

Illustrating Capital Budgeting Complexities with JIT Justification Data

Sue L. Visscher and Timothy C. Stansfield

Financial management textbooks use simple investments in fixed assets to teach basic capital budgeting concepts. However, the proper valuation of many projects in diverse industries involves considering costs and benefits that are difficult to quantify. This paper uses data from 13 manufacturing plants' just-in-time (JIT) justification and implementation experiences to illustrate many capital budgeting complexities. The ability to recognize such complexities will enable students in all areas of business to more effectively contribute to the justification of their own projects in their jobs.

■ Textbooks intended for the junior level introductory finance course present capital budgeting projects with fixed patterns of investment, easily quantifiable costs and benefits, and definite time horizons. However, investments can be very complex. Gradual process improvements and organizational learning can complicate forecasting the amount and timing of costs and benefits. Intangible benefits must be considered. Expansion and abandonment options can require a series of sequential decisions. Strategic concerns must be explicitly recognized. While the introductory finance course should not cover the justification procedures necessary to deal with these complexities, we believe that the course should include a general description of these issues. The purpose of this paper is to present data from the just-in-time (JIT) justification and implementation experiences of 13 manufacturing plants that can be used to introduce undergraduate business students to these capital budgeting complexities.

Finance and accounting majors learn about capital budgeting complexities in advanced courses. Textbooks such as *Capital Budgeting Under Uncertainty* (Aggarwal, 1993) present techniques for analyzing difficult capital budgeting problems. However, other undergraduate students may not be exposed to these complexities. Students employed in

management, marketing, and operations management positions after graduation may need to provide a finance staff or a cross-functional team with information to justify employee turnover reduction programs, customer satisfaction improvement strategies, or advanced manufacturing technology investments. With respect to employees of small businesses, Porter and McKibbin (1988) stated:

Anyone involved in developing a small, dynamic, and growing business cannot expect to work solely on marketing matters,...nor expect to have a lengthy career totally within the finance or production areas. The entrepreneurial problems to be faced will not come neatly wrapped in a distinct functional package, nor will the knowledge to solve them come from a single functional area of expertise.¹

Correct financial analysis of complex investments can be extremely difficult, but it is very important. Two plants of one of the parent companies in our study experienced JIT transformations in recent years that were completely successful from a production point of view. Financially, however, they were unsuccessful. Neither plant ever produced at breakeven, and both eventually closed. If students are unprepared to recognize capital budgeting complexities such as intangible benefits and expansion options illustrated in this paper by JIT justification and implementation, but evident in all types of projects, they may make similar disastrous investment decisions.

Sue L. Visscher is an Assistant Professor of Finance at The University of Toledo, Toledo, OH 43606-3390. Timothy C. Stansfield is a Ph.D. student at The University of Toledo and is President of IET, Inc., Toledo, OH 43614.

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¹Porter and McKibbin (1988), page 322.

I. What is JIT?

JIT is a philosophy of business where companies are committed to throughput time reduction, waste reduction, and continuous quality improvement. The transformation to a JIT environment requires a complete change in manufacturing philosophy to focus on pulling inventory through the production process as it is needed, instead of pushing inventory through the process as it is produced. A JIT environment is achieved by separating the manufacturing plant into product-focused cells, or mini-plants. Each cell has all of the equipment, labor, materials, maintenance programs, built-in quality control systems, scheduling procedures, and support to completely manufacture a finished product.

JIT attempts the virtual elimination of all costs that do not add value to the product. Activities such as moving, storing, counting, sorting, inspecting, and expediting are considered wasteful. Reducing these activities requires reducing inventory. As inventory is gradually lowered, hidden quality and productivity impediments are revealed. As these impediments are removed, the system becomes more efficient, product quality is improved, and inventory is no longer needed as a buffer to compensate for manufacturing problems.

II. JIT in the Finance Literature

The finance literature covers three types of JIT papers. Case studies (for example, Phillips and Ledgerwood, 1994) and surveys (Barton, Agrawal, and Rockwell, 1988) discuss the automation of the manufacturing process in great detail, but they describe the time and cost savings only in general terms. The actual justification process is not covered. The second type of paper describes, in general terms, the justification of the advanced manufacturing technology often associated with JIT (Kaplan, 1986; Gold, 1988; Howell and Soucy, 1987; Barwise, Marsh, and Wensley, 1989; and Diallo, Khan, and Vail, 1994). The third type focuses on specific justification problems. Sachdeva and Vandenberg (1993) discuss the expansion option. Majd and Pindyck (1987) focus on the option to delay sequential irreversible investment expenditures and cover the effect of learning curves on production levels and costs (Madj and Pindyck, 1989). Donaldson (1985) Bromwich (1991) Shank and Govindarajan (1992) and Shank (1996) discuss integrating strategic and financial analysis. While these last two groups of papers present important theory and useful examples, none present actual companies' justification experiences.

III. JIT Justification Complexities

JIT is executed on the plant level, so the many plants of a large corporation may each require a different level of investment, face a different time frame, and experience a different level of success. Therefore, financial information about the justification and implementation of JIT cannot be easily obtained from the S&P 500 companies' CFOs typically surveyed. The dearth of published JIT financial information prompted us to send a questionnaire in November, 1993 to the managers of 20 plants undergoing JIT conversion. We knew that these managers were familiar with both the financial and manufacturing aspects of their plants' JIT justification and implementation. Of the 20 plants surveyed, 13 detailed responses were received, and telephone follow-up clarified any remaining questions.

The annual sales of the 13 plants' parent companies ranged from \$200 million to \$4 billion, with four exceeding \$2.5 billion. The annual sales of the plants themselves averaged \$63 million, ranging from \$15 million to \$250 million. Four plants spent between \$1.25 million and \$4.325 million on the JIT transition, while eight plants spent between \$200,000 and \$600,000. Most plants employed between 100 and 500 people; the largest plant employed 1,400. The industries included automotive components, truck axles, replacement windows, plastic bottle caps, hammers, and office furniture. Exhibit 1 illustrates plant and JIT characteristics.

A. Planned Expenditures

The questionnaire asked the respondents to indicate the expected, and actual, amount and timing of 11 likely expenditures. Similar to typical textbook examples, the largest expenditure for nine of the 13 plants, including the four with total investments greater than \$1 million, was for new or replacement equipment. Rearranging equipment was a large expected cost for eight of the 13 plants. Unlike textbook examples, however, these investments did not all occur at "time zero." Equipment purchase and installation was expected to require between one and 24 months, while equipment rearranging estimates varied between one and 36 months. Both the amount and timing of these investments are generally easy to forecast. Only two of the plants indicated that the actual expenditure was different than expected. Only one plant experienced time frames significantly different from forecast; the explanation was "management reevaluation."

The next largest group of expenditures were for direct labor cross training to enable employees to operate a wider variety of equipment, and equipment accessories to reduce set-up time. These expenditures

Exhibit 1. Plant and JIT Investment Characteristics

Year Started Transition	JIT Stage	Size of Investment ^a	Annual Sales ^b	Number of Employees	Product Lines
1985	30 - 59%	600	45	650	Auto Fire Walls, Acoustical
1985	30 - 59%	1,250	34	380	Auto System Fuel Filters
1985	60 - 89%	3,000	55	900	Truck Axles
1987	30 - 59%	4,325	250	1,400	Office Furniture
1988	60 - 89%	400	65	250	Metal Stampings ^c
1989	60 - 89%	2,000	55	450	Auto Bearings, Door Panels
1990	60 - 89%	500	38	400	Auto Armrests
1990	60 - 89%	400	18	180	Auto Door Panels, Sun Visors
1991	30 - 59%	200	120	300	Hammers
1991	60 - 89%	200	32	400	Auto Exhaust Systems
1991	60 - 89%	500	45	250	Auto Door Panels, Armrests
1992	60 - 89%	45	15	100	Replacement Windows
1992	60 - 89%	500	53	330	Plastic Bottles & Caps

^aSize of investments is measured in thousands of dollars.

^bAnnual sales are measured in millions of dollars.

^cOf the metal stampings product lines, 60% were drawn from automobile manufacturing, and 40% were drawn from heating/cooling manufacturing.

are generally more difficult to forecast than investments in equipment. Four of the five plants with the largest expected expenditure in direct labor training overestimated the cost by at least two and one-half times. Some plants expected direct labor training to take less than six months, while others forecast two to three years. One plant manager indicated that the actual time required was double the three-year forecast because it was “ever changing and ongoing.” The four plants expecting the largest investments in set-up reduction overestimated this cost by at least two and one-half times. Four plants experienced actual set-up reduction times at least 25% greater than forecast. One plant with an accurate cost estimate underestimated the actual 72-month time frame by 50% due to “employee buy-in.” Whenever an investment involves training people and changing processes, particularly if employee buy-in is also a factor, forecasting both the cost and the time frame can be quite difficult. Investments with these characteristics should be subjected to sensitivity analysis to establish a range of possible outcomes.

Several of the plants indicated costs associated with organizational learning. Six of the eight plants experienced an expected productivity decline during the process. Two plants also experienced a decrease in the operating margin. According to Majd and Pindyck (1989), part of these decreases are, in fact, investments in future reduced costs. Anticipating the magnitude and timing of organizational learning’s

financial impact can be very difficult; therefore, sensitivity analysis is again important.

B. Expected Quantitative Benefits Used in Financial Analysis

The questionnaire provided a list of 12 benefits that could be achieved by JIT implementation. The respondents were asked to indicate whether each benefit was used in a quantitative analysis, and if so, to rate the importance of the benefit in the justification process on a one to five scale. Improved production capacity, reduced changeover time, reduced scrap and rework, and reduced material handling cost were the most important benefits cited. As the production capacity increases, either revenues should increase or overtime charges should decrease. As both changeover time and scrap and rework are reduced, direct labor costs should decrease. Decreased scrap and rework will also reduce direct material cost. Reduced material handling costs involves indirect labor as well as inventory storage, insurance, and finance costs.

The principle difficulty in forecasting the financial impact of these changes involves their timing. All of these benefits will occur gradually as new equipment is installed and direct labor cross training occurs, leading to manufacturing process and product quality improvements allowing inventory reductions. The timing of the expenditures and process improvements

must be accurately forecast before estimating the timing of the resulting benefits.

Another difficulty involved in complex investments is accurately defining the level of revenues that would occur without the investment. For example, four plants indicated that their customers required them to change to JIT. A decision to not implement JIT could result in a loss of revenue from these customers. Failure to adjust the base line for this potential loss would understate the investment's marginal benefits.

C. Expected Qualitative Benefits Used in Strategic Analysis

The plant managers were expected to provide strategic and financial justification of the investments to corporate headquarters. We asked the plant managers whether any of the same 12 benefits were used in a qualitative, strategic justification. Reduced production throughput time and improved production flexibility were ranked most important. Both of these allow a manufacturer to respond more quickly to a customer's needs, resulting in improved goodwill, which leads to the potential for increased revenues. The entire value of intangible benefits such as goodwill are not easily captured in marginal cash flows, but must at least be recognized in a strategic analysis.

Improved flexibility also incorporates the possibility of future options. The company may be able to produce new variations of existing products or entirely new products. Furthermore, the investment in technology and associated organizational learning required for JIT implementation may position the firm to be a step ahead of any future technological developments. The capital budgeting options literature mentioned earlier describes how the cash flows from product and technology options can be valued. However, if an option's future cash flows cannot be estimated at the time of the JIT investment, the option's strategic value must be considered to avoid underestimating the original investment's benefits.

The manufacturing changes and direct labor training required to implement JIT lead to the empowerment of employees enabling them to stop the production line and fix manufacturing problems when they occur, instead of needing to call a supervisor to stop the line. The improved employee morale that is associated with empowerment is a very difficult benefit to quantitatively measure, but it can also be a potentially valuable result of JIT implementation.

D. JIT Investment Justification Methods

The plants' JIT justification methods are presented in Exhibit 2. Of the plants, 12 used payback, with estimated periods ranging from six to 48 months. Two plants' actual payback periods exceeded their

estimated periods. Both plant managers explained that the difference (25% and 43%) was caused by a decrease in volume that was unrelated to changes in productivity. These decreases were not caused by the JIT implementation, but nonetheless, affected the financial results. On the other hand, the importance of capturing all of the benefits in the justification analysis is illustrated by the difference between the anticipated 36-month payback period and the actual 24-month period for one plant explained by not having included "lots of good things...(in the) pro forma."

Nine plants used IRR, six of which provided hurdle rates ranging between 6% and 25%. The three extreme hurdle rates (6%, 20%, and 25%) were provided to the plant managers by the corporate headquarters of companies with annual sales in excess of \$3 billion.² The three plants that used NPV also used IRR. Four plants did not use a discounted cash flow method, perhaps because the payback periods were relatively short.

Five plant managers indicated that a formal post-audit was performed. The difficulty involved in converting accounting profits to cash flows is always a hindrance to performing formal post-audits, but the inclusion of strategic, qualitative effects in a complex project would make the task even more difficult. However, nine plant managers believed that the financial objectives of the transition were met, including three who stated that they had not performed formal post-audits, and the two discussed above that did not meet their expected payback periods. The remaining four plants that did not explicitly indicate either financial success or failure all met their stated payback estimates.

IV. Summary and Conclusions

The experiences of the 13 surveyed plants illustrate many of the complexities involved in capital budgeting. The amount and timing of various costs and benefits can be difficult to estimate, particularly when a sequence of activities must be forecast. Employee training, process changes, and organizational learning can further complicate the estimates. Revenues may change even if the new investment is rejected. Options to create new products or adopt improved technology

²The 6% rate was provided by a British parent company which may encounter different borrowing and equity costs. This plant had an actual 18-month payback period. The plant using 25% indicated that payback was the preferred justification method, and that both the expected and actual payback periods were 24 months. Furthermore, since both of these plants' customers required the JIT conversions, strategic considerations may have made the discounted cash flow analysis even less important. The plant using the 20% hurdle rate had the second smallest JIT investment and the second largest level of sales, so the relative size of the investment was small.

Exhibit 2. JIT Justification Characteristics

Year	Investment ^a	Formal Post-Audit?	Financial Objectives Met?	Used NPV?	Used IRR?	Hurdle Rate?	Used Payback?	Est. / Actual Payback ^b
1985	600	—	—	—	—	—	Yes	36 / 36
1985	1,250	—	—	—	Yes	13%	Yes	36 / 24
1985	3,000	Yes	Yes	Yes	Yes	14%	Yes	48 / 60
1987	4,325	Yes	Yes	—	Yes	10%	Yes	42 / 60
1988	400	No	Yes	—	—	—	Yes	14 / -
1989	2,000	Yes	Yes	Yes	Yes	—	Yes	- / -
1990	500	No	Yes	—	Yes	—	—	- / -
1990	400	No	—	—	Yes	25%	Yes	24 / 24
1991	200	Yes	Yes	—	Yes	—	Yes	12 / 12
1991	200	—	Yes	—	Yes	20%	Yes	- / -
1991	500	No	Yes	—	—	—	Yes	- / -
1992	45	Yes	Yes	—	—	—	Yes	6 / 6
1992	500	No	—	Yes	Yes	6%	Yes	12-18 / 18

^aInvestments are in thousands of dollars.
^bEstimated and actual payback are measured in months.

in the future may result from the investment, even though the specific details of these options cannot be currently anticipated. Intangible benefits such as goodwill and employee empowerment must be considered strategically if they cannot be quantified.

While it is not necessary to teach non-financial

business students the justification methods for dealing with these complexities, students must at least be introduced to these issues. The ability to recognize capital budgeting complexities is a vital first step in gathering the information necessary for correct project justification. ■

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