Strategic Capacity Planning Process in Construction Business

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The purpose of the present paper is to analyze the capacity management needs and propose a new capacity planning framework for a construction company. The paper examines the capacity profile and proposes a strategy for capacity building based on time horizon; based on individual, business and industry levels; and finally based on components. The paper provides a strategic direction to the company to bid for bigger projects in partnership with prominent players rather than stay focused on smaller projects. The approach recommends ensuring the necessary resource and capital base for the company before it decides to go solo on bigger projects.

INTRODUCTION

Capacity is the amount of available resources or the output achievable to meet the operational challenges over a specified period of time. The capacity of a process is the maximum amount of theoretical output the system can potentially produce or the maximum amount of input the system is capable of processing at the existing resource level. The timing dimension emphasizes that capacity should be viewed from a short range, intermediate range and long range planning perspective and therefore, capacity management occurs at all the three planning levels in an organization i.e. at strategic level, tactical level and operational level. Capacity can significantly influence the quality of products and services and, therefore, it has an influence on the customer satisfaction. Capacity management is undoubtedly one of the toughest management challenges in running an organization. The issue becomes especially important for small to medium enterprises who do not have the required resource base and capital resources to build extra capacity cushions in the organization. The challenge really lies in how to deploy existing resources in an effective and efficient manner in order to meet the operational loads for these small and medium business operations. The objective is to set the capacity of capital intensive resources i.e. facilities, capital, labor at an appropriate level that best supports company's long term vision and helps to achieve short to medium range goals. The capacity level has an impact on response rate, costs, inventory level and various other performance measures. If the capacity in not sufficient, the company will lose customers and may not be able to successfully bid on larger and profitable projects. If the capacity is excessive, the company has to either stay under-utilized or carry excessive inventory and in many cases venture into less profitable projects to justify the capacity levels. In order to address some of these challenges, some companies pursue flexible capacity concept where they can rapidly enhance or reduce their operational levels from one product, service or project to another one. This flexibility in capacity is pursued by having flexible facilities, flexible internal processes and flexible work force that can easily switch from one job to another.

Some of the major drivers of capacity in small to medium sized businesses are their ownership and leadership, the business environment, capital base, the incentives and knowledge to build that capacity. The process start with the top management initiative who review the capacity needs and the expansion plans for their business. The next step normally is to perform an environment scanning to assess the ways in which extra capacity can be acquired. The companies operating in a high-tech environment opt for more automated solutions whereas companies that are more labor intensive try to seek the solutions from the skilled labor pool available in that industry and locality. The management need to further develop the capital and financial resource base to acquire the necessary capacity. The management must also provide incentives and knowledge to employees through various promotional and career advancement programs and provide them with necessary knowledge and training on how to efficiently perform their job in order to release the capacity hidden within the system.

LITERATURE REVIEW

Leachman and Carmon (1992) proposed a capacity planning model for substitutable and alternative equipment. Escudero et. al (1993) applied a simulated scenario analysis approach for capacity and production planning. Agapiou et. al (1998) work is specific to the construction industry and expresses the emerging role of builder merchants. Ballard (1999) and Ballard et. al (1998) discussed some issues specific to the work flow and capacity management in the construction industry. Sasser (1976) and Klassen & Rohleder (2001, 2002) discussed the synergy between product promotion and operations to manage the demand and capacity imbalances. Klassen & Rohleder (2001, 2002) argued that due to uncertainty of demand and perishability of capacity, service managers continue to struggle with the challenge of managing capacity and demand. Horman (2000) proposed the idea of buffer dynamics in capacity management of operations in a project management environment. Cakanyildirim and Roundy (2001, 2002) and Catay et. al (2003) provided an evaluation and extensive survey of successful capacity planning practices followed by the semiconductor manufacturing industry. Quantitative and mathematical optimization approaches to capacity expansion are provided in Ahmed and Sahinidis (2003) and Birge (2000). Yu-Lee (2002) proposed a management accounting as well as marketing perspective in the sense that capacity management represents a significant component of a firm's costs, represents a large amount of a firm's assets, impacts a firm's ability to manage cash flow, decides the ability of a company to operate and can potentially impact the organization's brand image. The perishable nature of capacity and the need for careful management is emphasized in Gu (2003) as idle capacity is non-recoverable and insufficient capacity can impact the business. Swaminatahan (2002) and Chou et. al (2007) considers the case of uncertain demand and prices to assess the capacity strategies. Capacity expansion strategies under specific demand patterns such as random exponential and auto correlated demands have been discussed in Ryan (2003, 2004). Huh et. al (2005, 2006) offer generic models under demand uncertainty. Hellermann (2006) provided a discussion on the capacity options available to air cargo industry to enhance their revenue management systems and the ideas are easily transferable to other service industries as well. Walley (2011) proposed a demand driven capacity management model to manage the healthcare operations.

COMPANY OVERVIEW

Steel and other metals provide significant benefits over other non-metallic and wood construction materials as per American Iron and Steel Institute (AISI 1998). The traditional wood construction experiences a price fluctuation, whereas metal prices have more price stability allowing small businesses to predict their costs with a high degree of accuracy and prepare an appropriate bid. Secondly, companies in the metal trade may potentially lock in the metal prices in advance, an option that is not normally available in the non-metallic market. In terms of structural benefits, steel is corrosion resistant and structurally more stable as it does not easily rot, warp, crack, termite or burn. Therefore, the windows and doors over steel framing function with the same ease in all weathers. Furthermore, steel offers better

energy efficiency due to its dimensionally stability as it does not expand or contract at various humidity and temperature levels which results in minimal energy loss through various building outlets. Steel products are also fire-safe due to their non-combustion nature and hence offer a better compliance with building codes and fire regulations. This may potentially lower the insurance premiums. As an additional advantage, steel provides a reduced chemical presence of resins and adhesives that is commonly found in joining the wood framing materials. Finally, steel framing is a greener option offering a better carbon footprint. As a rough estimate, one needs to mow around 100 trees to provide wood framing for a house whereas it takes recycled metals from 3 to 4 written-off cars to steel frame the same house.

Okanagan Construction provides steel framing construction for both residential as well as commercial customers in the Okanagan Valley (Okanagan 2013). The company is located in Kamloops. The company came into existence in 2007 as a general contractor and accepting all kind of renovation works on residential and commercial buildings. After couple of years into the business, the company started focusing on the framing business. The company would accept the challenge to experiment with the use of metal framing for household and buildings when their main competitors were focused on wood framing business. That's how the company differentiated itself and created a niche market. Okanagan construction and valley-view properties-a real estate holding company, are subsidiaries of Okanagan Corp. The company started as a limited partnership by five tradesmen; two of them were actively involved as general partners and the remaining three provided support and knowledge but stayed away at an arm's length from day-to-day operations of the business due to their limited liability involvement. The company initially employed ten full time workers, two office staff besides several seasonal workers depending on the project's requirements. After gaining significant knowledge and experience from small household projects, and medium sized projects like constructing strip malls and warehouses, the company landed its first major contract in 2010 to build a hotel with 120 rooms. Due to the green initiatives of the hotel chain, they preferred using as much steel as possible in the construction process that would not only provide longevity to the building structure but also show their pride and commitment to the green construction by saving more trees. After successfully completing this project, Okanagan's business took off with several contracts in the hospitality and hotel industry as well as in townhouse construction. The company also successfully bid for a resort construction near a major skiing destination. Okanagan business depends on the demand of steel construction both in residential as well as commercial facilities. The company has been taking an active as well as passive role to influence the demand. Okanagan has created a significant demand by advertising, price incentives and educating customers on the stability and environmental benefits of steel construction. On the passive side, the company accepts the demand created by the boom in real estate market through lower interest rates and the growth of economy. Capacity management at Okanagan construction starts with an analysis of demand and capacity profiles. This leads to the development of capacity management strategies for the company on a long range, intermediate range and short range basis.

CAPACITY ANALYSIS

An examination of Okanagan's capacity strategies reveals that the company's strengths lie in the flexibility and adaptability. The company uses the non-unionized and flexible work force that allows the company to have a flexible staffing level to match the demand and avoiding work force idleness and overtime. The company maintains flexible operations and this allows the company to bid for contracts even in the remotest of regions. This allows the company to explore the areas with real estate boom and avoid areas which are experiencing a slump. The economy of scope concept allows the company to achieve lower costs by working on multiple projects and by negotiating better prices with the suppliers. The economy of scope advantage is evident from the successful project bids on various projects such as townhouse project, up-gradation of a university building, installing gas fireplaces at residential houses, townhouse maintenance and a small distribution center. The availability of several sub-contractors is a blessing for the company's business. This competition among sub-contractors drives the cost of sub-contracting down. Furthermore, it also saves the cost of training.

The main weakness of the capacity strategy is a clear lack of long range capacity planning. The company relies heavily on flexibility and lacks capital base. This makes the company vulnerable to bigger players in the industry. During housing booms, fewer skilled workers are available which are lured by the bigger construction companies. Secondly, Okanagan focuses on steel framing business. A substantial reduction in lumber prices or a substantial price increase in metals could potentially negate the cost advantage the company is enjoying. Undoubtedly, sub-contracting is a blessing that comes with certain risks. It puts the company at the mercy of many small traders who have their own work schedules and a significant coordination with sub-contractors is required to keep the project on schedule. The chances of project delay are high in such an environment. Okanagan is also responsible for the overall quality of the project and is accountable to the customers but the quality of the project depends on the quality of sub-contracted work. Okanagan needs sub-contractors that meet the minimum quality standards. Steel framing also requires special skills from other trades. Several trades people such plumbing and electrical who are used to work in a lumbar framed construction project are unwilling to update their skills especially when their business is doing well. Finally, one major weakness of Okanagan's strategy is its inability to raise sufficient up-front capital to bid for larger projects and capture the untapped market potential for bigger residential projects.

CAPACITY MANAGEMENT STRATEGY

The first step in capacity management is to have an accurate estimate of the demand. Towards this end, the demand for Okanagan's business has been stable in the past or at-least predictable to a high degree of accuracy. The townhouse project has allowed the company to make fairly reliable forecasts of the needed production and has taken up the majority of its capacity. In order to enhance demand and capacity, the company has undertaken several initiatives. The main initiative is to educate the public about residential steel framing. Brochures from the Canadian Sheet Steel Building Institute, news coverage of projects, information disseminated through American Iron & Steel Institute, are some of the examples on how the company has tried to boost the demand of steel framing products. The company's aim is to further increase the public awareness of steel framed residential construction by highlighting its advantages over wood framed. During the last two years, the capacity planning at Okanagan has been mainly on a short term and intermediate term basis. The main basis for capacity management has been flexibility, economies of scale and the learning and growth opportunities. Okanagan has frequently tried to keep capacity buffers and several times utilized external sources such as subcontractors. However, Okanagan has not yet formalized a long-term strategic capacity management plan. Okanagan has utilized capacity flexibility to its advantage by developing the ability to rapidly change production levels and shift capacity by switching from one project to another. The key to achieve this flexible capacity is the use of flexible workers, flexible products, flexible facilities and a flexible process. Flexibility of capacity is clearly viewed as a source of competitive advantage for this company.

Okanagan uses labor force that possesses multiple skills and can shift from assisting in roofing and dry-walling to framing without any additional training. The foremen are skilled red-sealed tradesmen who can train employees in all aspects of construction. Flexible worksites allows the company to have equipment that is easy to install, tear down and move from one project to another. Okanagan takes advantage of economies of scope by working on renovations, subcontracts and construction of new houses at the same time thereby pooling its resources on various types of projects and processes. Okanagan's emphasis on building low cost steel framed residences certainly helps to maintain a cost focus. The company endeavors to achieve low cost simple framing designs rather than high-end expensive and elaborate designs. Okanagan has tried to make use of economies of scale by bidding on large contracts such as hotel, resort and townhouses.

With the successfully completion of many large scale projects, the knowledge and experience gained by Okanagan employees has allowed them to substantially reduce the cost and project time on each unit. For example, originally the steel anchors for framing came as plain pieces and the workers had to drill holes to allow wiring. Once the workers determined the locations for holes, the company asked the

suppliers to provide steel anchors with drilled holes, thus saving the company both time and money. An alternative to have internal capacity, from time to time Okanagan has used subcontractors and trade partners for tasks such as plumbing, electrical, masonry, excavation, mechanical, trim and cabinetry etc. We discuss the recommended strategy for the company under three different scenarios. First, we develop a capacity strategy across different time lines under low, medium and high demands. Secondly, we develop capacity strategy at individual, organizational and industry level. Thirdly, we propose capacity development under nine components and four levels.

TIME HORIZON MODEL

As discussed earlier, the strategic capacity planning must take into account the available resources and the timing dimension in terms of short range, medium range and long planning as shown in Table 1.

Short Range Plan

As a short range planning strategy, it is recommended the company should maintain the current resource level and combine it with overtime to manage the near term peaks. This strategy reduces the hiring and lay-off costs, training costs and at the same time maintains the capacity flexibility. However, if the demand had a downward trend and capacity becomes excessive, the company may consider giving price discounts on renovation work to stimulate a short-term growth. During the stable portion of the demand cycle, the company should focus on its core competency of steel framing and perform fewer other construction functions such as dry walling, painting and roofing. This will allow the company to maintain a focus and achieve efficiency and quality while keeping the costs down.

Medium Range Plan

In the medium range planning, the company must focus on advertising, customer awareness and product promotion to enhance the demand of steel framing. Incentives such as free steel appliances should be offered to customers who buy the steel framed houses. The main reason for this aggressive demand generation is the capital budgeting considerations to maintain a sustainable cash flow. The company must find ways to release the capital tied up in the building lots. These sites need to be sold at a faster rate in order to generate the revenues and cash flow. If the demand increases substantially, then the company should consider subcontracting out some core tasks but steel framing should be the last one to outsource. This will allow the company to release some internal capacity to meet the surge in demand while maintain the core competency and focus in steel framing. During the medium range the company should hire seasonal work force to have a greater labor flexibility.

Long Range Plan

In the long run, the company should continue to focus on building steel framed structures. There is a large untapped market potential for bigger residential steel framed projects and a lack of competition in this market. Steel-framed homes are increasing in popularity across North America and this trend should be allowed to build up through more consumer awareness. Okanagan would need to form an alliance with a larger company with access to substantial capital resources who are confident of bidding, undertaking and successfully completing larger projects with 100-150 housing units. Such a partner company must be willing to work with smaller companies like Okanagan by assigning them the steel framing work on a sub-contract or working profit-sharing basis. Finding a partner with abundant capital resources would be quicker and easier than trying to raise the capital required to pursue extensive projects. When Okanagan develops a substantial resource base and becomes more confident to undertake larger projects while working with a bigger partner, they may consider bidding independently and go solo in future.

TABLE 1
TIME HORIZON MODEL

		Time Horizon		
		Short Range	**Medium Range**	**Long Range**
Strategy During	**Low Demand**	• Price reduction • Advertising	• Product Promotion • Training	• Product awareness • Bid for bigger and diversified projects
	Medium Demand	• Core competency • Subcontracting	• Process flexibility • Utilize worker flexibility	• Build sub-contractor pool
	Excessive Demand	• Subcontracting	• Subcontract on a priority order basis	• Build resource base • Partner with big players • Go solo

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LEVEL MODEL

Furthermore, the company should try to develop the capacity at an individual level, then at the organization level and finally at the industry level as suggested in Table 2. Each level of capacity must be strengthened using the action plan for that level. For example, at an individual level, the company must focus on training, incentives and job enrichment initiatives such as job rotation to enhance capacity flexibility. At an organization level, the efforts must be focused on waste reduction, project diversity and capital equipment. At an industry level, the company must encourage the allied trades to take up steel framing and provide appropriate incentives.

TABLE 2
INDIVIDUAL ORGANIZATION INDUSTRY LEVELS

Strategy Level	**Individual**	• Train employees on steel framing • Provide incentives to workers • Job rotation to achieve worker's flexible capacity
	Organization	• Release capacity through waste reduction • Capital equipment acquisition • Flexible operations • Achieve diversity of projects
	Industry	• Skill development for the steel industry • Provide incentives to allied trades

COMPONENT MODEL

Finally, we evaluate capacity building as suggested in Potter & Brough (2004) based on the nine components and asses how these nine components strengthen the capacity in terms of tools, skills, infrastructure and system roles.

- Performance capacity: This component ensures an adequate supply of tools, capital and equipment available.
- Personal capacity: This component of capacity evaluates if the staff are sufficiently knowledgeable and skillful in their respective trades.
- Workload capacity: This component of capacity assess if there are adequate number of employees to manage the workload.
- Supervisory capacity: Under this component, we evaluate the managerial and supervisory resources available to run the organization.
- Facility capacity: This component refers to the operational and physical capacity of the facility.
- Support service capacity: This component basically refers to the training facilities, quality control and other support services necessary for the business.
- Systems capacity: This component refers to the effectiveness of information flows in the organization.
- Structural capacity: This component refers to the organizational decision making and the accountability structure.
- Role capacity: This applies to the delegation of authority and responsibility provided to individuals, teams and committees to make quick decisions.

The nine component levels and how they strengthen the capacity across four different levels is presented in Table 3. Each level enables the next level and requires the previous level in this framework. As an example, the tools require a sufficient level of skills and it is the skills that enable the tool capacity as the tools themselves cannot operate without skillful workers. This model is both component as well as hierarchical in nature. The four different levels also differ in their technical versus socio-cultural emphasis, the time horizon as well as the ease with which the capacity level can be implemented. These details are provided in Table 3.

As evident from Table 3, it is advisable for the company to sub-contract work on larger projects and provide training and incentives to their sub-contractors. In the meantime, the company should gain more experience on large commercial projects by partnering with bigger companies. On the internal side, the company needs to delegate more authority to the lower echelon of the organization chart and empower employees and front line supervisors to speed up the projects.

TABLE 3
CAPACITY DEVELOPMENT ACROSS COMPONENTS

Attribute	Component	Company Position	Capacity Plan
Tools ⇧⇩	• Performance capacity	• Lack for bigger projects	• Subcontract or locate partners for bigger projects
Skills ⇧⇩	• Personal capacity	• Adequate in-house skills but lack in sub-contractors' skills	• Train & motive subcontractor trades
Infrastructure ⇧⇩	• Work load capacity • Supervisory • Facility capacity • Support staff capacity	• Adequate for smaller projects but lack for medium to bigger projects	• Subcontract • Form Partnerships • Gain experience on larger projects
Structure and Systems Roles ⇧⇩	• Systems capacity • Structural capacity • Role capacity	• Efficient systems • Unclear lines of authority • Lacking employee & committee empowerment necessary to expedite projects	• Develop clear organizational chart • Delegate work to subordinates • Employee empowerment and build quality circles

CONCLUDING REMARKS

The main theme of Okanagan Construction's capacity strategy is in the areas of flexibility, focus and adaptability to changes in demand. However, this focus has been short to medium term and the company clearly lacked a long range planning process. From a survival stand point, it is understandable but the company has now come a long way and established a substantial staying power in this business. Therefore, it needs to develop a long term capacity plan and partner with bigger companies to move into the higher league. In the near future, Okanagan construction is advised to keep the existing work force level, focus on its main strengths in the steel framing, use sub-contractors occasionally and continue to maintain the flexible process and flexible facility model. In the intermediate range planning, the company needs to be more pro-active with a strong advertising campaign to increase demand. For the long range plan which the company is currently lacking, it is crucial for the company to approach and bid for larger construction projects in collaboration with major players in the industry. This will ensure that the company has access to the required capital and resource base to take advantage of the untapped market potential. In general, the company is recommended to follow the capacity model explained in Tables 1-3.

REFERENCES

Agapiou, A., Flanagan, R., Norman, G. & Notman, D. (1998). The changing role of builders merchants in the construction supply chain. *Construction Management and Economics*, 16, 351-361.

Ahmed, S. & Sahinidis, N.V. (2003). An approximation scheme for stochastic integer programs arising in capacity expansion", *Operations Research*, 51(3), 461–471.

American Iron & Steel Institute (1998). The many reasons to build with steel, *Available:* http://www.floridasteelhome.com/build.html

Ballard, G. & Howell, G. (1998). Shielding production: an essential step in production control, *Journal of Construction Engineering and Management*, 124, (1), 11-17.

Ballard, G. (1999). Improving work flow reliability, *Proceedings of the Seventh Annual Conference of the International Group for Lean Construction: IGLC*, The University of California, Berkeley, USA, 275-286.

Birge, J. R. (2000). Option methods for incorporating risk into linear capacity planning models, *Manufacturing Service Operations Management*, 2, 19–31.

Çakanyildirim, M. & Roundy, R. (2001). Optimal capacity expansion and contraction under demand uncertainty, *Technical Report*, School of Management, University of Texas at Dallas, USA.

Cakanyildirim, M. & Roundy, R.O. (2002). Evaluation of capacity planning practices for the semiconductor industry", *IEEE Transactions on Semiconductor Manufacturing*, 15(3), 1-15.

Catay, B., Erenguuc, S. S., & Vakharia, A. (2003). Capacity planning in semiconductor manufacturing, *Computer & Operation Research*, 30, 1349-1366.

Chou, Y.C., Cheng, C.T., Yang, F.C. & Liang, Y.Y. (2007). Evaluating alternative capacity strategies in semiconductor manufacturing under uncertain demand and price scenarios, *International Journal of Production Economics*, 591-606.

Escudero, L. F., Kamesam, P. V., King, A. J. & Wets, R.J. (1993), Production planning via scenario modeling, *Annals of Operations Research*, 43, 311-335.

Gu, Z. (2003). Analysis of Las Vegas strip casino hotel capacity: an inventory model for optimization, *Tourism Management*, 24(3), 309-314.

Hellermann, R. (2006). *Capacity options for revenue management: theory and applications in the air cargo industry*. Berlin, Germany: Springer-Verlag.

Horman, M.J. (2000). *Process dynamics: buffer management in building project operations*, Ph.D. Thesis, The University of Melbourne, Australia.

Huh, W.T. & Roundy, R.O. (2005). A continuous-time strategic capacity planning model, *Naval Research Logistics*, 52, 329–343.

Huh, W.T., Roundy, R.O. & Cakanyildirim, M. (2006). A general strategic capacity planning model under demand uncertainty, *International Journal of Naval Research Logistics*, 53, 137-150.

Klassen, K.J. & Rohleder, T.R. (2001). Combining operations and marketing to manage capacity and demand in services, *The Service Industries Journal*, 21(2), 1-30.

Klassen, K.J. & Rohleder, T.R. (2002). Demand and capacity management decisions in services. How they impact on one another, *International Journal of Operations & Production Management*, 22(5), 527-532.

Leachman, R.C. & Carmon, T.F. (1992). On capacity modeling for production planning with alternative machines, *IIE Transactions*. 24(4), 62-72.

Lovelock, H. C. (1992). Seeking synergy in service operations: seven things marketers need to know about service operations, *European Management Journal*, 10(1), 22-31.

Okanagan-construction (2013). *Consulting Interviews with Okanagan Management and Ownership*, Kamloops, BC.

Potter, C. & Brough, R., (2004). Systemic capacity building: a hierarchy of need, *Health Policy Planning*, 9(5), 336–345. doi: 10.1093/heapol/czh038, Oxford University Press.

Ryan, S.M. (2003). Capacity expansion with lead times and auto correlated random demand, *Naval Research Logistics*, 50, 167–183.

Ryan, S.M. (2004). Capacity expansion for random exponential demand growth with lead times, *Management Science*, 50, 740–748.
Sasser, WE. (1976). Match supply and demand in service industries, *Harvard Business Review*, 54 (6), 131.
Swaminathan, J.M. (2002). Capacity planning for semiconductor fabrication facilities under demand uncertainty, *European Journal of Operational Research*, 120, 545–558.
Yu-Lee, R.T. (2002). *Essentials of capacity management*. New York: John Wiley & Sons.
Walley, P (2011). *Demand and capacity management in healthcare: a systems perspective*, *PhD Thesis*, University of Warwick.