productivity and profit rates (ROI) for district based firms. Further

## Supplier Parks

A Supplier Park is a conglomeration designed around a single host organization in which all other participants are suppliers of goods primarily to the host but possibly each other as well. The average structural coherence of both corporate and physical relationships between any two organizations in a Supplier Park is higher than in an Industrial District due to the Supplier Park's dedication to a single host organization. Toyota and Dell have made this type of conglomeration famous.

There are two basic sub-types to a Supplier Park. In the first, the Supplier produces its components remotely and warehouses them in the Supplier Park facility with inventory levels set to maintain the service level agreed to with the Host. The arrangement may be on consignment or the host may own the inventory once it enters the Supplier Park. In this model, warehousing space (capacity) for a particular supplier will most likely be 100% committed to components destined for use by the Host. In the second Supplier Park model, the Supplier sets up production operations within the Supplier Park itself. The Supplier's product is produced locally, enhancing cooperative efforts to maximize value. However, care must be taken to safeguard against the negative effects of loss-inducing excess capacity during low points in the market cycle. The Host may need to allow the Supplier to use excess capacity to supply other customers in order to maintain the Supplier's financial viability. Hosts may customize and hybridize these models in a variety of ways to suit specific organizational needs.

Toyota makes very effective use of a production based Supplier Park, meaning suppliers locate production capabilities in close proximity to Toyota's own assembly operations. Toyota has developed its supplier network for approximately 50 years and, as described by Peter Hines[17], its supplier network characteristics include:

- A many tiered system with high bought-in content at each level
- A close and flexible long-term relationship between buyer and seller
- A small number of direct suppliers
- A reliance on small subcontractors (92% of Japanese manufacturing firms have 18 or less staff)
- Price determination through costing: A high degree of inter-firm cooperation in setting prices for upstream components produced within the Supplier Park, based on a transparent understanding of the cost to produce those components.
- A high degree of strategic and operational assistance given to suppliers
- A high degree of supplier driven innovation

Toyota's system of supplier management follows the Kyoryoku Kai (Cooperative Circle) model in which a collection of an organization's most important suppliers are brought in close, both physically and organizationally, to increase trust, Just-In-Time production, Statistical Process Control, and Value Analysis / Value Engineering. So well developed is Toyota's system that 80% of the value of its products is provided by the Supply Chain (Mazda, which uses a similar model, purchases 70% of the value of its products). As a

result, Toyota has been able to focus intensely on its core competencies of designing vehicles customers want to buy, reliability engineering, and product development cycle-time reduction.

Dell's Supplier Park model is warehouse-based. Suppliers maintain inventories on consignment in shared warehousing facilities close to Dell's final assembly operations. Suppliers deliver components to Dell approximately every two hours on a Just-In-Time basis. Coupled with the fact Dell receives cash for customer orders at order time, and does not start building product until a customer has made an order, this JIT/consignment based system has provided Dell with a negative conversion cycle, meaning it pays for the production of an order some time after being paid for its construction. Dell provides a significant amount of Supplier training and process development in the belief that such investment yields cost reduction benefits over time. Dell considers its core competency to be customization (frequently called Application Engineering in other industries) and has used its supplier network to shift unrelated value-added steps up-stream in order to focus its Fixed Cost basis on what it does best.

## Supplier Cities

Supplier Cities occupy the highest point on our continuum of industrial conglomerations. There are two basic types: Industrial Condominiums and Modular Consortiums[10]. Modular Consortiums represent both the highest point on the continuum as well as the highest degree in virtual vertical integration. The average structural coherence of both corporate and physical relationships between any two organizations in Supplier City is the highest on the spectrum. This result obtains because both host and supplier firms share the investment in resources and/or infrastructure; the firms are physically co-located or, if separate, often have part-conveying infrastructure connecting their buildings; and the legal, or otherwise binding, aspects of their corporate relationships are highly structured and intricately designed.

### Industrial Condominiums

In an Industrial Condominium, the host organization maintains direct control only over key manufacturing activities. The remaining activities are broken into logical modules and outsourced (production and frequently design as well) to well-trusted suppliers. These suppliers may or may not conduct operations under the same roof as the host organization

but are typically at least within close geographic proximity with formalized or dedicated lines of material flow and communication. The level of coherence in the physical/geographical layout of the various participants and the level of coherence in the relationship between them are very high.

In 1995 to preparing for the launch of its Ka model, Ford introduced an Industrial Condominium near its facilities in Valencia Spain. By modularizing the components involved and outsourcing them to producers within the Industrial Condominium, Ford reduced the number of components its own workers handled from 3,000 to 1,200. Ford outsourced 60 modules and components, reducing vehicle assembly time 25%. While the suppliers are under different roofs, they are in very close proximity and at least three of them have conveyor tunnels that transport finished modules from the supplier to Ford's facility for immediate integration on the vehicle assembly line.

### Modular Consortiums

In a Modular Consortium, the principal organization has withdrawn from any direct involvement in manufacturing or assembly, instead focusing its efforts on design, process sequencing, quality oversight, and schedule management. Generally, all work occurs in one or more facilities owned and controlled by the host organization. The level of coherence in the physical/geographical layout of the various participants and the level of coherence in the relationship between them are very high.

NASA's ground operations, at Kennedy Space Center, are one excellent example of this phenomenon. At Kennedy Space Center, NASA outsources the detailed design, manufacture, maintenance, operation of all ground support equipment (GSE), vehicles, and payloads. NASA's role is to develop mission and vehicle requirements and specifications, award contracts to private sector organizations, and to oversee the various contractors as they perform their duties. For instance, USA maintains (Orbiter Processing Facility), assembles (Vehicle Assembly Building), and integrates the payload (Launch Pad) into the Space Shuttle launch vehicle. Boeing processes, tests, and prepares International Space Station (ISS) modules and other cargo and experiments in the Space Station Processing Facility before handing them off to USA to integrate. Boeing also acts as prime contractor for providing engineering expertise for the Shuttle. Lockheed constructs and delivers each external tank to the Vehicle Assembly Building for mating with the Shuttle during vehicle assembly (USA). ATK receives, refurbishes, and refuels the solid rocket boosters in Utah

before shipping them back to Kennedy where they are delivered to USA personnel in the Rotation Processing and Storage Facility. All facilities are within close proximity and many have either specialized vehicles or physical infrastructure between them to transport the artifacts of the processes in one facility to another. The legal arrangements between NASA and the contractors and between the contractors themselves are structured in great detail. NASA itself keeps a small number of its own personnel in the loop for most activities only in order to maintain some degree of institutional expertise. However, Kennedy Space Center is, in effect, a Modular Consortium on a very large scale with NASA as its host organization.

| | Geographically Co-located | Related Industries | Same Industry | Single Company | Physically Interfaced |
|---|---|---|---|---|---|
| Industrial Park | X | | | | |
| Industrial Clusters | X | X | | | |
| Industrial District | X | X | X | | |
| Supplier Park | X | X | X | X | |
| Supplier Cluster | X | X | X | X | X |

*Figure 2: Industrial Conglomeration Attributes*

## Conglomeration Development and Risks

Our research suggests different roles for firms, government, unions and trade associations in the creation and development of Industrial Conglomerations. In particular governments should avoid unilaterally specifying and setting the conditions for the creation of a conglomeration. Instead conglomerations, of any type, should result from the emergent behavior of firms to optimize operational and strategic efficiency. Once a conglomeration has begun and is recognizable as such, it then behooves government organizations to assist in the upgrading of the conglomeration through infrastructure development, regulatory relaxation, local academic development or expansion, and worker training programs. The evolutionary concept is similar in quality to crystal formation. A conglomeration will start with a small number of firms choosing to locate in close proximity to each other to exploit some potentially resulting competitive advantage or a local geography (waterways) or infrastructure (nexus of transportation modes such as airports, train stations and highways)

feature. As the competitive advantage becomes publicly apparent through the success of the pioneering firms, other firms will seek to exploit and expand the same advantages. The inception is the formation of the seed crystal in the analogy, while secondary and continuing development is akin to the expanding growth of the crystal. Once a sufficient level of development has occurred appropriate government action is easier to identify (versus well-intentioned yet ultimately detrimental action).

The rationale behind the various stakeholders assuming different roles is associated with risk. One aspect of the risk involved is predicting the innovation roadmap. Firms interacting with each other, exchanging goods, services, information, people and technology have a better chance of identifying innovations with high probabilities for success than governments do. Government investment in a conglomeration based on an unproven innovation roadmap or a roadmap unproven in a given geographic or environmental context run the risk of forfeiting investment funds in the likelier event of failure. Another aspect of risk is the rigidities necessarily created when government intervenes in competition or by action induces companies to "persist in old behaviors and relationships that no longer contribute to competitive advantage."[26] Further, government protection, early in development, can encourage premature vertical integration and blunt innovation which retards conglomeration development. Instead of restrictions on conglomeration location, subsidies, or regulatory advantages, governments should focus early conglomeration policies on developing inter-regional or inter-country trade and academic development.

## Spill-over Effects of an Industrial Conglomeration

In addition to careful consideration of risks, it is also important that consideration is given to spill-over effects. Spill-over effects are the impacts that an industrial conglomeration can have on the surrounding area and populous. These effects can have many forms. Of national significance, it is common for "clusters to be a driving force in increasing exports" and they can become "magnets for attracting foreign investments"[27]. Likewise, an the investigation of Italian Industrial Districts found that through the evolution of efficient industrial districts, "economic dynamism coexisted with stalemated and polarized politics"[1]. In other words, despite a dysfunctional and paralyzed political system, the local economy managed to develop and flourish anyway. The spill-over effects can have the potential to compensate for major structure issues at even the national level.

In addition, spill-over effects can have great "local" impact, raising the average wage rates in an area, increasing the quality of local education, creating informal networks that aid in developing management talent and generally increasing the competitiveness of individual companies. These spill-over effects, while real and measurable, are not typically part of the operational decision making process for any given company. Additionally, it is impossible for these spill-over effects to be created by one company, acting alone.

We point out that these effects specifically spill over from the industrial conglomeration to the surrounding community and not the other way around. There are synergistic benefits available if a community and/or its government choose to promote the industrial conglomeration by investing its own funds in infrastructure and other developments beneficial to the conglomeration. However, we remind the reader of our earlier conclusions that governments and communities should begin significant financial investment only after a conglomeration has begun to form and take shape. Our research leads us to believe this assures a natural development of the conglomeration in response to the competitive landscape, keeping the characteristics of the conglomeration competitive. But it also reduces the risk of a community losing their infrastructure investment should the conglomeration not mature to its full potential.

It is for reasons such as these, that the presence of industrial conglomerations and the associated spill-over effects should be characterized as public goods. As such, it is important that conglomerations are nurtured by public policy in a manner that is consistent with encouraging their formation while allowing competitive pressures to shape their location, scope, size, and participants.

## *Virtual versus Vertical Integration*

A company achieves vertical integration when it has direct control over the production of the inputs for its primary product. The further up-stream a firm controls the production of inputs, the more vertically integrated it is. The generally accepted height of vertical integration is Henry Ford's River Rouge plant which actually received iron ore and rubber as inputs and produced automobiles as an output. Ford's plant and employees handled all processing of these input materials.

Cisco Systems represents virtual integration in the same sort of extreme that the River Rouge plant represents vertical integration. Cisco focuses on designing new products and

selling them to customers. Manufacturing, supply chain management, final assembly, and distribution are all contracted out to partners. Cisco rarely sees the products its customers receive.

The concept of virtual integration is treating a select group of suppliers as if they are very close business partners, almost as if they are inside the company. A firm seeks to outsource non-core competencies to trusted suppliers while focusing its in-house efforts on competencies that are critical competitive advantages. This degree of close cooperation allows a high level of collaboration on product, process, and market problems while insulating the host organization from the cost burden associated with producing the input components itself. Should the market for a firms products shrink, the firm is now not responsible for carrying the fixed and variable costs associated with the business of producing the input components for its primary product (and in the case of Cisco is insulated from even the costs associated with final assembly). According to Michael Hammer[39], the key to virtual integration is to get all participants to work together as smoothly as they would if they all belonged to the same enterprise. Good communication mechanisms must be in place to achieve this smoothness.

One aspect of Virtual Integration's relevance to Industrial Conglomerations is clear: the outsourcing of non-core competency activities. However, it is to the Michael Hammer's point, mentioned above, that the chief synergy between Virtual Integration and Industrial Conglomerations occurs. Smooth inter-corporate operations are better achieved if the players are located within close geographic proximity of each other. As discussed in other parts of this thesis, close proximity makes high bandwidth communication and problem solving more convenient, reduces some operational costs (associated with WIP, Lead Times, and Quality), and develops trust which speeds inter-firm decision making. If a firm is considering Virtual Integration an Industrial Conglomeration may help the firm extract the most value possible.

## *Supplier City Concept Detail*

### Purpose

*An army marches on its stomach.* - Napoleon Bonaparte

In a Supplier City, a host company invites a selected array of suppliers to co-locate in close

geographic proximity to the host in order to improve the supply chain and logistics performance of the overall enterprise. By co-locating, the suppliers can share infrastructure and resource costs and develop cooperative support mechanisms. The host company can develop stronger relationships with key suppliers, increase data sharing, cooperation on problem identification, and resolution, and pursue shared cost reduction initiatives. Typical supply chain optimization too often focuses on locally optimizing a single organization or process. In contrast, a Supplier City, by bringing participants closer together and fostering trust, and more directly, cooperative relationships, can broaden the scope of optimization to include many organizations across multiple layers of the supply chain.

A Supplier City moves an organization closer to virtual vertical integration versus corporate vertical integration. This transition enables the organization to focus on its core competencies and leverage those of its suppliers thereby reducing cost, increasing quality, and increasing enterprise responsiveness. In this way, an organization can push the cost-quality pareto front while focusing on areas where it truly provides value for its customers.

## Description of a Supplier City

## Key Benefits

Supplier Cities provide a set of key benefits to both the host and participants critical to the value proposition. In fact, Supplier Cities provide a large set of primary, directly measurable as well as secondary, indirect benefits. The secondary benefits tend to create virtuous cycles among different sets of stakeholders and value generation is measurable if not precisely quantifiable. For example, investing in a local supply base through a Supplier City may create secondary investment effects such as attracting talent and outside investment to the area. This will eventually develop the concentration of talent, potential partners, industry capability, and availability of capital in the environment surrounding the host and Supplier City. Primary benefits focus on the more immediate impacts of a Supplier City on supply chain and logistics metrics including cost, schedule, responsiveness, and exposure to business risk. The complete set of benefits create a direct and near-term improvement in enterprise value returned and set in motion a system of business environment development to pay dividends over the long term.

The next few sections describe some of these benefits in more detail.

## Lead Time Reduction

By locating suppliers close to the host, lead times are greatly reduced. This reduction in lead time is achieved several ways. The bulk of this reduction occurs through greatly reduced shipping times. In the most dramatic cases, long ocean voyages, passages through customs, and multiple vehicle hand-offs may be completely eliminated. Shipment is as simple as loading up a single ground transport vehicle in the Supplier City, driving it the short distance to the host, and unloading it. Physically integrating a supplier with the Host can even eliminate the transport vehicle.

The degree of lead time reduction achieved is a function of the supplier's ability to maintain, through inventory or short cycle time production capacity, the ability to deliver parts shortly after they are ordered. Simplifying and shortening the shipping process is only part of lead-time reduction. More generally, lead time reduction depends on the degree to which factors chiefly responsible for long lead times are eliminated from the supply chain and not just moved one or two steps away from the host. For example, if a host invited a supplier to Supplier City in order to eliminate its dependency on a complex or lengthy overseas sourcing strategy, but the supplier has a similar dependency for parts or components used in its production of components for the host, then the degree of lead time reduction will be limited and possibly even negated.

Faster quality cycles and lower costs are the chief benefits of reducing lead time. Shorter lead-times and closer distances means less inventory not involved in value added steps (e.g.: machining, assembly) freeing up capital. Components may also cost less due to cheaper shipping fees. Quality problems may be discovered and dealt with more quickly and effectively if the supplier is located close by. Lead-time reduction has the potential of moving a host firm further out into the cost-quality frontier, giving it a competitive advantage.

## Holding Cost and Storage Space Savings

If the host organization is using a formal Economic Order Quantity model to calculate its order quantities and order intervals, lead-time reduction will result in a reduction in on-site inventory of component parts. A shorter lead time and cheaper shipping costs (due to supplier proximity to the host site) mean components may be ordered in smaller quantities, more frequently, and closer to the time of actual usage in the host's production process. This transition to a more just-in-time supply methodology lowers the inventory levels at the

host's site which translates directly to lower annual holding costs, freeing up capital for other purposes. It can also lead to reduced inventories at the supplier facility which reduces the total capital tied up in the enterprise. The additional space made available by the reduction in inventory may also be re-purposed for value generating activities. Other holding cost reductions come from the reduction or elimination of the physical inventory process and the reduction or re-purposing of some fraction of the procurement personnel.

## Shared Infrastructure Costs

Co-locating multiple suppliers enables them to cooperatively share common resources and reduce operating costs, sharing the value created with the host. By sharing capital equipment, warehousing facilities, and delivery vehicles, suppliers can dramatically reduce their overall cost of operations. The limits to this sort of infrastructure sharing are dependent on the degree of commonality in the infrastructure requirements of each organization, the degree to which each organization needs to protect proprietary information, and each organization's ability to develop cooperative relationships with the host and other suppliers. During the planning phases, the host should develop a sensible cooperative sharing profile for the Supplier City that takes into account the balance between the expected infrastructure commonality (including shipping requirements) and protection of proprietary information for the set of components to be supported. The host may then use this profile to prepare a Supplier City infrastructure attractive to potential participants as a standard for supplier selection and as an ideal target for continuous cost reduction and improvement of the Supplier City over time. By understanding the possibilities for shared infrastructure costs, incorporating them practically into the infrastructure development, and soliciting participation by suppliers interested and able to function in a cooperative environment, the host's holding cost savings can be enhanced by lower component prices across the board.

## Quality Control

The host can use its close, cooperative relationships to the suppliers in Supplier City to improve the quality and consistency of components delivered to its production facilities further enhancing cost savings associated with supplier quality improvement. To do this, the host uses the relationship to develop an enterprise wide culture and policy of conducting root cause analysis of quality problems proximal in time, location and people to the problems' occurrence. The involved personnel, including individuals from both the supplier and the host, then re-engineer the process that generated the defect to reduce or eliminate

defect occurrence. The benefit of a Supplier City to Quality control is realized through proximity. Information has a half-life. Root cause analysis is made more effective the sooner the problem is attacked, the closer the solvers are to the place of occurrence, and the more completely represented all the directly affected stakeholders are. Having a supplier across the street versus across the country, or even across town, means quality problems discovered by the host in a supplier's delivered component may be more quickly attacked, at the point of occurrence, by both the customer and the supplier in a cooperative root cause analysis. Such a system of consistent and immediate root-cause analysis and process re-engineering by the operators, engineers, and managers directly involved, from both the supplier and the host, yields continuously improving component quality, reduces the enterprise's dependency on inspection and rework, and enhances the host's cost competitiveness in the medium to long run.

## Quick Response

To successfully handle the volatile nature and unexpected opportunities of an evolving and developing market, an organization must ensure its supply system can support its target level of flexibility. Supplier City groups key suppliers together locally where relationships can be developed to create a more team oriented system with common goals, interests, and understandings. By engendering trust, transparency and cooperation beyond that of geographically dispersed stakeholders, a Supplier City allows product, design, and process decisions that affect host and supplier alike to be taken on a much shorter time scale. This is because less travel is involved, more high-bandwidth communication can occur through convenient face-to-face encounters and a common language that develops over time, and less legal wrangling ensues as each player seeks to protect itself. Another source of flexibility comes from the convenience of impromptu meetings between the host and suppliers to discuss how internal or external developments may be addressed to the benefit of all. This one-for-all culture, when coupled with short delivery times and the ability to quickly connect physically for problem identification and resolution, creates an overall system capable of responding quickly to changes in external factors. These unexpected external changes can include regulatory, environmental, community, and customer requirements. Developing an understanding of the likely risks enables the host and suppliers to proactively tailor, by design, the Supplier City's quick response capability, further improving the enterprise's ability to avoid or resolve issues and exploit opportunities.

## Value Cascade

The following diagram illustrates the cascading value of a Supplier City. Beginning with a Supplier City, value flows down through a variety of mechanisms and processes such as Shared Infrastructure, Shorter Lead Times, and Risk Mitigation to result in overall increased enterprise value. Some entities are directly measurable benefits while other, less directly measurable, benefits result from the creation of virtuous cycles in the system.

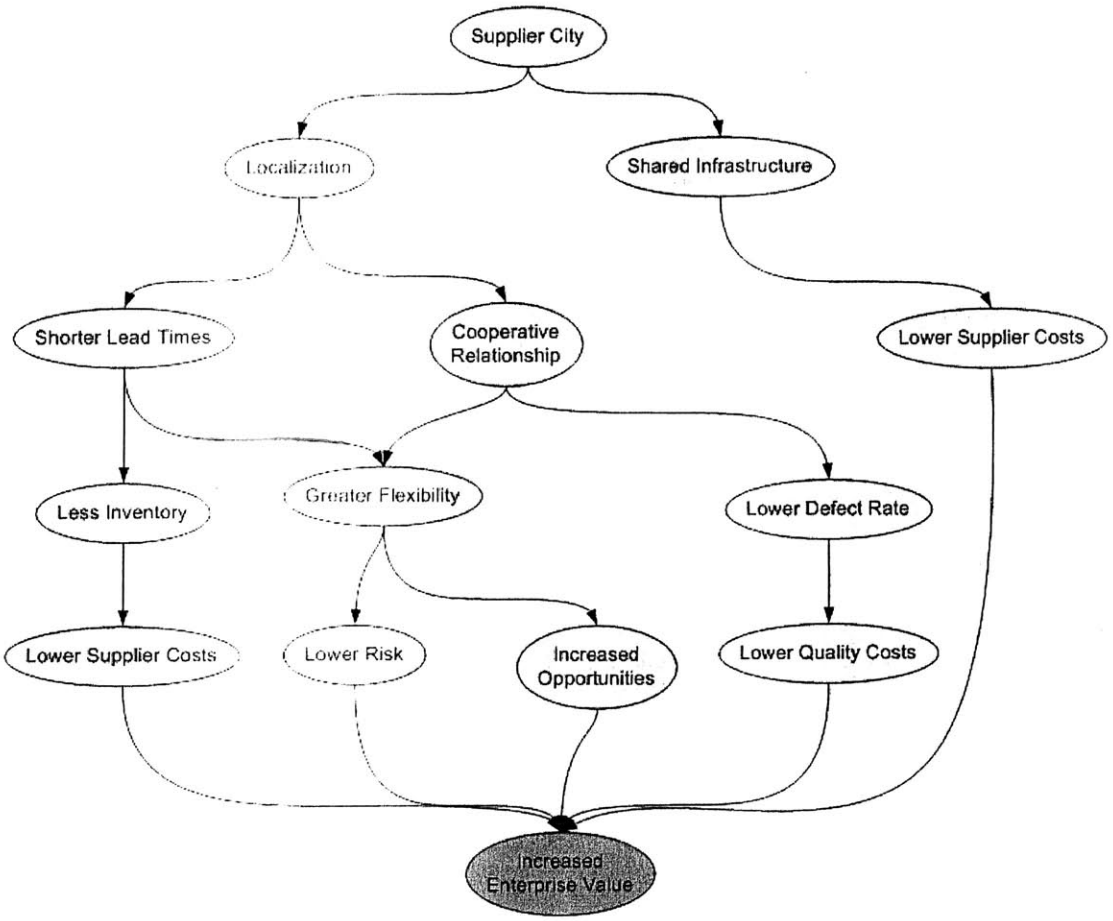


*Figure 3: Potential Value Flow-down Pathways*

## Location and Geography

In determining the geographic parameters for a Supplier City, it is important to consider the economic, regulatory, community, and infrastructure attributes of the candidate locations as well as their available expansion-avenues. The tax situation of different locations can impact the value of conducting supplier activity. Special economic zones may exist in some

locations but not others, or government authorities may be interested in creating one to support a Supplier City development. The amount of space available will determine the number and size of suppliers the Supplier City can host. Of related importance are the specific activities of each supplier: manufacturing may require more space or be subject to more economic or environmental regulations than a warehouse style Supplier City. If there is a surrounding or nearby community, evaluating their needs early can help avoid litigious or political difficulties later. Future physical expansion of the Supplier City should also be considered to ensure future requirements for space, possibly for additional suppliers, can be met. This may indicate locating adjacent to open space owned by a cooperative agent or even purchasing an option on open space. Finally, proximity to supporting infrastructure and services such as utilities, emergency management services, second tier suppliers, etc. can improve the value proposition of the Suppler City.

## Supply Network

In addition to improving operational efficiency and product quality, lowering costs, and increasing flexibility a Supplier City can also reduce or mitigate certain risks present in an organization's supply network. However, to effectively realize this benefit, it is important that the selection of Supplier City participants includes only suppliers with less exposure to the most significant risks. One example is shipping risk. Distant suppliers have greater shipping costs; longer shipping times, and are exposed to increased risk of loss, damage, theft, or delay. To the extent a local supplier uses different sources for its materials; it can reduce or eliminate these risks for the host. The upstream supplier network may differ in being all local or may include distant upstream suppliers located in regions carrying less shipping risk than the host's original supplier network. Another example is avoiding negative regulatory impacts. Depending on the differences between the relative regulatory environments of local vs. distant suppliers, the host may be able to eliminate the regulatory risk of sourcing from a distant supplier by localizing.

# Chapter 3: Strategic Issues

The evaluation of a Supplier City needs to begin with an understanding of key issues that will guide and shape important decisions. In our research, we found seven concepts critical to understanding the decision making process for any company investigating such an implementation. In our work, we uncovered and examined these concepts by first looking at the imbedded assumptions in our host organization. These exercises allowed us to challenge the assumption, verify or refute the underlying reasoning and science as well as develop structured explanations of the strategic issues. It is important for us to review them here, because they build the foundation for our evaluation and development framework.

## *Value Creation vs. Value Capture*

In our investigation and discussion of the Supplier City concept we made the discovery that most people fixate on the "how" of the relationship. How do we structure the relationship? How do we share investment and later profits? How do we manage intellectual property? All of these issues are secondary to that of Value Creation through the relationship.

In order for a Supplier City to really work, the Host and its participating suppliers must forge a genuine partnership based in trust and mutual development and benefit. If the amount of enterprise value does not grow as a result of the relationship (Value Creation), the various parties may get bogged down with the struggle to claim a greater share of the available value (Value Capture). Value Creation is the phenomenon associated with increasing the Potential Industry Earnings (PIE – see Figure 4), where Value Capture is the activity focused on distributing the PIE to various stakeholders. Value Capture centered behavior will ultimately degrade the utility of a Supplier City. The primary focus of a Supplier City should be to grow the available enterprise value and thus, all considerations for creating and developing a Supplier City should begin with the issue of value creation. Once accomplished and before actually implementing the Supplier City, or any additional phased developments, the partners should then build constructs to ensure a fair and satisfactory degree of value capture for each relevant party. If Value is created with each additional development everyone may benefit from the Value Capture arrangement.

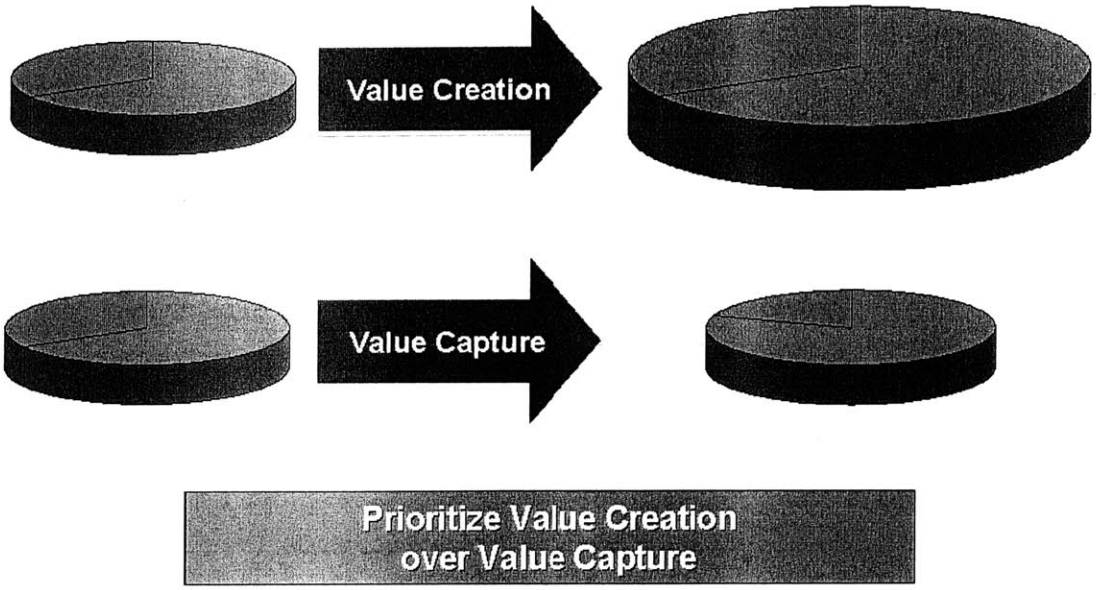


*Figure 4: This figure highlights, visually, the difference between Value Creation and Value Capture. Companies that focus on creating value to be shared among all partners create more collaborative relationships than those that focus on capturing a larger portion of the existing value.*

## *Marginal Benefit vs. Marginal Cost*

A commonly held bias in business is that bigger is better. This bias surfaces in many different ways and it can have an impact on the decisions facing a company implementing or investigating the development of an industrial conglomeration. Each decision to add another process, another partner, and greater complexity needs to be made in the best interest of the company and the Supplier City.

An underlying concept of economic decision making is ensuring that any expansion in the business's activities should yield at least as much value as the cost required to implement the expansion; that is, Marginal Benefit minus Marginal Cost, the marginal increase in total benefit associated with the addition of a supplier or process minus the cost associated with those same additions should be positive. Figure 5 shows the total cost associated with the nth supplier (yellow bars) overlaid on the total benefit or value of the same implementation (orange bars). In this illustration, for the third supplier the change in value is greater than the change in associated cost. However for the seventh supplier the change in value is not great enough to compensate for the additional costs. Applied to the Supplier City concept,

any modification of a Supplier City or introduction of a new supplier should yield greater value than the cost of the introduction.

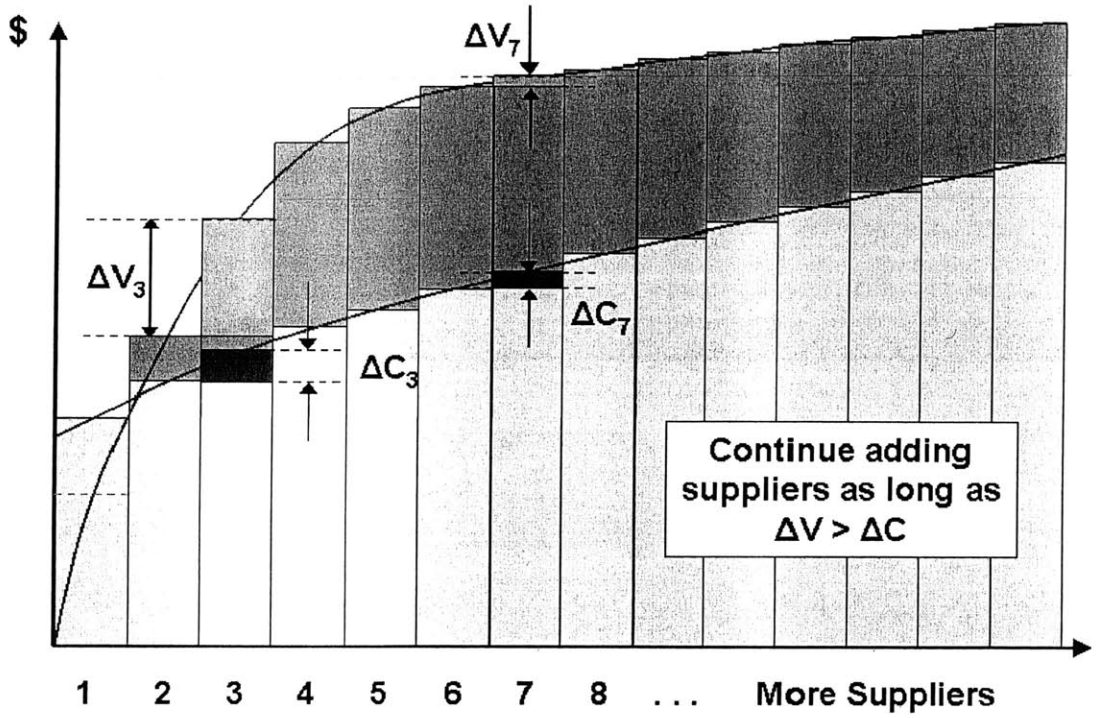


*Figure 5: Illistration of a Marginal Cost vs. Marginal Benefit analysis. Suppliers are represented as independent and are ordered by decreasing marginal benefit.*

As shown in the figure above, as long as the derivative of the value, or benefit, curve is greater than the derivative of the cost curve, it makes sense to introduce more suppliers. It is important to note that Figure 5 represents an idealized situation in which the suppliers have been pre-ordered according to their value yield in a Supplier City. In real life the curves may not be smooth, steady increases as opportunities rarely present themselves so conveniently in order of greatest value to least. The analysis also assumes that each supplier is independent. There are many examples where the value of implementing a set of processes is greater than the sum of implementing each individual process separately. The important thing to remember is that each addition should be considered on the basis of Marginality. This concept applies equally well to all modifications of a Supplier City: relocation, sharing a new resource, adding capital equipment, etc. This concept is a central tenet of our analysis and framework.

## *Complexity vs. Risk*

Related to the above discussion of Cost and Benefit is the issue of Risk. As we evaluate the opportunity for enterprise value creation, it is important to consider the likelihood and magnitude of both positive and negative events. The use of outsourcing typically provides significant shielding to the host company from business cycles and other market based events. By entering into a supplier/host relationship, the ability of the host to respond to the market can be affected.

Hosts should weigh Supplier City complexity against associated risks. This cuts both ways. Complexity is related to the number of independent actors in a system, the variety of their roles, and the number and character of the relationships between them. Risk is the product of the probability of an event and the consequence (for example, cost) of the event. Risk mitigation follows risk identification. In effect, once a risk is understood you can reduce the probability of the event occurring or reduce the degree of consequence if it does occur. Generally, increasing the complexity of any system increases the level of risk in unpredictable ways. However avoiding complexity may also expose an organization to additional risk. When considering the initial or developmental complexity of the Supplier City, it is important to weigh both the risks of adding complexity as well as not adding the complexity. This assessment should be made independently of the value assessment, although both risk and value will be weighed together in the final determination of whether to proceed. While it is difficult to quantitatively value complexity, it is possible to determine value quantitatively, and to determine the value of risk with some degree of precision. Whether the analysis is done qualitatively or quantitatively, a consistent framework will serve the enterprise well.

## *Deployment Phasing*

The impact of a Supplier City on a company's competitiveness can be significant and in the evaluation and investigation phase it can be tempting for the host company to desire a grand implementation. It is important that companies carefully consider where they should draw boundaries for the initial implementation and how they should proceed with development of the Supplier City overtime with continuously changing business conditions.

The authors do not recommend "shooting the moon", or overreaching, with any phase of Supplier City implementation or development. Management's vision of a Supplier City may be grand and capable but long term success is more likely with a "step by step,

courageously" approach. Gradatim Ferociter. The Host should break down the overall vision for a Supplier City into high value, low complexity segments to implement over time in a phased approach. The Host should evaluate each phase independently of any subsequent phases according to the Marginal Benefit versus Marginal Cost function described above. The Host may determine whether or not to pursue the next phase of the development based on financial considerations and market conditions. Regardless, a phased approach to Supplier City deployment provides valuable learning at each step that enhances the Value Creation and Capture of each subsequent step. In fact, the knowledge gained with each phase lowers the Marginal Cost of subsequent steps which may make developments that were previously off limits more attractive. This concept is shown in Figure 6.

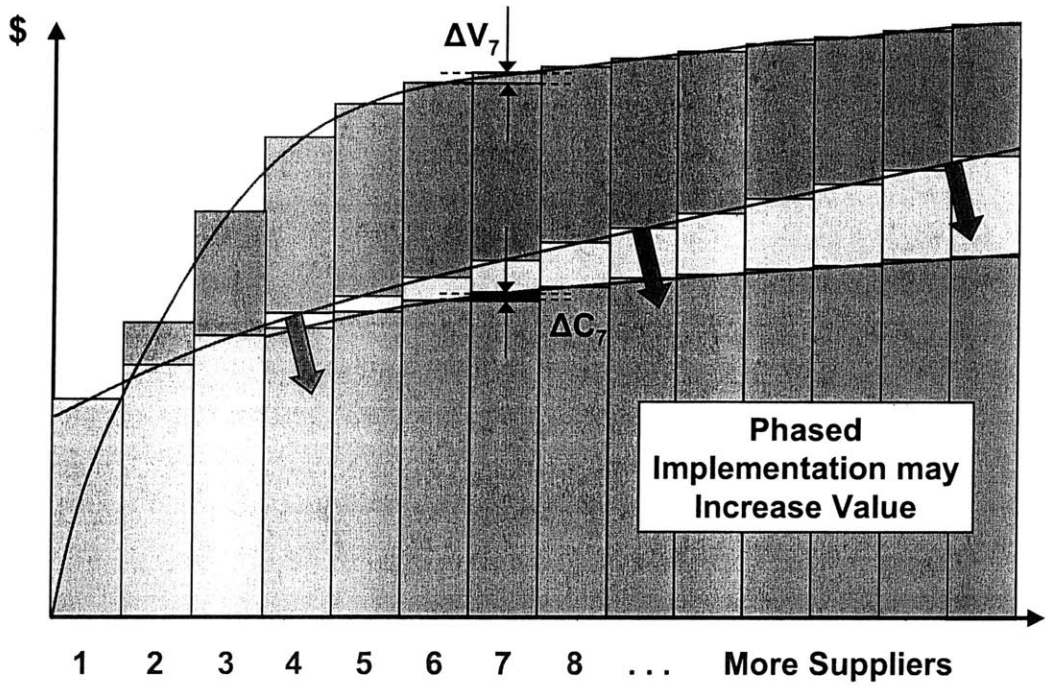


*Figure 6: Illustration of the impact of previous Supplier City implementation on the addition of subsequent suppliers.*

## Learning Effects

A key advantage of vertical integration and consolidation of production activities is the increased efficiency experienced during output (production, development, design, etc.). Though there are definite economies of scale and scope, it is also important to consider the organizational learning that takes place within a Supplier City. One of the key benefits of the Supplier City is the ability of the host to leverage their organizational knowledge,

experience and expertise to reduce the burden of developing new, capable suppliers.

The concept of the learning, or experience, curve was developed by Boston Consulting Group consultants in the 1960s to correlate the cost of production and the cumulative volume of units produced. The theory predicts as workers perform an action they subsequently become more efficient at performing the action. Experience has shown this assumption valid with typical learning curves of 10 – 30% for every doubling of production output. Consideration for the learning curve is common in supply chain organizations.

A strong Supplier City concept should enhance this effect and provide opportunities to increase a supplier's learning curve. Greater access to operations personnel within the host organization gives workers a better understanding of the end usage of the products they build and provides opportunities for process improvement. Typically the host company has more manufacturing expertise than Supplier City participants which creates more opportunities for supplier learning. Improved access to quality and engineering at the host company should eliminate barriers to learning about the products and processes the customer requires. At the extreme, the host company could become a mentor to weaker suppliers drastically improving learning effects. Calculating these learning benefits is relatively straightforward: the difference between the supplier's historical learning curve performance and an estimate of improvement due to closer proximity should indicate unit cost savings over time.

## *Foreign-Domestic Capability Curves*

Companies attempting to expand production into developing regions have two choices with regard to developing suppliers: 1) develop local suppliers often starting with companies with no direct experience with the related products or processes or 2) import foreign suppliers that have the technical product and process expertise. The second option many times may be met with greater organizational appetite, but it is important to evaluate the short, medium and long-term impact of supplier selection.

An important consideration for global companies is to evaluate if a Supplier City needs to include foreign suppliers – those suppliers that are headquartered in countries different from the Supplier City. For some companies, utilizing foreign suppliers provides opportunities to import process, engineering, and manufacturing expertise superior to the local supply base. By relocating these suppliers to Supplier City, the host organization can take advantage of the resources and capabilities of suppliers with whom they have existing relationships.

However, this experience may come at a slightly higher price compared to local suppliers. The amount of this experience premium and the improvement in the rate of capability development varies greatly based on country conditions and the skills the foreign company brings.

Plotting curves representing total supplier capability on the y axis and time on the x axis, we highlight some of the short and long term tradeoffs between local and foreign suppliers. Capability represents a theoretical composite of cost, quality, and delivery. As can be seen in Figure 7, the capability for the local supplier begins at time zero because they already have a local presence. For the foreign supplier, there is a delay in implementation because they have to relocate operations to the host country. However, once they begin operations, their capability quickly develops because of the foundation of experience and expertise that they posses. The same curves should be plotted if a Supplier City is implemented and these curves are represented in Figure 8. Through the implementation of Supplier City, the capability of both the local and foreign suppliers is shifted to the left. Because of the efforts of the host companies and the advantages of shared infrastructure, increased communication and technology transfer, their capability develops at a faster rate. In this instance, the capability of the local supplier quickly eclipses that of the foreign supplier; potentially becoming the preferred choice for inclusion. Strategic decisions within the organization may also influence how much influence is placed on different points in the future which may also influence foreign vs. domestic supplier decisions.

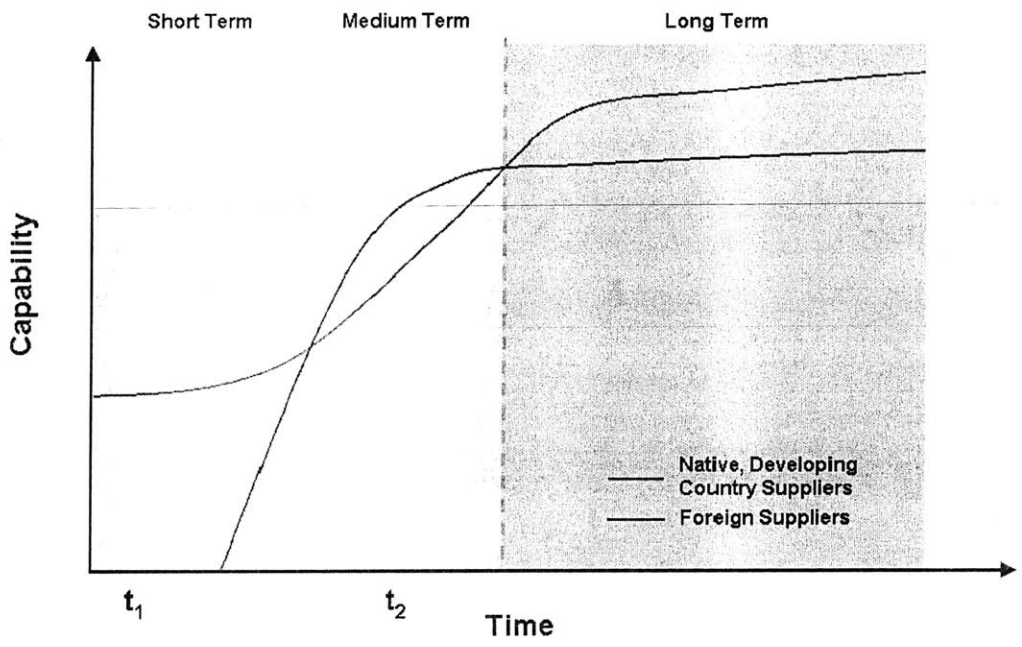


*Figure 7: Foreign vs. Native Supplier Capability Curves w/out Supplier City shows that the local supplier is immediately able to deliver product due to their local presence. The foreign supplier is delayed because they have to relocate operations to the host location.*

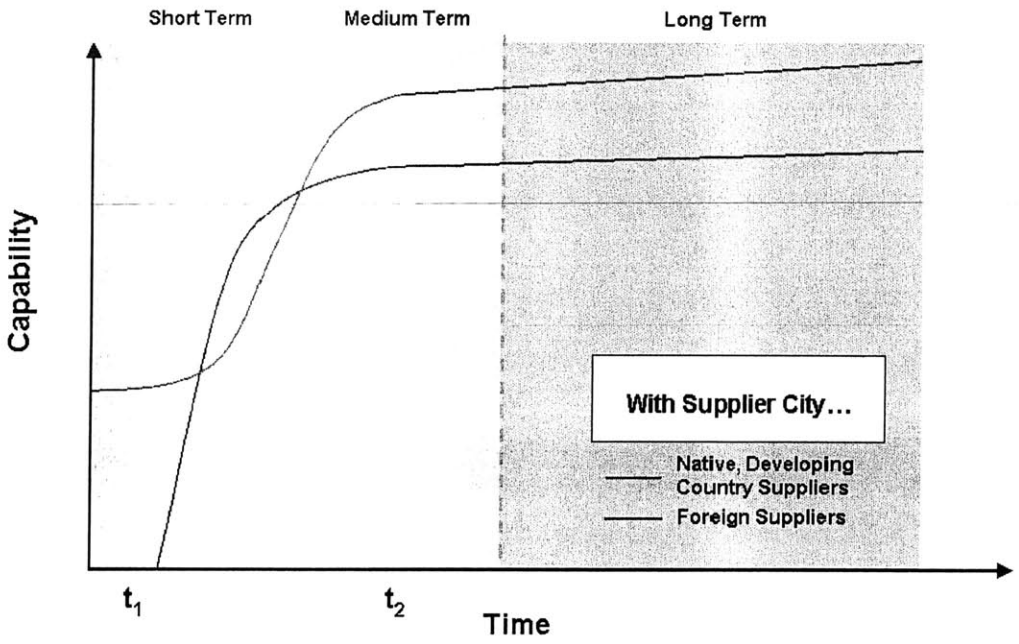


*Figure 8: Foreign vs. Native Supplier Capability Curves w/ Supplier City. Due to the Supplier City, both curves are shifted to the right and the rate of improvement increases due to shared infrastructure, improved communication and technology transfer between the host and other Supplier City participants.*

# Chapter 4: Supplier City Scenario Design and Evaluation Framework

While there has been some research on the characteristics, risks, and benefits of Supplier Cities and Industrial Conglomerations in general, there appears to be no guiding frameworks for helping a firm determine if a Supplier City is right for it. In this section we present a novel approach for designing and evaluating Supplier City scenarios. It does not pre-assume a Supplier City is fundamentally good or appropriate. Rather, it helps an organization determine if a Supplier City may be beneficial, and if so, what organizational processes to out-source to one, how to stage deployment (grow the Supplier City over time), and how to compare various candidate scenarios for greatest benefit to the firm. We developed this framework as part of our GLAB (see Appendix C) project work for Timken, China. The process outlined in this section is shown graphically in Figure 9, below.

## *The Null Hypothesis*

When taking a decision to pursue a course of action, a team may unwittingly make the assumption that doing something is fundamentally required and the decision is simply about what the action should look like. This assumption ignores the possibility that doing nothing may be the most advantageous option. The Null Hypothesis is simply a Scenario candidate, equal in stature with all other Scenario candidates, in which no Supplier City is built. It should be evaluated in an equal manner against all the other candidates.

## *Scenario Design*

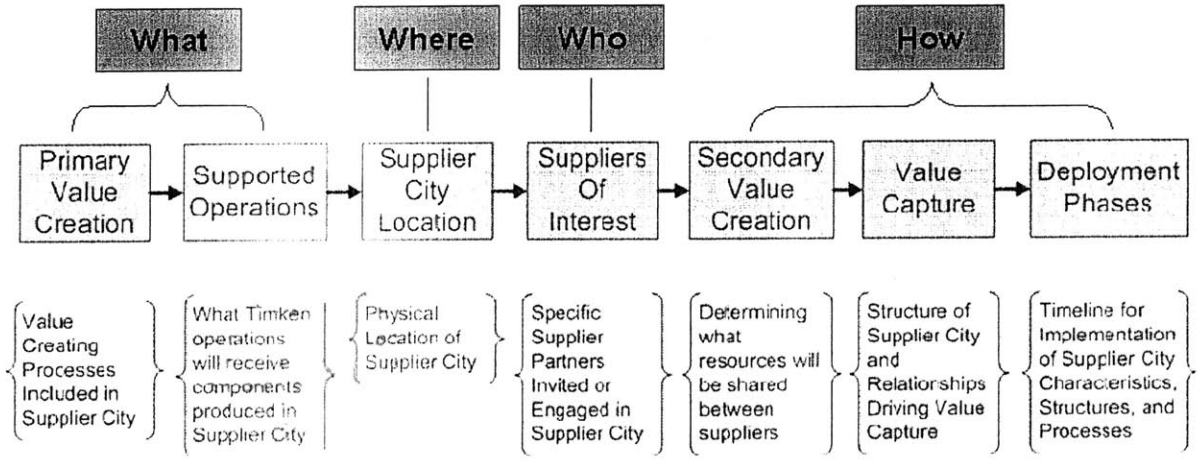


*Figure 9: Graphical Representation of Scenario Design Process*

## Primary Value Creation – Process and Component Selection

The first and most important step in the Scenario development framework is determining which supplier processes and components will create the most value by being moved into Supplier City. Arguably, a Host may create value by moving any process into a Supplier City; however, some processes have greater potential for cost savings than others. Some possible metrics to consider for value creation are holding cost reduction (e.g., the cost of a particular component's buffer inventory or safety stock), lead time reduction (e.g., shipping times or forecasting errors), and transportation cost reduction (e.g., large, awkwardly shaped, or distantly produced items). Another interesting method of selection is to favorably weight interrelated processes with the goal of leveraging savings in standard operations metrics across multiple processes. For example, locating closely related steps under one roof can greatly reduce or eliminate buffer inventory driving down overall WIP. The important aspect of this step is to identify real and quantifiable value generation that can be accomplished by moving a process into a Supplier City and ranking the processes accordingly.

## Supported Operations – Supplier City Customers

This paper assumes the decision to evaluate the attractiveness of a Supplier City was taken at the level of an individual plant or regional grouping of plants, or that the decision was made at a higher level but targets a particular plant or region. Indeed the first part of this framework, "Process and Component Selection", depends on having selected a given value stream. Three dimensions in particular are important to consider, two of which are underpinned by Marginal Benefit versus Marginal Cost analysis.

First, since the decision about what processes to include in Supplier City was taken in the first step of the framework, choosing which other Host facilities to support should be based first on component commonality. If the processes designated for the Supplier City can also produce components needed by other Host facilities, then those facilities become candidates for Supported Operations (i.e., potential customers of Supplier City). If there is a strong organizational desire to support a second value chain in another facility and commonality does not exist, the Host may need to loop back to the first step in this framework to re-evaluate assumptions about the scope of the facility. Otherwise, the next step is to make a

more detailed Marginal Benefit to Marginal Cost analysis.

The Marginal Benefit (MB) v. Marginal Cost (MC) define acronyms detailed analysis is conducted from two perspectives. The Marginal Benefit to the newly supported value chain versus the Marginal Cost comprised of the incremental cost of any step increase in capacity in Supplier City and the landed cost of the component at the newly support Host facility. Again, if Marginal Benefit is greater than Marginal Cost, supporting the additional facility would seem to be a good idea.

The third dimension to consider is corporate politics. Unfortunately, political positioning may lead a particular facility to resist allowing some or all of their sourcing development function to be controlled by a committee of Host facilities or by another facility altogether. Power maintenance and consolidation are very powerful drivers though they frequently yield globally sub-optimal solutions.

## Supplier City Location

Where to locate a Supplier City can be a particularly controversial debate. Dimensions for consideration include location of Economic Development Zones, proximity to Host operations, cost and availability of land and skilled workers, availability of resources and infrastructure, proximity to a variety of transportation modes, and desirability of living conditions. It is important to consider, however, that the chief medium and long-term benefit of a Supplier City is supplier development, both in terms of process and relationship. While it may, at first, seem prudent to locate a Supplier City at a mid-point between Host facilities, if the distance is too great, the effect of having a local Host presence will diminish greatly. Being within visual distance of the Host serves to provide the resident suppliers with a physical sense of Host presence; indeed, Host engineers and managers can provide nearly immediate assistance and oversight should the need arise. With respect to supplier development, troubleshooting, collaborative design, and instilling loyalty, close proximity to a Host facility is an unmatched advantage. A potential Host should consider this and other dimensions very carefully when developing Scenarios.

## Suppliers of Interest

Selecting suppliers for invitation to Supplier City is a subtle and complex problem. Since the relationship being forged is intended to last indefinitely, it is important to consider more than the suppliers' recent performance against the standard metrics of cost, quality, and

timeliness. It is also important to consider how well a supplier understands the local culture and business environment, its commitment to the Host, and its capability and willingness to engage in a long term continuous improvement effort. During our study we found a number of strong assumptions existed both within the team and in the Host organization regarding the quality, capabilities, and cost structures of national vs. global suppliers. Our examination of assumptions specifically dealt with the differences between relatively new suppliers native to a country in an early stage of industrial development versus well established global suppliers who would be entering that country for the first time. The assumption stated the global suppliers were more appropriate candidates for Supplier City than the native ones. Careful analysis of the assumption led us to create the cost capability curves in Figure 7 and Figure 8. The stories the curves tell indicate the capabilities of the two classes of supplier intersect twice at different periods after the introduction of Supplier City. We now believe the assumption is only correct during a temporary, and relatively short, medium term interval, after which the native suppliers gain and maintain the advantage. These capability curves serve to demonstrate that the various hard and soft dimensions of evaluating suppliers for suitability to a Supplier City interact in complex and sometimes counter-intuitive ways.

## Secondary Value Creation – Resource Sharing

Value Creation has two parts to it. As indicated, the most important part is determining which value stream processes to import to a Supplier City. The second part, Resource Sharing, is more easily determined once it is clear which specific suppliers the Host will invite to participate. Suppliers may share any number of a broad range of resources: legal, HR, utilities, waste disposal, laboratory, indirect materials, warehousing facilities, transportation, food, janitorial, training, buildings, etc. It is tempting for the Host to make a far reaching determination of what resources will be shared by the suppliers; however, the authors recommend a conservative approach. Setting up sharing of only the most obvious resources with strong value propositions and low likelihood of political opposition (e.g.: land, factory space) allows the Host to minimize up-front capital costs while providing the suppliers an opportunity to collaborate on further resource sharing in a way that makes sense according to the emergent characteristics of the community over time.

## Value Capture Profile

Once the Host has ensured Value Creation through a Supplier City, it must undertake the complex steps of arranging a Value Capture Profile agreeable to all Supplier City

stakeholders. This is done through policies, contracts, and physical arrangements. The specific dimensions to consider are profit sharing (when component costs fall due to joint process improvement efforts), maintenance responsibilities, leasing arrangements (for space in the Supplier City facility), liability sharing, best practice sharing, capacity assurance, resource cost sharing, and termination conditions and policies. Profit sharing must be given considerable thought before entering into any agreement. Since one of the chief financial benefits of a Supplier City is an accelerated learning curve for participating Suppliers, cost reductions for components must be expected. Any arrangement for sharing the cost deltas must, to the extent possible, satisfy both the specific supplier and the Host to ensure continued relationship development and loyalty. It is important to note that these various dimensions for value sharing among suppliers and hosts are not all required, but they are important possibilities to consider. In other forms of Industrial Conglomeration, due to the lower degree of coherence in inter-firm relationships, there will be fewer of these dimensions represented in any formal agreements or relationships. Unfortunately, the specification of the different types of conglomeration have not yet reach the point, in literature, where clear demarcations of what or how many dimensions may be included in each type.

A potential host must determine the most suitable methodology for itself; however we recommend the following technique as a baseline.

1. Complete the "Secondary Value Creation" and "Value Capture" portions of the framework to determine what savings due to resource sharing will accrue to the Supplier City enterprise and how that and other forms of cost savings will be divided among the stakeholders (including the Host)
2. Develop rough cost models for each Process-Supplier in Supplier City
3. Determine the NPV of savings for each stakeholder (all suppliers and the Host)
4. Rank each scenario according to the relative variance in value capture. For example if, in a scenario, each of four suppliers saves $0.25M while the Host saves $7M, that scenario is ranked lower than one in which the suppliers each save $2M while the Host saves $2M. If any of the stakeholders (including the Host) have a negative NPV in a particular Scenario, that scenario is moved down in the rankings.

## Deployment Phases

Our analysis has convinced us of the validity of Gall's Law:

> "A complex system that works is invariably found to have evolved from a simple system that worked."[40]

We have found a frequent assumption about Supplier Cities is the up-front capital cost and continuing fixed costs will require a very large scope to justify. This is not necessarily true. The key is to find the highest value, lowest complexity, lowest cost Scenario that will justify the commitment in the short term; in other words a high value, small-to-medium scale project with a short ROI. Subsequently once the "experiment" has demonstrated its worth, additional suppliers and Supplier City "constructs" may be deployed into the Supplier City on a case by case basis or as package deployments. The only clear requirement in developing the Supplier City over time is adherence to the Marginal Benefit versus Marginal Cost rule. Any expansion of the Supplier City either in size or scope should yield greater value than it costs otherwise it should not be pursued.

# *Scenario Evaluation*

## Down-Select Process

Once the Host has developed a list of feasible candidate scenarios it must compare them in a meaningful way to determine a road-map forward. In the product design and development domain the down-select process provides a structured framework for evaluating each candidate against a list of pre-determined, critical metrics to rank-order the list. A matrix is created in which each candidate is ranked relative to the others in each of the individual metrics. Summing across the metrics for each candidate provides an overall ranking indicating the preference order of the solutions. It is important to follow some degree of discipline in this process to mitigate against the introduction of individual biases or political influences. Even after a Host has initially implemented a Supplier City, it is important to evaluate each additional phase of Supplier City development against the given criteria to maximize the probability of successful implementation and enterprise value enhancement. An example selection matrix is shown below followed by a list or recommended metrics and their descriptions.

## Dimensions

### Overall Value Created

Arguably the most important of all the metrics is an assessment of the value created by the Supplier City (or subsequent additions/modifications to it). It is determined by taking the

enterprise Marginal Benefit and subtracting the enterprise Marginal Cost. If the result is not positive, then the Host should not implement the Supplier City (or the phase being evaluated). The Host should determine the value created across the entire enterprise (including the relevant suppliers) in order to ensure a complete analysis free of unforeseen pitfalls. This will require a detailed, enterprise-wide, cost model to determine accurately. Cost modeling is notoriously complex and it is difficult to precisely capture all relevant detail in any given view of the enterprise. At a base level it is important to generate a discounted cash flow which includes capital expenditures and forecasted after-tax cash flow for some reasonable period of time or for long enough to see what the return on investment will be. This naturally includes all fixed costs and variable costs directly related to the Supplier City or some expansion thereof. Greater detail can be achieved by doing Monte Carlo analysis on the expected demand rates the Supplier City will be expected to fulfill based on historical trends analysis of past demand volatility. Any given finance department may have its own particular cost modeling methodology. It is important that whatever techniques are used to model a Supply City for a firm, they are consistent with cost modeling techniques used elsewhere in the firm for consistency's sake.

### Value Capture Profile

Next in degree of importance is the Value Capture Profile, so called because it illustrates the amount of Value Created "captured" by each of the relevant stakeholders; that is Marginal Benefit minus Marginal Cost for each stakeholder. This metric may be more difficult to determine accurately due to the lack of perfectly transparent insight into any given stakeholder's cost function. However, over time the ability to accurately predict Marginal Benefit and Marginal Cost for a close partner should improve. While it is clear from anecdotal evidence that hosts tend to have a clear understanding of their supplier city suppliers' costs, the methodologies used to determine the value capture profile appear to be closely held. We assume there is an effort to be equitable in order to keep all parties engaged and satisfied by the arrangement.

A key aspect of a Supplier City is strong, committed relationship development. To ensure long term positive effect for the Host, the Host must ensure all partners are appropriately incentivized and rewarded for their good-faith participation. This metric is high when the Scenario is structurally designed to ensure a positive value capture for each relevant stakeholder and low when one or more stakeholders have zero or a negative Value Capture. Incidentally, a qualitative side-assessment of how closely each stakeholder's Value Capture

correlates to the Stakeholder's expected Value Capture will provide insight into the success of the Host's stakeholder management policies.

### Complexity/Risk

Value Creation and Value Capture provide an indication of the promise of an endeavor but much of its success will lie in the Host's accurate prediction and preparation for the inherent complexity and risk of the endeavor. A Host may determine the value of this metric with some degree of precision using formal risk assessment coupled with a subjective ranking of the scenarios for complexity. Greater complexity gets a lower relative score. Risk quantification should be determined by listing the possible negative events (e.g.: lawsuits, supplier defection, nationalization, intellectual property leakage, etc), assigning each a dollar value for consequence and a probability of occurrence. Multiply the probability and consequence for each event, and sum the results Scale the result to the same scale used for ranking complexity (most likely single digit numbers) by dividing by some multiple of 10. Finally, for each scenario, add the complexity ranking to the risk value and enter the result in the Complexity/Risk column of the matrix.

$$RISK_{Scenario} = \sum_{Events} \$\$_{Event} * P_{Event}$$

Where:

$RISK_{Scenario}$ = The risk inherent in the scenario
$\$\$_{Event}$ = The dollar consequence of a particular event occurring
$P_{Event}$ = The probability of a particular even occurring

The above equation indicates that the risk for each scenario is the sum of the risks for each event associated with that scenario. Per event risk is calculated by multiplying the probability of that event by the dollar value of its consequence.

$$Complexity / Risk_{Scenario} = ComplexityRanking_{Scenario} + RISK_{Scenario}$$

The above equation indicates that the Complexity/Risk metric for a scenario is determined by adding the Scenario's Complexity Ranking to its Risk level.

### Organizational Appetite

Finally, Organizational Appetite is the most qualitative metric in our framework. Many organizations find it difficult to reliably determine their overall desire for a particular value

proposition including their robustness to the relevant risks. Understanding what Scenarios are an appropriate cultural fit for the company is key to selecting a way forward. Such understanding may indicate implied demands on leadership for organizational change, or may prevent the organization from committing to a course of action to which it cannot genuinely commit.

# Chapter 5: Levers and Issues in the Creation and Development of a Supplier City

## *Levers*

There are many levers that impact the implementation and justification of a Supplier City that are worth noting. The following three sections are critical levers for the creation of value within the Supplier City. These tools come from manufacturing process selection, supply chain, and operations management research and publications. All of these topics will feed directly into a company's analysis and use of the design and evaluation framework outlined in this paper. The following sections provide an overview of the topics.

## *Manufacturing Process Selection Method*

Following the framework presented in the previous chapter, it is of paramount importance to the success of the Supplier City that the appropriate processes are included in the initial and subsequent implementation. The following sections provide a detailed overview of the various factors that impact this decision process.

### Outsourcing

Every company has to understand the strategic implications of outsourcing in their business. In "Is the Make-Buy Decision Process a Core Competence?" [Fine and Whitney [8]]the authors assert that there is no single "best" policy with regard to outsourcing. In addition, the optimal solution at any given time is likely to require modification as the pressures on the business change with time. For these reasons, it is important that a company investigating the effects and impact of a Supplier City understand the underlying outsourcing decision and how the Supplier City impacts that decision.

In the paper, Fine and Whitney assert that there are two kinds of dependency associated with outsourcing: 1) dependency for capacity (where the company maintains the knowledge) and 2) dependency for knowledge. The risk associated with Type 2 outsourcing is much greater as the technology associated with the activity is harder to replicate (think Intel and Microsoft). So, the company needs to carefully consider if by making an outsourcing decision, they are helping their supplier develop an expertise that will make

them powerful as a value chain partner, or if they are simply using a supplier's resources to lower fixed costs and increase capacity. Making this decision is a very difficult choice and becoming world-class at the process is a sustainable competitive advantage.

Within our analysis, we have chosen to focus on the decision of where and how to produce those items that we have chosen to outsource, and have not focused on the issue of how the presence of a Supplier City could impact a company's decision to outsource – we have treated these as serial decision making processes. However, it is important to mention a couple of reasons why, as a company evaluates the appropriate scope for their Supplier City, it is appropriate to check the assumptions that were used in the outsourcing decision making process. First of all, intellectual property is a major concern in some developing markets. Many companies choose different outsourcing policies to protect their IP in developing markets because they feel that their supplier relationships are high risk. The presence of a Supplier City and the corresponding relationship with the host company will result in tighter control of technology for the host, and as such may allow them to re-evaluate this decision. Likewise, it is often the case that companies choose not to outsource certain components for concerns of quality, material integrity and general product performance. Again, the deepening of the supplier/host relationship through the Supplier City can have positive impacts on these concerns and again could cause the host organization to re-evaluate the outsourcing decision.

So, as Fine and Whitney[8] assert, the decision process for which part of the product value chain should be outsourced can be a strategic, sustainable competitive advantage. It is possible to develop a core competency in this skill. In doing so, it will be important to consider the effects of a Supplier City on those decisions, but that topic is appropriate for development beyond the scope of this work.

## Value Chain Analysis

Value Chain analysis is an important tool required for making the decision of which components to supply from the Supplier City. First of all, it is necessary to understand the value associated with each outsourced commodity. For every business, there will be appropriate methods of slicing up the value chain, but essentially, it is best to look for guidance in the current supplier pool. For example, if it is normal for a single supplier to produce Part X, Y and Z, then those three components may be a logical commodity group for analysis. Of course, the relative minimum efficient scale for each individual component

and other factors may challenge that assessment.

Following the segmentation of product into commodity groups, it is necessary to estimate how much product could be diverted to the Supplier City. These numbers will quickly provide an indication of which commodity groups may be able to support a Supplier City supplier. For example, does the volume of material in commodity group C meet the minimum efficient scale for products in that category? Secondly, this analysis will highlight those core processes that have the most significant value opportunity. Following the pareto principle, it is not uncommon for a few commodity groups to contain the majority of the value in a given product. For example, if you look at an automobile platform, the majority of the product value is in the body assembly, the power train assembly (engine and transmission) and the chassis. In a modular supply chain, these represent three key suppliers and harnessing them in a Supplier City (or Supplier Park as is more common in the industry), significant savings can be realized. In addition, identifying the top few suppliers will make management of the relationships simpler and increase the likelihood of positive enterprise value. It is appropriate to consider each relationship as a high fixed-cost, low variable cost (with respect to volume) investment. So, it is appropriate to focus on those products with sufficient annual spend to justify establishment of the relationship.

Based on this analysis, we recommend that the company first identify appropriate product segmentation by identifying commodity groups. Then, a value analysis of these groups will allow comparisons to be made with the MES requirements for the product type, and relative opportunity for each product category. And, finally, it is appropriate to conduct a value stream analysis. This is appropriate for analysis at the finished product level to identify the greatest areas of opportunity across steps. For example, if one product is processed through three consecutive steps, all completed by different suppliers, then there will be work-in-process inventory, cycle stock inventory and safety stock inventories held by each supplier. The opportunity provided by consecutive suppliers often offers compounding of value stream savings my co-locating process steps. It is also appropriate to look at the value stream within a commodity group. For example, let us consider the example of an axle seal that is supplied to an automotive power train assembly plant. This axle seal represents a component that is produced in a vertically integrated assembly process. An inspection of the value stream analysis demonstrates that the process is highly efficient with very little waste in the form of inventory or excess handling. In addition, an inspection of the entire value stream shows that the high value density (an indication of cost to ship related to the product value) leads to low logistical costs. In this case, an inspection of the

value stream reveals that there would not be sufficient benefits to justify inclusion of this commodity group in the Supplier City.

## Technology Transfer

One of the key challenges facing many companies establishing manufacturing operations in developing countries and emerging markets is that of developing suppliers. Developing supplier expertise can be a very expensive endeavor. As an early entrant, it is quite likely that many suppliers will not be used to the type of quality, manufacturing and communications technology required to meet world-class manufacturing targets for quality, cost, and delivery. As discussed in "Geographical Proximity and Adoption of Advanced Manufacturing Technologies",[Parhi[24]] investigations of informal industry clusters in India showed a strong correlation with the use of AMT (advanced manufacturing technology) by firms clustered together as opposed to those that were operating in disparate locations. Parhi attributed this correlation to the linkages (formal and informal) with other proximate firms leading to adoption of technologies based on the informal exposure to the technology. This is highlighted in the research by the fact that AMT adoption follows a regional pattern. In addition, there is some evidence that upon adoption, these firms will be more successful with the technology that they choose to adopt because of the resources contained in these linkages.

Furthermore, he goes on to state that "locational advantages due to proximity to the customers and machinery suppliers are highly correlated with the higher use of AMTs". This is particularly relevant to the Supplier City concept. By co-locating suppliers, in close proximity to the host company, there is an increase in the communication between the two groups and therefore the exchange of information and ideas. These exchanges lead to the more expedient and more successful adoption of technology.

Additional evidence on the power of proximity can be found through examination of the Manufacturing Extension Partnership (MEP) – a program sponsored in the United States by the National Institute of Standards. The Partnership has grown to 350 independent non-profit offices that are linked together to provide access for even the smallest companies to the latest technologies assisting them in the implementation of new technologies and the wise investment in modernization. This model has potential replication opportunities within the walls of Supplier City.

If we assume that the proximity based advantages for a cluster are gained by the Supplier City, then we can draw some powerful conclusions from these findings. For the host company, the use of a Supplier City will lower supplier development costs and will accelerate the development of advanced capabilities. For the supplier firms, the increased interaction with the host company and other Supplier City members will help them develop advanced manufacturing skills that are applicable to many customers and will therefore increase overall firm value.

## Manufacturing Process Considerations

It is important that the host company make appropriate considerations for how the manufacturing process will affect the performance of Supplier City. Specifically, they should consider the maturity of the process technology, the relative expertise of the supplier, compared to the host, and the possible impact of the process on other processes hosted at Supplier City.

The invitation of a supplier to Supplier City indicates an increase in commitment. An evaluation of the process maturity will help the host company understand the potential for disruption. Simply by including a supplier and their current technology in Supplier City, the host company has increased commitment to that production technology. If there is a chance that the technology introduced to Supplier City could be eclipsed in the near term, this could be a costly mistake limiting the host's ability to respond to market pressure.

It is critical for the host company to understand their level of expertise versus that of their supplier. As discussed above, technology transfer is a key attribute and function of Supplier City. But, the majority of these transfers are likely to be from the host to the supplier. If the supplier already has developed more sophisticated technology than the host, it is not likely that the technology transfer gains will be very substantial. Furthermore, a comparison of each supplier with their Supplier City peer group may also reveal some opportunities for learning across suppliers and so those opportunities should be investigated as well.

Finally, there needs to be some consideration made regarding the possible interaction between Supplier City processes. This could take two forms: 1) physical process interaction or 2) organizational interaction. An example of physical process interaction would be if two processes that were previously separated are brought under one roof and the heat

generated by one process step impacted the stability of the machines in another process step. This is not a likely case, but with the desirability of locating the Supplier City under one roof, it is evident that this needs to be consideration during the process selection step. On the other hand, a process interaction could take on the form of an organizational process interaction. An example would be a case where historically two processes were separated to keep their technologically interaction hidden to the suppliers (Host IP protection). If these processes are both housed within Supplier City, the interaction of employees of two suppliers and their heightened understanding of the two processes will put the technology at risk

## *Supply Chain*

Supply chain tools such as inventory and order management account for one of the more easily and rigorously quantifiable Value Creation opportunities for a firm evaluating a Supplier City. These tools help to understand impact of various scenarios on product lead time, system inventory, and inventory holding costs. The impact of proximity can be significant in businesses where the value of supply chain responsiveness and inventory value are high.

### Lead Time Reduction

Lead time is the period of time between when a firm makes an order and when the order is delivered. Safety stock not-with-standing, a firm makes an order for a given amount a period of time equal to the lead time before it expects its input inventory to drop to zero. Typically this is tracked in terms of a Reorder Point (ROP):

$$ROP = L \times R$$

where:

L = Lead Time

R = Average Process Consumption Rate

When firms and their suppliers are located in closer proximity, lead time is reduced by the shipping time savings of the new location. Additionally, lower transportation distances often lower the cost of smaller orders and can consequently reduce the economic order quantity.

In addition to transportation savings, a reduction in total supply chain inventory can also greatly reduce the flow time of work-in-process and therefore can reduce the average production lead time for a given product. Depending on where the supplier was located before and how much inventory is in the pipeline (a combination of process, proximity and management), this can have a dramatic effect on lead time and therefore the re-order point and system inventory.

## Cycle Stock Reduction

Cycle stock (or cycle inventory) is the average input inventory for a particular process. In terms of flow time, the first unit of cycle stock enters the process immediately while the last unit enters some period of time later dependant on the number of units in the cycle stock and the process rate. This suggests a triangular profile over time for cycle stock. At the high point, a new order of product has just arrived. Over time, the manufacturing process depletes the cycle stock until it reaches some low point, triggering the delivery of a new order of inputs. In a typical order cycle, cycle stock is the number of units ordered divided by 2:

$$I_i = Q/2$$

where:

$I_i$ = Cycle Inventory

Q = Order Amount

A firm may reduce its cycle inventory by convincing suppliers to locate in close geographic proximity. Closer proximity relates to shorter lead times and therefore smaller economic order quantities. Smaller orders often result in the implementation of smaller production lot sizes, and lower work in process inventories. And, consequently, these features allow for a given supplier to be more responsive to production demand and changes increasing flexibility. So, because the supplier is closer, deliveries may be smaller and more frequent. Less space is needed to store inputs, less money is tied up in holding costs, and the flexibility of the overall production process is increased.

## Safety Stock Reduction

Safety stock (or safety inventory) is the amount of inventory over and above the average cycle stock for a given forecasted demand. Safety stock is recommended in any situation where demand is variable. It is calculated by multiplying the standard deviation of the process demand with a "z" value as taken from the normal distribution that correlates to the percent service level a firm expects to maintain for inputs to that process.

$$I_{safety} = z \times \sigma_{LTD}$$

Where:

$I_{safety}$ = Safety Stock Inventory

z = "z" value from normal distribution representing

$\sigma_{LTD}$ = Standard Deviation of Demand over the Lead-time of delivery

Locating a supplier within close geographic proximity will not reduce demand variability for the firm's processes nor will it specifically raise or lower the service level the firm has set for the process. However, a reduction in the lead time of order fulfillment will reduce $\sigma_{LTD}$ by the square root of the ratio of lead times (lead time prior to Supplier City/lead time after Supplier City).

$$\sigma_{LTD\ (after)} \sim \sigma_{LTD\ (before)} * \sqrt{(L_{(before)}/L_{(after)})}$$

Where:

$\sigma_{LTD\ (after)}$ = Standard Deviation of Demand over the Lead-time of delivery after the change

$\sigma_{LTD\ (before)}$ = Standard Deviation of Demand over the Lead-time of delivery before the change

$L_{(after)}$ = Lead time after the change

$L_{(before)}$ = Lead time before the change

Firms may expect the same effects described above: lower holding costs, space savings, and increased flexibility.

## *Operations Management*

The operations management tools of Learning Curves ,Geographic Proximity and Partner/Supplier Development, are very important to Supplier City evaluation. The appropriate selection of suppliers, as well as creations of reasonable expectations with regard to supplier development, is both contingent upon these issues. The following sections provide the reader with an overview of key concepts.

### Learning Curves

The learning (or experience) curve describes the mathematical relationship between the unit cost of a product and its cumulative output. It measures the rate at which unit costs decrease with each doubling of total number of units produced since production began. It is important to note the operative word "cumulative" does not represent production rate. Instead it is the measure of the total number of units delivered since the very beginning of production. The mathematical relationship is a negative power law:

$$C_t = C_0\left(\frac{P_t}{P_0}\right)^{-a}$$

where:

$C_0$,$C_t$ = cost per unit (corrected for inflation) at times 0 and t, respectively;

$P_0$,$P_t$ = accumulated volume of production at times 0 and t, respectively;

a = constant, reflecting the elasticity of unit costs to accumulated volume (an exponential factor representing the percent reduction in costs over cumulative units produced).

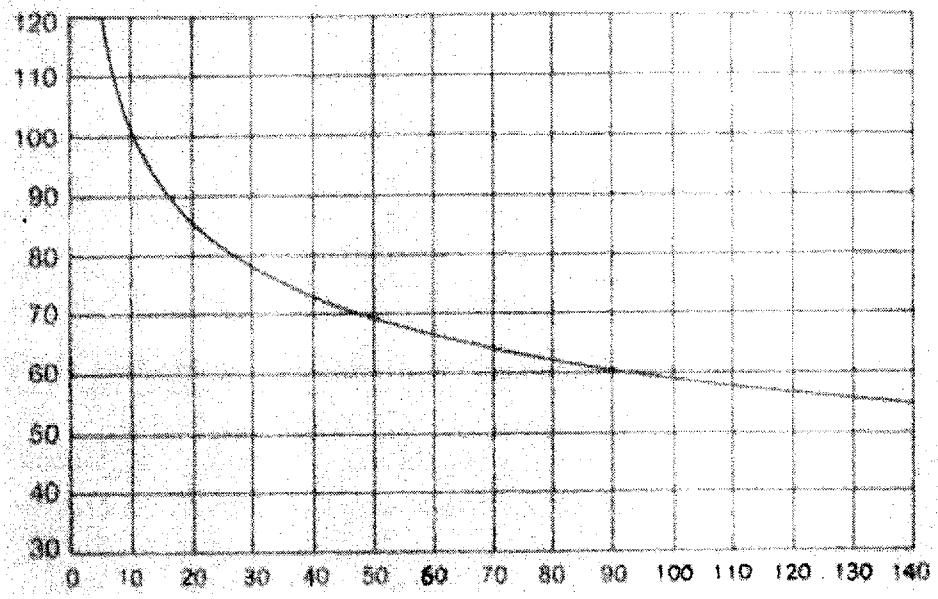


*Figure 10 - An 85% experience curve. The horizontal axis is the accumulated volume of production (in units), and the vertical axis the deflated direct cost per unit (corrected for inflation)* [16]

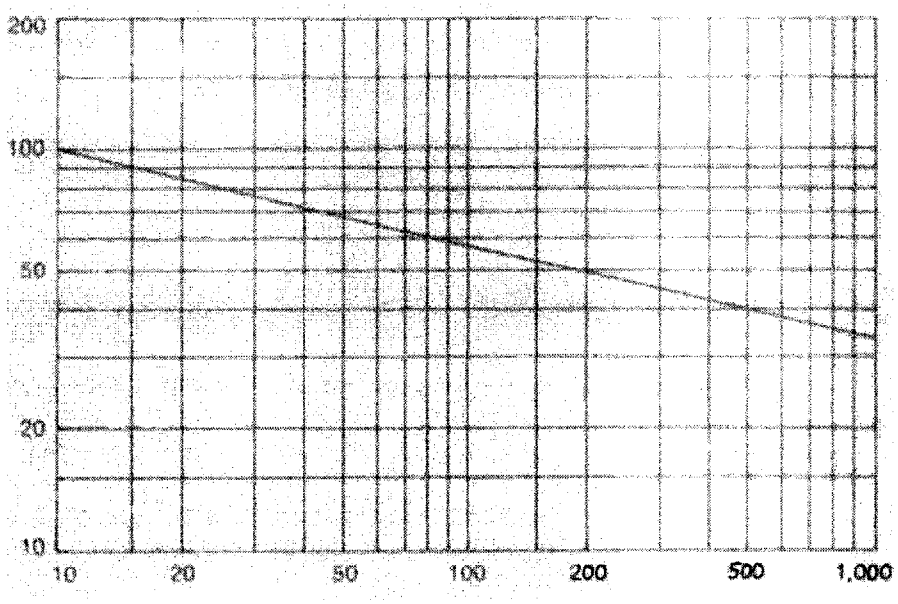


*Figure 11 - A log-log graph of an 85% experience curve expressing the relationship between the accumulated volume of production (horiz axis)*

*and the deflated direct cost (vertical axis)* [16]

Different industries and different products will have different experience curve effects, real or potential, based on the degree to which learning effects can change unit costs and the product or industry maturity. This is even true for countries based on their level of industrial development. For example, in high complexity processes, the potential to exploit learning effects is great. However this is also true for developing countries where relatively simple manufacturing processes are not yet performed at a world class level by most suppliers. In this case, the learning effects push the cost-quality pareto front towards those of suppliers in more developed countries. Further, costs tend to decline rather steeply for products with standardized product ranges.

Experience Curves result from improvements in general technical knowledge, exploiting economies of scale, and basic improvements in product and process design and operational efficiencies. When designing a strategy based on exploiting an experience curve, it is important to understand not just what the rate of the curve will be, but also what drivers are most likely to contribute strongly to the curve's effect. Betting on massive increases in market share to drive economies of scale and rush down the experience curve, for example, can, and has, lead a company to over-expand capacity prior to a market slow down or other market destabilizing event. Such a situation could lead to disaster. In many situations the most reliable effects come from steady basic improvements in product and process design and operational efficiencies through continuous improvement.

Finally, companies in different countries may possess different capabilities to exploit learning curves. Learning curve strategies tend to take a significant investment in capital early on, to be returned through low unit costs later as the learning curve takes effect. Governments, through their cost of capital policies, can significantly affect the degree to which a company in their region can invest in and exploit experience curve strategy. According to one estimate, for example, the real costs of capital in 1981 were 19% for American corporations but only 5.5% for their Japanese counterparts [14]].

## Geographic Proximity and Partner/Supplier Development

Transnational companies outsource to exploit the cost of production in a given locale and to free themselves to focus on core competitive capabilities. Our investigation and experience

supported the presence of a positive correlation between geographic proximity and the rate or "bandwidth" of both soft and hard technology transfer between companies. Taken together with the experience curve discussion, above, this phenomenon is a critical driver behind the cost advantages of an Industrial Conglomeration, particularly in a developing country. Suppliers in a developing country depend on their Transnational Corporate customer to teach them to make the product required, develop manufacturing and operational skills, and expand the cost-quality frontier.

The effects are so consistently positive not because of a reduction in transactional costs of communication (i.e.: walking across the street is cheaper than a web tele-conference), but because smaller distances facilitate, and encourage, more frequent, regular and unscheduled, face-to-face interaction between companies. Studies have shown that geographically proximate suppliers (and similar related firms) receive benefits that result in more effective technology transfer than remote suppliers[24].

We should point out, however, different developing countries showed different degrees of positive effect for geographic proximity, even within the same transnational corporation and product line. There does not yet appear to be much clear understanding of the reasons for this disparity. It could be the alignment (or misalignment) of management style to local cultural norms, regulatory barriers or advantages, country-specific technological maturity, etc. More study is needed in this area.

However, there are positive spill-over effects for the rest of the locale when a firm develops a supplier in a developing country. This is due to the fact it is impossible for transnational firms to capture 100% of the rents on improved supplier efficiency and capability. Through the turn-over of people, their professional associations with each other, and the fact that any given supplier often produces more than one product for more than one customer, the capabilities developed tend to spill-over into other companies and industries in the locale, much like a virus, but a virtuous one.

## *Issues in the Creation and Development of a Supplier City*

Many issues play into the creation of a Supplier City, but at the heart of the decision process is a deep understanding of the industrial landscape and the country specific factors regarding the location. The industry can have a major impact of the decisions regarding Supplier City implementation. And, at the center of any Supplier City implementation is the

issue of location. Beyond the plant level issues of order lead times and inventory levels, there are a host of issues related to location. These issues stem from the fact that in a given locale, there are a myriad of factors impacting the ability to operate competitively. These key issues are discussed in detail in the following sections.

# *Industry*

## Clockspeed

The clockspeed of the industry has a very important influence on expected supply chain design and capability. Higher clockspeed industries necessitate more flexible supply chains in order to follow technology changes. This flexibility has multiple dimensions including response time, technologies utilized, capacity increase/decrease, and number/types of suppliers in the supply chain. All of these elements influence Supplier City design and the expected benefits from implementation. In high clockspeed industries the nature and type of competitive advantage evolves rapidly, exposing the purchasing company to the risk their insource/outsource arrangement may become a liability. In this situation insourced capabilities have a short half-life and outsourced capabilities may rise in importance. Additionally, new capabilities may be developed outside the company by competitors or potential competitors, rendering the company's competitive advantages obsolete. In this case suppliers may control more of the technology knowledge giving them more leverage to capture value from the supplier relationship.

## Complexity

Industry complexity refers to the relative quantity and quality of the industry's stakeholder relationships. For example, aerospace is a very complex industry with a multitude of different stakeholders with disparate needs such as government organizations, airlines, military organization, multi-national organizations (NATO, EU, WTO), life cycle management services, labor unions, and vast supply chains to name but a few. Complexity also refers to product complexity which can be a precursor to the stakeholder complexity listed above.

Complex organizations usually necessitate more complex supply chains in order to satisfy different stakeholder needs. Examples of this include providing work to suppliers in different areas, both domestic and global, to garner political favor. This increased complexity increases the expertise required to manage these suppliers and has both positive and

negative impacts on the supply chain. Political considerations might limit the co-location of supply chains thereby limiting implementation of the Supplier City. This supplier complexity also makes implementation of an initial Supplier City quite difficult since multiple stakeholders need to be convinced of its merit. Follow on implementations will not be as contentious making it easier for competitors to emulate the concept and reducing competitive advantage for the first mover.

## Globalization

Globalization is a large source of complexity for an industry but is important enough to warrant its own explanation. The number of stakeholders will multiply when customers, suppliers, and operational sites include international locations. The increasing global nature of business makes globalization more the rule rather than the exception. As countries look for stronger economic growth, they may create value in the form of free land, tax rebates, or other credits to encourage investment. This can create value for the host organization although these benefits may be time phased making them temporary in nature. The existence, or development of, multiple global operational sites increases the options for Supplier City implementation; both for local consumption and global sourcing.

## Maturity

More mature industries have longer, more developed relationships between current customers, suppliers, and competitors. This can make industry wide change more difficult thereby limiting how far a Supplier City implementation can vary from the current state. On a more micro level, mature industries attract mature organizations which have more internal cultural inertia. This makes change more difficult and implementation planning more important when considering a Supplier City.

## Supplier Population

An industry's supplier base usually mirrors the characteristics of the industry itself. Suppliers are the stakeholder most affected by the Supplier City concept and warrant more consideration during evaluation. Understanding where the current supply chain is located, supplier density, interrelationships, ability to scale, quality and responsiveness capabilities, and willingness to change are all critical to determining if implementation will be successful. It goes without saying a good Supplier City design that can't be implemented is worthless.

## *Country / Locale Risks*

The Host's appropriate supply chain strategy group should identify the primary countries to consider for locating a Supplier City. While proximity to existing operations is one of the key factors, there are a multitude of other country considerations that need to be analyzed before deciding if and how to implement a Supplier City. The following sections identify some of these factors as well as what impacts they might have on the value proposition and design of the Supplier City.

### Culture

Understanding the unique cultural considerations of both the host manufacturing plant and the potential participants in the Supplier City are critically important when considering the implementation risks and opportunities. Different host countries and even different regions within those countries may have very different reactions to the concept of Supplier City based on their cultural beliefs concerning independence versus interdependence. Foreign firms can experience vastly different operational learning curves depending on the level of cultural difference between their home country, where senior management resides, and the host country. Furthermore, there may be ingrained historical cultural conflicts to consider between potential foreign suppliers and the host country when deciding which firms to invite into the Supplier City.

### Industrial Maturity

The host country's industrial maturity is a key decision variable when considering if and how to implement a Supplier City. Industrial maturity is a key factor in determining the expected learning curves for both foreign entrants utilizing local labor and native suppliers. Differences in these learning curves will partially determine the short and medium term benefits for foreign and native suppliers locating in the Supplier City. Finally, the industrial maturity of the host country has a large impact on the decision to invite foreign suppliers or local suppliers.

### IP Protection

In order to harness the benefits afforded by the Supplier City concept, suppliers and the host company need to have more transparency and closer contact. Combined with the

increasing global nature of business, IP issues are of great concern. The cultural attitude toward IP factors into how comfortable a host company will feel in building the relationships required for the Supplier City to be successful. Furthermore, government enforcement of IP infringement is a key indicator for how these cultural attitudes might change in the future. Identifying the appropriate structures and costs to minimize IP leakage and the damage this leakage might cause are an important consideration when designing and evaluating Supplier City implementation.

## Labor Costs and Availability

For products where labor content is high, the cost and availability of skilled labor will influence the choice of where to locate the Supplier City, how many foreign suppliers might be invited to participate, and the level of export that might be financially viable. After accounting for differences in productivity, the wage gap between current sourcing countries and the proposed host country helps determine the value creation offered by the Supplier City. If the required labor skill set is not available, costs associated with creating a resource pool through increased training opportunities or company expatriates should be estimated and included in any cost justifications.

## Economic Development Zones

Economic development zones (EDZs) are a key incentive for developing countries to encourage foreign direct investment (FDI) and are important when weighing different Supplier City locations and the associated value creation and capture. The attractiveness of the individual economic development zone is directly correlated with the government's value placed on FDI. Each economic zone places different value on different business processes (operation, R&D, HQ, etc.). The level to which the primary purpose of the Supplier City fits with the goals of the EDZ influences the amount of concessions the EDZ will be willing to make. These concessions can be a key benefit for deciding where to locate the Supplier City. The EDZ treatment of foreign versus local suppliers as well as the timing and duration of any concessions are also key determinants of the value creation opportunities provided by individual EDZs.

## Customs

There are a myriad of host country governmental policies and political factors that influence

the relative benefit of implementing a Supplier City. Of these, the most critical, more easily controllable factors are tax and tariff rates and flow time through customs: a key determinant in lead time calculations and therefore required inventory levels. Politically, there can be limitations or intentionally prohibitive tariffs on imports and exports as part of a larger political policy that governs the interactions between countries. A final consideration that is less controllable is the relative amount of local and central government corruption and the impact it has on regular business operations.

## Transportation

Transportation and logistics costs can vary widely across different companies. The infrastructure maturity and reliability are important supply chain considerations since they impact variation in required lead time and therefore required safety stock inventories. Another transportation consideration is the local or tribal knowledge required to navigate logistics decisions. Developing the sometimes intimate knowledge of logistics peculiarities can take extended amounts of time and may prohibit the immediate inclusion of foreign suppliers given their relative lack of knowledge on how to move goods and services.

# Chapter 6: Application to Timken

We developed the framework presented in the previous chapter while evaluating whether a Supplier City made sense for Timken's operations in China, and if so, what form it should take. In this section we discuss our application of the framework to Timken's China operations: our process, country and corporation specific considerations, scenarios developed, and conclusions reached.

## *Overview*

The Timken Company, a Fortune 500 company, based in Canton, Ohio, USA, operates in 27 countries around the world. Its Asia Business is headquartered in Shanghai, PRC. As a global leader in friction management, power transmission and steel their products and services include high quality bearings, service parts, alloy steel, specialty steel, precision components, seals, lubricants, remanufacturing and repair, and technical engineering services. Timken caters to the requirements of a range of industries – aerospace, industrial, automotive, construction, mining, rail and super precision. With a 10% world-wide demand for anti-friction bearings originating in China, Timken understood the importance of success in the Chinese market and, as part of their Asian business strategy, has located multiple manufacturing operations in China. Running and operating a factory in China is not without challenges, some of which include immature logistics infrastructure, limited capital resources, and insufficient supplier capabilities.

The manufacturing capabilities necessary to build world quality products are in many ways unique to this industry and highly specialized to serve the specific needs of these products. Timken has, over its long and successful history, developed some of the best suppliers in the industry. These suppliers provide a significant advantage to Timken's manufacturing capabilities all over the world in the form of better quality, faster product introduction, and lower development costs to meet cost targets. So far Timken's experience in China has not shared these same benefits. They have been forced to source to local companies lacking the capabilities to which they have become accustomed. This situation has required Timken to spend extraordinary effort developing and evaluating suppliers. There is a very real threat that the current supply base may choke Timken's growth both domestically and globally.

To address these issues, Timken is considering implementing a Supplier City concept within their China operations. Timken is hopeful that for their Chinese operations, the Supplier City concept will help them to be successful at attracting suppliers that can meet their

expectations for capability and expertise. As a demonstration of the above framework, we will apply it to Timken's challenges in China.

## *Timken Characteristics*

### Core Competencies

Timken considers its core competency to be the design and manufacturing of high quality anti friction bearings. Its highest product competence is the tapered roller bearing; the bearing design Henry Timken founded the company to produce in 1898. Timken has grown to make bearings of all types as well as specialty steel for bearings. The company grew during a time when tight vertical integration was the way to manufacture high quality products at low cost. Thus, Timken has historically had a very good understanding how to manufacture bearing components that are now outsourced to suppliers. As Timken moved towards outsourcing more components, it had to teach suppliers to how to manufacture components to Timken's high quality standards.

A key differentiator between Timken and its competitors is that Timken's vertical integration has included steel production. Timken considers its expertise in metallurgy to be a core competency and guards tight control over any processes downstream that affect the material properties of the Timken-specified steel used in Timken bearings.

### Timken's Supply Chain in China

Timken's Chinese suppliers are normally smaller operations that are not accustomed to Timken's tight material and dimensional requirement. Typically they do not have extensive manufacturing and financial experience. Most struggle to understand why Timken would have more stringent requirements than other bearing manufacturers and may choose not to supply Timken given the level of effort required to meet Timken specifications.

Timken's growth plan for China is very aggressive and hence needs to be supported by equally aggressive and creative supplier growth strategies otherwise internal capacity may far exceed that of the supply chain. For Timken global operational sites, sourcing within China raises the importance of protecting one of their most important competitive advantages: Brand Promise. As Timken pushes to maintain and grow global market share they recognize that they have to be successful building stronger in-roads into the Chinese markets. Finally, many companies have experienced quality leakage in their Chinese supply

chains causing Timken to have limited faith and trust in their Chinese suppliers.

## *The China Business Environment*

### Chinese Culture

China's culture will have a great impact on the successful implementation of Supplier City. The most significant cultural impact comes from the Chinese concept of guanxi; the extensive use of personal relationships to guide business and personal decisions. Given the increased relationship building opportunities afforded by Supplier City, the concept should do well in China, particularly if local suppliers are used.

### IP Protection

IP protection is a major concern in China. Specifically for foreign suppliers who have more technology and manufacturing expertise to protect, IP protection is possibly the largest concern they have related to opening operations in China. Supplier City offers both risk and benefit in this regard. Since IP is a known concern and Timken has some expertise in managing the diffusion of this information, IP needs can be addressed during the implementation of the Supplier City. However, closer proximity between suppliers and Timken will necessarily create more opportunities for IP leakage. IP will need to be one of the defining characteristics of the Supplier City design.

### Labor Costs and Availability / Special Economic Zones

Our team believes that if a Supplier City is far enough away that Host personnel feel they must pre-arrange any site visits to the participating suppliers (send an e-mail, make a phone call, or arrange transportation), the Supplier City is too far from the Host to extract optimal benefit. Our proposal was for Timken to locate Supplier City within walking distance of two of their Chinese operations (which we refer to as Plant 1 and 2). Placing the Supplier City within walking distance would locate it in the same development zone as the locally supported Timken plants, which is a relatively mature industrial zone with ambitious growth plans. Further, while this site has slightly higher than average labor rates compared to other areas in China, compared to global labor rates, this location provides a low cost labor. We feel that these characteristics will outweigh the initial start up and labor rate savings available in other areas of China. Timken should complete a more detailed analysis to support these conclusions with specific consideration and weight placed on the softer aspects of supplier partnering.

## *Bearings Industry Overview*

### Industry size

The world antifriction bearing (AFB) market is about a $30 billion market. Asia Pacific accounts for 35% of the world AFB demand, with Europe and North America trailing behind at 31% and 28%, respectively. Growth of the Asia Pacific market continues to outpace growth in other more established regions. Timken has experienced 43% annual business growth in China, its fastest growing region, over the past few years and currently holds 10% world-wide market-share. The primary applications of AFBs are industrial machinery (54%) and motor vehicles (25%).

### Maturity

The bearing manufacturing industry is a mature industry with a slow clock-speed. Bearing manufacturing companies have improved bearings with better manufacturing equipment, metallurgical techniques, and the use of computer-aided design tools, but in general, bearings have not changed much throughout the years. Obsolescence is not a problem in this industry.

### Complexity

The bearing manufacturing industry is also on the simple end of the complexity scale. This industry was traditionally very vertically integrated. Bearing manufacturers have in recent years begun to outsource more components such as turned rings, rolling elements, and cages. Bearings themselves can be relatively simple products. Sourced commodities generally come from component suppliers, thus the supply chain may only run a couple of layers deep. The complexity of bearing manufacturing is managing thousands of SKUs of different sizes and grades of bearings for various applications. However in addition to this, the challenge for many Timken suppliers is how to produce right the first time in a highly productive manner.

## *Building Scenarios*

Following the framework established in this paper, it is important to define scenarios for analysis while keeping in mind the prioritization of Value Creation over Value Capture. Returning to Figure 11, if is critical that the items on the left are given priority and first consideration. During this process, it is also important to keep in mind the key evaluation

metrics of Value Created, Value Capture Profile, Complexity/Risk and Organizational Appetite.

## What

By starting with an investigation of scope, it is possible to identify the core set of processes that will sustain the Supplier City concept. For Timken, an investigation of the value chain quickly reveals some information regarding where the greatest opportunity for the Supplier City lies. For Plant 1 approximately 60% of the direct manufacturing costs lie in purchased material. Of this 75% of this cost enters Timken operations as one type of purchased component (Part A) manufactured by numerous suppliers. Currently the processes involved in the manufacture of these items are fragmented between multiple suppliers and are geographically distributed in a wide region surrounding the facility. By investigating the level of inventory in this value stream, it is apparent that there is an opportunity to greatly improve the performance of this process. A value stream exercise demonstrated that the lead-time could be reduced by almost 80% through co-location of these processes. These insights justified the development of several scenarios involving co-location of these core processes. This simple value stream provided the opportunity to justify Supplier City on a minimum complexity solution.

In addition, it is also clear that the value stream for one additional purchased component (Part B) has an opportunity for improvement as well. Currently Part Bs are manufactured in various countries for import into the Chinese manufacturing facilities. Though the process value stream is relatively compact with these suppliers generally producing these components from raw material through finished product – there is significant opportunity in the logistic supply chains as well as the development cycle to be captured through the establishment of a Part B supplier within Supplier City. For this reason, these components were added to the scenarios that were investigated.

The second priority for the scenario development is the identification of appropriate facilities to supply from Supplier City. By starting with the selection of those value streams offering the greatest value creation opportunity, it was possible to limit the search of appropriate customer facilities. For the Timken facilities in China that could potentially leverage the production of Part A, the list is short: the Plants 1, 2 and 3. However, the opportunity to supply the needs of Timken manufacturing facilities world-wide through expansion of low-cost capability and capacity is an important opportunity for Supplier City. Currently, there

are opportunities to source components from China that are going unmet because of the limited current capability of Local Chinese suppliers. Again, it is appropriate to identify the minimum efficient scale to justify Timken's investment in Supply City while understanding the opportunity to serve Timken's growth and profitability goals. To serve this need, multiple scenarios were developed combining each permutation of customers for Supplier City: Plants 1 and 2, Plants 1, 2 and 3, Plants 1, 2 and Global Export and Plants 1, 2, 3 and Global Export.

## Where (Locations)

During the team's investigation of locations for Supplier City, a few key considerations emerged. The first and primary driver of location selection should be the ability of Timken to leverage resources to the greatest degree possible in order to provide superior and more cost effective supplier development. This is directly related to proximity of the Supplier City to customer sites (Timken manufacturing locations). By being close, the level of communication and responsiveness between Timken and the Supplier City will increase dramatically. As many sources illustrate, the level of communication drops off quickly with distance.

The second key consideration is relative position of the Supplier City to Timken sites as compared to competitors. One of the key characteristics of the potential competitive advantage created by the Supplier City is the closer physical proximity to the point of use for supplied materials. By shortening distances, lower transportation costs, shorter lead-times and less on-hand inventory are possible. If the site chosen for Supplier City is chosen based on purely easily quantifiable financial considerations (e.g., labor cost, land cost, etc.), then the distance between Timken sites and the Supplier City may be great. In this case, a competitor could locate near the Supplier City and utilize the Timken Supplier City as a competitive weapon. Keeping it close to Timken mitigates this risk.

In the case of potential Chinese locations, there seems to be a compelling case for locating the site close to Plants 1 and 2. This site is planned for incredible growth over the coming months. This growth comes with a lot of activity on-site in the form of Timken's global process experts. Additionally, within only a few years, this site will be the largest candidate operation in China to be supported through Supplier City. Additional research is appropriate, but the argument for a location next to Plant 1 and 2 is compelling enough that it was the only one considered in the analysis of scenarios.

## Who & How

Due to the constraints of our investigation, it was necessary to focus on the issues most significantly impacting Value Creation. Prior to implementation it is necessary to refine the scenarios evaluated and make a series of decisions regarding who should be invited to Supplier City and how those relationships should be structured.

There are several important recommendations regarding this procedure. First, the suppliers that are invited will need to be those that most closely support the value creation opportunity opportunities identified using the above framework. These suppliers may or may not be the first choice of Timken. The attitude of the suppliers toward Supplier City and their interest in supporting Timken through a mutually beneficial relationship will obliviously be a key question. It may be necessary to make compromises moving Timken away from the ideal relationship structure to accommodate a particular supplier, but it is important to establish a list of non-negotiable characteristics that will result in looking elsewhere for the supplier with which to partner.

Secondly, using some of the insights above, local and foreign suppliers should be considered for inclusion in the Supplier City. It is important to understand the short, medium and long-term compromised between the two groups and choose those suppliers that provide the optimal benefit to Timken.

It will be necessary for Timken to structure the relationship between each and every supplier. These relationships should be guided by the principles that the value created through Supplier City should be split between partners making everyone better off for their participation in Supplier City, the only way for Timken to maintain competitive advantage through Supplier City is to pass the majority of physical infrastructure, shared service and other costs onto suppliers (avoid supplier subsidization) and that additional benefits should be considered when the opportunity for value creation out weighs the costs.

Finally, a phased implementation will provide maximum benefit. By beginning with a key set of processes with high value density (high spend with great opportunity for improvement through Supplier City) will allow Timken to learn from the process of implementing and managing supplier relationships. These initial steps will create experiential expertise that can be leveraged to extract additional value creation and capture opportunities out of additional suppliers added. But, the phased implementation process should be predicated on the marginal benefit versus marginal cost model introduced above.

## *Comparing Scenarios*

The following table illustrates how the different Scenarios generated using Scenario Development Framework can be compared side by side using the above metrics. To protect Timken, we do not include a detailed description of the scenarios we generated for them in this thesis. However, based on Timken's weighting preferences, scenario four was dominant. Building such a table can help force a quantitative and objective comparison of the difference scenarios developed and even force a firm to recognize its own assumptions about which metrics are most important. We did not conduct a sensitivity analysis as we are not providing a detailed and rigid objective function or methodologies for determining certain values (like organizational appetite). What we are providing is general framework for comparison into which a company may insert more detailed valuation methods suited to their needs or customs. For example, objective weighting has a large impact on sensitivity analysis, but objective weighting is specific to each individual firm.

**Scenario Comparison Matrix**

| Scenario | Value Created (in $ Millions) | Value Capture Profile | Complexity /Risk | Organizational Appetite (relative) | Totals |
|---|---|---|---|---|---|
| Weighting | 45% | 25% | 15% | 15% | 100% |
| Scenario 1 | -2.5 | <n/i> | 5 | 5 | 0.375 |
| Scenario 2 | -2.1 | <n/i> | 3 | 4 | 0.105 |
| Scenario 3 | -0.94 | <n/i> | 4 | 7 | 1.227 |
| Scenario 4 | 0.64 | <n/i> | 2 | 6 | 1.488 |
| Scenario 5 | -0.41 | <n/i> | 1 | 8 | 1.1655 |

*Table 1: Comparison of the 5 Scenarios Generated for Timken*

### Weighting

Each metric in a selection matrix has a different importance in an organization's value system. It is important to reflect that variance in importance in the selection matrix to ensure a result compatible with the organization. The weightings applied above were

determined by the team after extensive interviews, discussions, and analysis. It is appropriate that Timken would review and re-value these weightings as they see fit.

## Value Created

Evaluating the scenarios for NPV, we found the results in the "Value Created" column of the Scenario Comparison Matrix. It is important to note that Scenario 5 is based on a pre-supposition that the current Part B manufacturer would be invited to Supplier City and, according to their stated position, would prefer and possibly insist upon a separate building in which to operate. The NPV difference between Scenarios 4 and 5 is based on the authors' estimation of the value of that building.

## Value Capture Profile

Because the mechanisms that control the value capture of each stakeholder are developed in the "How" section, which was outside the scope of this study due to time constraints, we were unable to analyze this metric for the candidate scenarios. We expect and recommend Timken reproduce the effort used to create this study and in doing so, include a numerical analysis of the Value Capture Profile for each scenario.

The methodology described earlier is a rough sketch. Timken should build an actual methodology for valuing this metric only after careful consideration and adherence to its own organizational values and objectives.

## Complexity/Risk

We were unable to perform rigorous, Timken specific determinations of Complexity and Risk for each scenario due to time constraints and the pre-requisite of completing the "How" section for each Scenario. Instead we simply ranked each one according to the Team's subjective estimation of relative complexity, taking into account the expected customers of Supplier City and the number of processes planned for it.

The previously described methodology is only a rough sketch of one way to evaluate this metric. However we recommend it as a good starting point for a more Timken-appropriate methodology.

## Recommendation Reprise

As shown in the "Totals" column of the selection matrix, following the framework outlined in this paper and based on the included level of analysis we recommend that Timken pursue the development and implementation of Scenario 4. Its NPV, level of Complexity, and appeal to Timken's Organizational Appetite make it a strong first phase of Supplier City development.

# Chapter 7: Conclusions

At the inception of this project, there were many publications on various industrial conglomerations, but there was no source that pulled them together and provided a framework for comparison and analysis. Through this research we have been able to understand the diversity of structures and relationships in various conglomerations. We have uncovered the lack of detailed literature and understanding on the topic. From this foundation, we were able to dig deep into the costs, benefits, risks and opportunities associated with establishing of a Supplier City. By challenging many institutional assumptions and building a comprehensive framework we were able to uncover many of the key factors in how Supplier Cities should be approached by host companies and how the structure of these competitive tools should be leveraged for significant bottom-line rewards.

## *Summary of Contributions*

We have presented a summary of Industrial Conglomeration types compiled from existing literature on the subject. This resulted in the creation of the Conglomeration Curve to show the relative position of various definitions within the space of coherence of physical and corporate relationships, thus tying together current literature on the subject while presenting a consistent approach for their comparison. Furthermore, we have identified the potential to leverage the creation of a Supplier City to be used as a competitive weapon by a host company. We have created a framework for the development of Supplier Cities by companies hoping to create more versatile, robust and competitive supply chain structures in a world with more demanding customers and more difficult global constraints. We have documented many of the tools required for successful framework implementation and have posed warnings for several of the pitfalls that may trap host companies – robbing them of their potential benefit. And, finally, we presented an example application of the framework for Timken, China, including a discussion of the business environment in China, the limitations of current suppliers, and a recommended course of action. We feel the new developments contained in this work will help companies leverage the benefits of proximity and supply chain integration to become more capable and competitive than ever before.

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# **Appendix A:** Terminology

**Capability Curve** – This curve represents the capability development over time of a particular supplier as a function of Cost, Quality, and Responsiveness and allows the comparison of two or more suppliers over various time horizons.

**Capacity Assurance** – Having an arrangement whereby a specified minimum level of a supplier's capacity is guaranteed to a specific customer. A customer is not required to maintain a demand level that satisfies the corresponding level of capacity; however, should the need arise, the supplier must make the capacity available. This concept is similar to a Service Level Agreement.

**Clockspeed** – Clockspeed represents the rate of evolution of a product or industry. Faster clockspeeds indicate shorter evolutionary cycles and fleeting competitive advantages. Slower clockspeeds indicate longer evolutionary cycles and more lasting competitive advantages. In a fast clockspeed environment it is necessary to focus more effort on predicting the next evolution and adjusting a company's competitive advantages to maintain or improve relative position in the industry.

**Complexity** – The level of complexity of an industry or product is directly related to the number of parts, relationships between those parts, difficulty in producing the parts, difficulty in assembly, and criticality of on-spec function of the final product. Large passenger aircraft, for example, are highly complex products in a complex industry. Tires, on the other hand are far less complex.

**Core Competencies** – A core competency is a skill an organization can execute well and meets three criteria specified by Hamel and Prahaland (1990):

1. It provides customer benefits
2. It is hard for competitors to imitate
3. It can be leveraged widely for many products and markets.

A core competency can take various forms, including technical/subject matter know how, a reliable process, and/or close relationships with customers and suppliers (Mascarenhas et al. 1998). Modern business theories suggest that most activities that are not part of a

company's core competency should be outsourced.

**Economic Development Zone** – Economic Development Zones are designated areas that receive specialized government consideration in the form of tax breaks, investment, regulatory leniency, etc. intended to encourage firms to develop projects that help create jobs and private sector investment.

**Deployment** – Deployment is the staged, physical, legal, and processed based implementation of a plan for resources and organizational development in support of a set of goals.

**Down-Select** – A down-select is the process by which a set of candidate solutions is systematically compared against pre-determined criteria by assigning each candidate a relative weight for each criteria, summing the weights across each candidate and ranking accordingly. This process is a rough form of multi-objective optimization; however it is not as purely objective and rarely employs simulation or optimization algorithms and heuristics. It is commonly used in the field of product design and development, even for systems as complex as complex military defense systems.

**Free-Loader Theory** – The free-loader theory suggests that if a certain good is (1) available to everyone (i.e. no one can be prevented from using it without cutting off access to everyone, like with the interstate highway system) and (2) non-exhaustive (using the good does not make it unavailable to everyone else), then a rational actor will choose to use the good without paying for it. In the business sense this theory is often treated with great fear in that an organization may develop a resource at great expense to itself only to see the value of that resource utilized by direct competitors. This would tend to indicate a reduced gain relative to the competitor and therefore a bad move. It also tends to entice both competitors not to develop the resource even though they would gain benefit, hoping the other will move first. As indicated in the text of this paper, the application of this theory is not always appropriate.

**Host** – Host, in this document, is used to refer to the sponsor of and primary recipient of goods from a Supplier City.

**Learning Effect** – Learning Effect deals with the Learning Curve: a Boston

Consulting Group theory from the 1960's that predicts as workers perform an action, they subsequently become more efficient at performing the action. Experience has shown this assumption valid with typical learning curves of 10 – 30% for every doubling of production output.

**Marginalism** – Marginalism is the use of marginal concepts within economics. Marginal concepts include marginal cost, marginal productivity and marginal utility, the law of diminishing rates of substitution, and the law of diminishing marginal utility. "Marginal" here implies that economists look at what happens when "a small change" is made to the subject under study.

**Marginal Benefit** – Marginal Benefit is the incremental benefit realized after some incremental change is made to the Supplier City. For example, what cost benefit is realized upon the addition of a single new supplier? Clearly this is not perfectly generalizable to all suppliers as each supplier is different. Therefore the Marginal Benefit must be assessed on a case by case basis for each proposed change to the Supplier City system, and only implemented if it exceeds Marginal Cost.

**Marginal Cost** – Marginal Cost is the incremental cost incurred after some incremental change is made to the Supplier City. For example, what cost expenditure is indicated upon the addition of a single new supplier? Clearly this is not perfectly generalizable to all suppliers as each supplier is different (however, the character of a Supplier City would tend to suggest a smaller variance in Marginal Cost across supplier types than in Marginal Benefit). Therefore the Marginal Cost must be assessed on a case by case basis for each proposed change to the Supplier City system, and only implemented if exceeded by Marginal Benefit.

**Organizational Appetite** – Organizational Appetite is a generally subjective determination of an organizations interest in pursuing a particular value realization plan given the level of risk involved. This is generally a culturally based phenomenon and not easily changed.

**Scenario** – A system of constructs describing, in detail, the value creation structures and processes, location, operations supported, targeted suppliers, shared resources, value capture structures (contractual arrangements), and deployment phases of a

Supplier City. Feasible Scenarios are individually developed then compared for highest enterprise value to determine the appropriate path forward.

**Supplier City** – A supplier city is a geographic concentration of suppliers localized near a common customer or Host for the purposes of increased cooperation with the host, lowering value chain inventory and accelerating capability development.

**Value Creation** – Value Creation refers a change in the system that increases the profitability of the system (that is the difference between incoming value and the cost of creating that value). For example, if a cost-reduction initiative lowers the cost of a product without impacting other metrics (quality, timeliness, etc) then the product may still be sold for the same price even though it costs less to produce. Value has been created. It is important to distinguish this concept from Value Capture.

**Value Capture** – Value Capture refers to the processes and structure that govern which stakeholders realize what value from a shared system. For example, if a quality initiative lowers the cost of a particular operation in a Supplier City, the arrangement by which that incremental cost savings is shared between the Supplier and the Host determines each party's relative Value Capture.

# Appendix B: Research

## *Plant Tours*

Wuxi Operation Sites 1 and 2
Liyuan Operations
WuXi YuanTong Bearing Co., Ltd

## *Interview List*

**Timken Interviews**

- Roger Lindsay: Senior Vice President, Asia Pacific
- Doug Smith: Director, Operations, Wuxi
- Paul Henry: Manager, Supply Chain and Logistics
- Ajay Das: Director, New Business Development, Asia Pacific
- Rajat Modi: Manager, New Business Development, Asia Pacific
- Peter Malik: Director, Needle Bearing Operations Strategy, Asia Pacific
- Calvin Kee: Director, Supply Chain Management
- Ji Gang: Sourcing Deputy Manager
- Sherry Zhao: Legal Counsel, Asia Pacific
- Mike Sun: Senior Sourcing Engineer
- Bruce Mi: Supplier Quality Development Engineer
- Linda Li: Sourcing Engineer
- Yuancheng Liu: Senior SQD Engineer
- Keen Gao: Sourcing Engineer

**Other Interviews**

- Leila Lu, Assistant to the Director, Foreign Investment Promotion, Wuxi New Development Zone

# **Appendix C:** Research

GLab (MIT Sloan School of Management course 15.389) enables teams of students to work with the top management of international start-ups and gain experience in starting and running a new enterprise outside the United States. It focuses on start-ups operating in various emerging markets. Lectures expose students to the issues and policies that affect the climate for innovation and start-up success around the world. GLab begins in fall term and continues for three weeks during IAP, when students spend time at company sites.

GLab students self-form into four person teams near the beginning of the fall term. The internships are then posted on the GLAB online portal for review by the teams. Each team develops its own process for evaluating and recommending themselves for three internships in order of most preferred to least preferred. Each team submits their preferences along with their resumes to the faculty after the first third of the fall term. The faculty and TAs then evaluate each team's preferences against the team's strengths and capabilities, striving to optimize the value for both the students and the participating organizations.

It is the team's responsibility to negotiate and manage all aspects of the work plan and the project. The goal is for each team to professionally and effectively deliver analysis, advice, and recommendations that are immediately useful to the company. Each team makes a formal presentation to the companies at the end of the onsite internship and provides them with supporting written analysis and data as appropriate. Finally the team delivers a copy (or summary) of company deliverables to the team's advisor upon return to MIT and will meet as a team with the advisor to discuss these findings in February. Students are not materially compensated for their work, having only their travel and accommodations reimbursed during the three week internship by the host organization. The class concludes with small group discussions with faculty about team internship experience in the first weeks of the spring term. Students must complete all three components to receive credit.