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Appendix A: The Economics of Quality

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The Implementation and Economic Impact of Quality Management in the Homebuilding Industry

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Introduction

With high performance homes, energy performance and cost savings are quantifiable. Energy performance in the Building America program is estimated in the design phase using energy simulations and verified through testing and monitoring. In addition the economic cost benefits of energy efficiency for both the builder and ultimately the homeowner are also quantifiable. One Building America goal is that for each high performance home the amortized costs of energy efficiency upgrades is less than that of the monthly utility bill savings. The result is a home that is more energy efficient and is cost effective for a homeowner to buy and operate.

To ensure that the homes are built as designed to achieve optimal energy savings, a builder's quality control and assurance processes are necessary. There are economic costs to a builder for quality management including the costs for prevention, appraisal, and the cost of failure that can directly affect the economics of energy efficiency upgrades in a high performance home. An effective quality management system should create efficiencies and related savings that are greater than the investments in the quality activities required to achieve the savings. However, the costs of quality are difficult to measure due to the fact that the performance metrics have not been fully defined and are often not effectively utilized by builders.

The goal of this paper is to detail the value of quality management in general as well as specifically to new home construction and high performance homes. Therefore, the paper outlines the economics of quality including the cost of quality which breaks down the impact of quality into its component parts, its value, its impact in the construction industry, and its value for high performance homebuilders. In addition, it lays out recommended tools and techniques for the introduction of quality management and the monitoring of its impact based on metrics. Those builders using these tools and techniques have seen dramatic improvements in energy and quality performance, profitability, and customer satisfaction.

The Economics & Value Impact of Quality

The economics of quality include the fact that there are costs to prevention, appraisal, as well as costs of failure. Ultimately the goal is to be able to track the costs and benefits of each to determine the most cost effective solution. The cost of quality (COQ) relates to the costs of Prevention, Appraisal, and Failure (PAF). The COQ can be further broken down into the cost of good quality (conformance) and poor quality (non-conformance) as shown below (Cokins, 2006).

$$\begin{aligned} \text{Cost of Conformance (good quality)} &= \text{Prevention Costs} + \text{Appraisal Costs} \\ \text{Cost of Non-Conformance (poor quality)} &= \text{Internal Failure Costs} + \text{External Failure Costs} \end{aligned}$$

In other words, the cost to achieve high quality consists of the cost to prevent errors plus the cost to monitor or appraise performance to detect errors. The cost of poor quality (non-conformance), on the

Cost of Quality Definitions

Prevention: Cost of all activities specifically designed to prevent poor quality in products and services.

Appraisal: Costs associated with measuring evaluating or auditing products or services to assure conformance.

Definitions (cont.)

Internal Failure: Costs resulting from products or services not conforming to requirements or customer user needs, which occur prior to delivery or shipment to the customer.

External Failure: Costs resulting from products or services not conforming to requirements or customer / user needs which occur.

other hand, is equal to the cost of correcting failures before delivery to the customer (Internal Failure) and the cost of failures after delivery to the customer (External Failures).

Figure 1 shows how the cost of poor quality or chronic waste can be reduced by focusing on the three fundamentals of quality, planning, control and improvement.

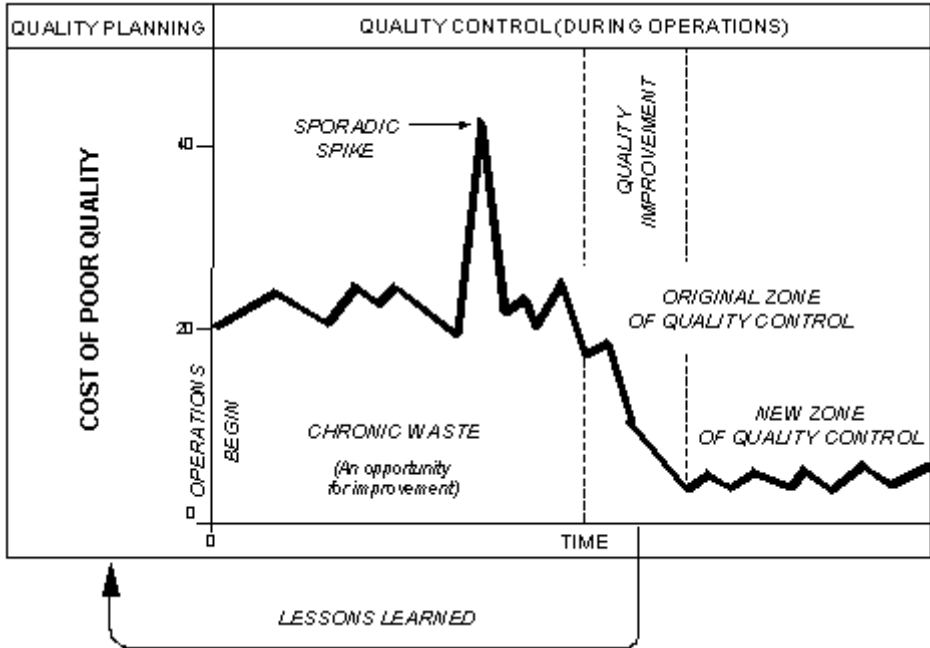


Figure 1. The Juran Trilogy

Examining the PAF (Prevention, Appraisal and Failure) model graphically, (Figure 2) total quality costs are the sum of prevention, appraisal, and failure costs. The cost of failure decreases as the cost of prevention and appraisal rises with increasing quality, there is typically a minimum point along the total cost curve. This point represents the ideal investment in prevention and appraisal that will present the least total quality cost. Below that investment in prevention and appraisal, failure costs—and, hence the total cost of quality—will be high. By contrast, investing too many resources in prevention and appraisal will reduce failure rates, but at an excessive cost. When embarking on a quality management program, companies which wish to minimize the total COQ invest the optimal amount in prevention and appraisal that provides the maximum return on investment with respect to failure costs.

The goals of a quality program include reducing the overall COQ and to invert its components such that the majority of costs are spent on preventing and catching defects rather than correcting failures. But obviously the aim is to then also reduce the cost of prevention and appraisal also. Figure 3 depicts the hypothetical COQ, including its component costs, for a corporation before and after quality program implementation.

Understanding the cost of quality and its potential impact are two of the most fundamental aspects of quality management.

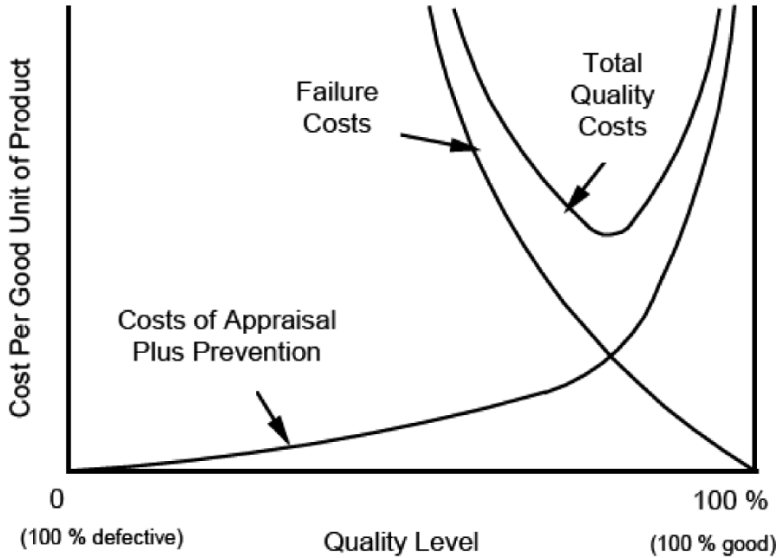


Figure 2. The classical COQ model

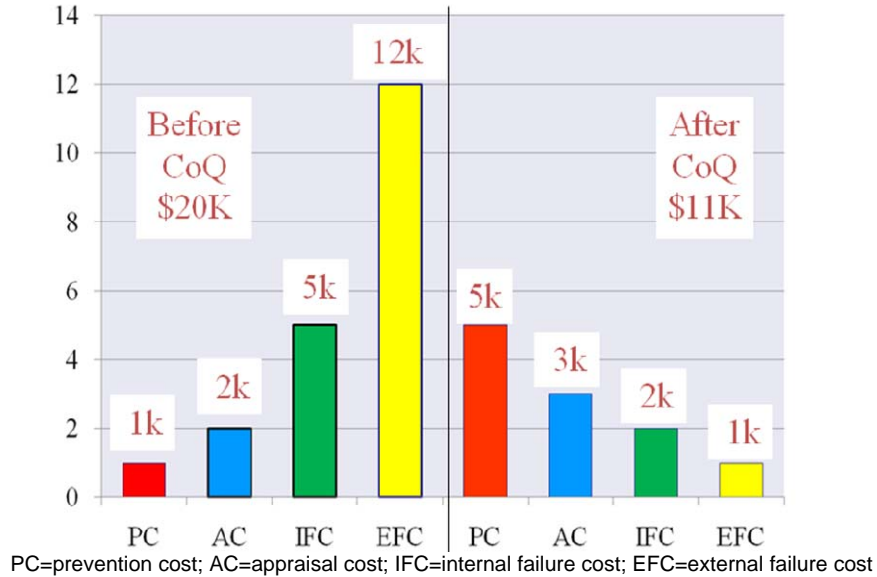


Figure 3. Hypothetical cost of quality (Cokins, 2006)

The Impact of Quality

Beyond the costs of quality, there is the impact of quality on revenue and reducing the total cost of quality (TCOQ) by increasing preventative costs and decreasing failure costs. There is ample evidence of the strategic importance of quality management and the positive impact it has on businesses due to its systems approach, focus on the customer and links to strategic planning and competitive advantage (e.g., Cokins, 2006, Harrington, et al., 1999, Easton and Jarrell, 1998, Cable and Healy, 1996).

One study (Samson and Terziovski, 1999) examined quality management practices and operational performance at 1,200 Australian and New Zealand manufacturing companies. Researchers identified a statistically significant relationship between quality management practices and operational performance

with the strongest predictors of performance being leadership, personnel management, and customer focus. These factors and their correlation to rates of return are supported in numerous other studies. For example, *Evans and Jack (2003)* found that improving quality management practices had a positive correlation with financial performance. A 1998 study of 307 companies in 50 US states also found that quality driven strategies improved financial performance. In other words, investing in quality management techniques leads to increased profitability (Handfield, Ghosh and Fawcett, 1998). A study of Swedish national quality award recipients found a significantly higher return on assets than their competitors and a comparable group (*Eriksson and Hansson, 2003*).

In a study of 63 manufacturing organizations (*Rodchua, 2009*), the total cost of quality was shown by to be between 8% and 10% of expenses or between 2.6% and 4% of sales revenue. Failure costs among the organizations studied represented between 70% and 80% of the total cost of quality (Figures 4 and 5).

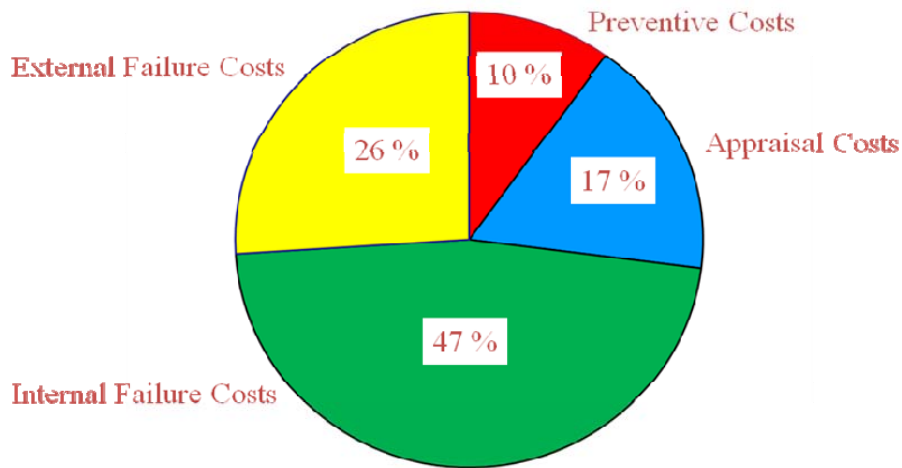


Figure 4. COQ in small to medium-sized organizations (*Rodchua, 2009*)

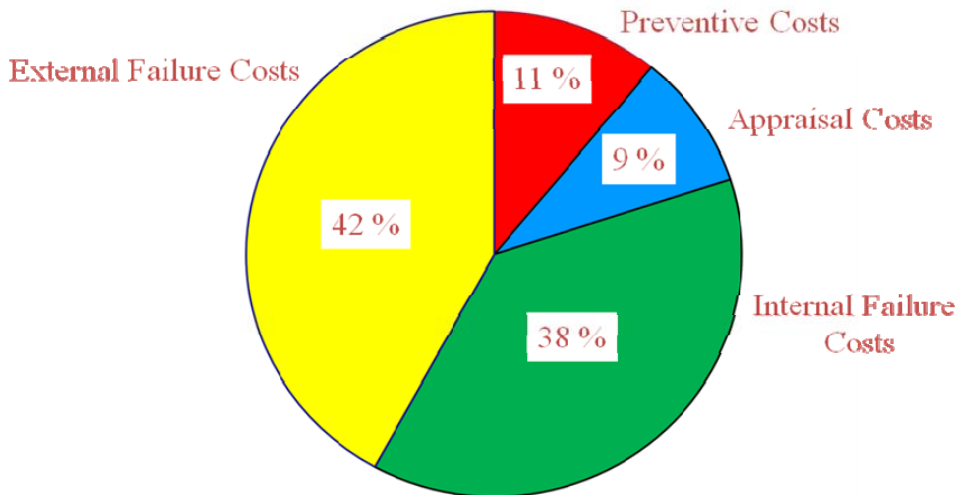


Figure 5. COQ in large-sized organizations (*Rodchua, 2009*)

Schiffauerova and Thomson (2006) showed that the total COQ can be reduced by introducing quality management processes. In their study, organizations which introduced quality management reduced the total COQ by:

- 25% in one year (Hewlett Packard, PC manufacturer)
- 65% to 15% in eight years (Raytheon, electronics)
- 35.8% to 18.1% in four years (Philips, semi-conductors)
- 23.3% to 17.3% in five years (United Technologies, telecommunications)

These studies provide clear evidence that quality management can yield significant returns on investment.

Customer Satisfaction Starts from Within

In addition, reducing the failures and the associated costs has the benefit of increasing customer satisfaction. It has been long established that organizations with a focus on quality management achieve high levels of customer satisfaction (*Nilson, et. al, 2001*). Research has shown that a key driver for customer satisfaction is employee satisfaction. *Bernhardt, et al. (2000)* report a “positive and significant relationship between customer satisfaction and employee satisfaction,” while *Brown and Lam (2008)* describe the relationship as “positive and statistically and substantively significant.” Concludes *Lee et al. (2008)*, “Employee satisfaction is significantly related to service, quality, and to customer satisfaction, while the latter in turn influences firm profitability...leading to a satisfaction-quality-profit cycle.”

Harter et al. (2002) studied 7,939 business units in 36 companies and found that businesses that had employee satisfaction ratings in the top 25% had, on average, 1% to 4% higher profitability and similarly higher productivity (revenue or sales per month), as well as between \$80,000 and \$120,000 higher monthly revenue.

Satisfied employees, are more productive, innovative, and loyal which, in turn, leads to customer retention. *Yoon et al. (2002)* suggest that employee satisfaction plays a “strong, central role” in predicting profitability and *Koys (2006)* further relates it to “organizational effectiveness.”

So what are the elements that drive employee satisfaction? In a study of over 5,000 employees across 90 companies, *Cozzani and Oakley (2005)* are the three key elements leading to employee satisfaction.

- organizational communication
- employee engagement and
- organizational culture

To effectively connect employee and customer satisfaction, the Corporate Leadership Council advises that “companies must build their own models because customer satisfaction is only one variable in understanding the relationship between employee satisfaction, customer satisfaction and financial performance. Moreover, each company must determine how it defines employee satisfaction and customer satisfaction, which can even differ between departments and business units within one company,” (Corporate Leadership Council, 2003).

The Impact of the Malcolm Baldrige National Quality Award Criteria

Companies successfully implementing quality management are typically businesses that are recognized for their successes. Since its inception in 1987, the Malcolm Baldrige National Quality Award (MBNQA) has generated substantial interest in the benefits of quality management and has served as a motivator for implementing quality management systems. The program, created to stimulate quality improvement by U.S. manufacturers, recognizes achievement, establishes criteria for evaluating improvement, and publicizes the practices of award-winning companies in order to educate others. In its 23 years, there have been more than 1,300 applicants, 72 award recipients, 2,800 quality examiners trained, and 750,000 copies of its Performance Criteria for Excellence distributed. It has inspired the creation of 43 state awards and nearly 45 international quality award programs. This reflects the international success, rate of adoption and impact of the MBNQA. Many of the research studies cited here, as well as many others, have been carried out using MBNQA winners, applicants, and companies which use its Criteria for Excellence to drive improvement.

MBNQA applicants and winners consistently outperform other companies in key metrics. For example, the U.S. Commerce Department compared return on investment for MBNQA winners to S&P 500 index companies. Between the years 1988 and 1994, MBNQA winners had 188% ROI compared to 28% for the S&P 500 companies (*Jacob et. al, 2004; Ramasesh, 1998*).

These exceptional returns are from MBNQA winners, however, are not realized for all companies involved in the MBNQA program, and it is important to set reasonable expectations especially with timelines for implementation and results to follow. In many cases, expectations of financial returns from administering quality programs and following MBNQA criteria are unreasonably high. In fact, *Davis (2005)* found that managers expected impractically low implementation cost and lofty returns—reporting expected improvements of 12% return on investment, 6.5% return on assets, 14% profits, and 15% customer satisfaction. When unrealistic expectations are set, the programs often cannot deliver and are deemed unsuccessful (*Hendricks and Singhal, 1999*).

Therefore, quality programs and MBNQA should not be seen as a “panacea for business, but rather a means with which to build and maintain a strong competitive foundation” and should not be expected to provide instant results (*Hendricks and Singhal, 1999; Zari, et al., 1994*). At the same time, many companies have demonstrated dramatically improved financial returns while pursuing the MBNQA and, hence, improving profit remains a top justification for involvement with MBNQA (*Davis, 2005*).

Perhaps the best-known study on the financial results of the MBNQA is the ‘Baldrige Index.’ In this annual study, \$1,000 is placed in a fictitious stock fund of publicly traded MBNQA winners and compared to \$1,000 hypothetically invested in the S&P 500 index. Between 1992 and 2002, the Baldrige Index outperformed the S&P 500 by 6.5 to 1 (NIST, 2003).

Another study compared 17 MBNQA winners between 1988 and 1996 to the S&P 500 index while adjusting for risk, market conditions such as inflation and interest rates, and variability unique to individual stocks such as labor strikes and lawsuits. In this study, MBNQA winners consistently outperformed the S&P 500 stocks having similar risk (*Tai and Przasnyski, 1999*).

Another fictitious stock index, the Q100, was created to track the quality leaders of the S&P 500. Between September 1998 and December 2001, the Q100, which was weighted and diversified to align with the S&P 500, experienced a return of 27% while the S&P 500 return was 17.6% during the same

time period. It was concluded that “in both bull and bear markets, quality improvement efforts have a direct and measurable impact on performance” (George, 2002).

Wisner and Eakins (1994) studied 17 MBNQA winners between 1988 and 1992 and found impressive achievements in customer service cost, production costs, product reliability, defect rate and cycle time reduction. During this time, companies increased sales by 75%, employee job satisfaction by 57%, and return on assets by 50%. Detailed analysis of financial performance (including annual sales, 5-year growth, return on sales, return on assets, return on net worth, P/E ratio, earnings per share, and 5-year average growth in earnings per share) on four of the companies calculated an increase of 58% in overall financial performance during the 4-year study period.

Ramasesh (1998) examined 13 publicly traded MBNQA winners between 1988 and 1996 and used S&P 500 index and the Wall Street Journal Index to track key performance metrics. Compared with the two indices, this study found significantly higher returns for the MBNQA winners, especially in regard to net sales per employee and reduction in inventories.

Jacob et al. (2004) compared 18, publicly-traded MBNQA winners between 1988 and 2002 to a benchmark group of 18 comparable (by SIC code and sales revenue) companies. Researchers compared several accounting metrics including a market-to-book ratio (market value of assets to the book value of assets), P/E ratio, and excess value ratio. Under uni-variate and multivariate tests, MBNQA winners performed significantly better than the industry medians in terms of profitability and asset utilization while having more leveraged debt and spending more on capital, R&D, and advertising. In short, winners were more valuable than the benchmark group and valued more highly by investors.

Wrolstad and Krueger (2001) compared 25 state quality award winning companies from 1988 to 1996 to companies matched by size and SIC code. Average changes for key metrics over the four year period are shown in Table 1.

Table 1. Changes in key indicators in 8-year study period (Wrolstad and Krueger, 2001)

	MBNQA Winners 1988-96	Matched, Non-Winning Companies, 1988-1996
Return on equity	+18.73%	-5.91%
Return on assets	+10.28%	-5.5%
Operating profit margin	+46.77%	+2.69%
Operating margin	+1.12	-1.71
Return on investment	+18.1%	+16.2% (S&P 500 Index, +13%)

Hendricks and Singhal (1999) studied 600 winners of different awards, including the MBNQA, state quality awards, and others created by large companies based on the MBNQA. All subject companies were publicly traded, allowing financial data to be obtained for the four years prior to the award (implementation period) to six years after winning (post implementation). The award winning companies’ performance was compared to benchmark companies selected from the same industry and having similar asset value. During the implementation period, researchers found no significant differences in any performance criteria between the winners and non-winners. Post implementation, researchers found the following indicators:

Table 2. Performance indicators after winning quality award

Indicator	Quality Award Winners	Benchmark Companies (non-participants)
Growth in operating income	91%	43%
Sales increase	69%	32%
Total asset increase	79%	37%
Return on sales increase	8%	None

Many believe that, of quality-award winning firms, larger companies have an advantage. However, the researchers showed that small companies outperformed benchmarks by 63% on average, compared to 22% for large companies. The study also concluded that winners of independent awards (MBNQA and state awards) outperform winners of supplier awards. On average, independent award winners outperformed benchmark companies by 73% while supplier award winners outperformed benchmarks by 33%.

Other examples of high performance as a result of the use of the MBNQA criteria include the following. This data has been obtained from summary award application documents and profiles from MBNQA winners on the MBNQA website.

http://www.baldrige.nist.gov/Contacts_Profiles.htm

Small Businesses	Service Businesses	Manufacturing
<u>MESA Products Inc</u> <ul style="list-style-type: none"> 93% increase in sales 20% increase return on equity 	<u>Premier Inc</u> <ul style="list-style-type: none"> 90% Customer satisfaction 15% increase in operating margin 	<u>Motorola Inc</u> <ul style="list-style-type: none"> 32% increase employee productivity 99% customer satisfaction
<u>PRO TEC</u> <ul style="list-style-type: none"> 2% employee turnover 0.12% defect rate 	<u>Ritz Carlton</u> <ul style="list-style-type: none"> 99% guest satisfaction, 80% extremely satisfied Pre tax return on investment and earnings doubled 	<u>Sunny Fresh Foods</u> <ul style="list-style-type: none"> 93% revenue increase Market share increased while competition decreased by 10%
<u>Texas Name Plate Co</u> <ul style="list-style-type: none"> Profit increase from 36% in 1998 to 40% in 2004 	<u>DynMcDermott Petroleum Operations</u> <ul style="list-style-type: none"> Customer satisfaction increased from 67% in 1999 to 74% in 2004 	<u>Boeing's Airlift and Tanker Program</u> <ul style="list-style-type: none"> Avoided loss of 10,000 jobs 60% productivity increase

When used effectively, the MBNQA and other quality programs improve financial and non-financial performance. But, like any other aspect of business, there is no silver bullet. Instead, a company must apply knowledge, use judgment, clarify appropriate expectations, evaluate consequences, and monitor processes continuously. This is the case whether an organization plans to apply for the MBNQA or

simply to use its self-assessment process (Hardie, 1998, Hendricks and Singhal, 1999, Davis, 2005). However, Garvin (1991) may have stated it best, “While MBNQA winners are as vulnerable to economic downturns, shifts in fashion and technology, and other environmental impacts, they are better positioned than others to recover gracefully because they have superior management processes in place.”

Quality in the Construction Industry

The next step is looking and quality management specifically in the construction industry. As quality management processes including Total Quality Management, Quality Assurance, ISO 9001, Six Sigma, and Lean continue to expand globally in manufacturing and other industries, these techniques have seeped into the construction industry (*Dahlgaard and Dahlgaard-Park, 2006; Aberdeen Group, 2005; Salem et. al, 2005; Abdul-Rashid & Abdul-Aziz, 2002; Mathews, et al., 2000*). Quality has been adopted in the construction industry mainly because, as in any other industry, “it is critical that client satisfaction is achieved if an organization is to succeed, or indeed survive,” (*Barratt, 2000*).

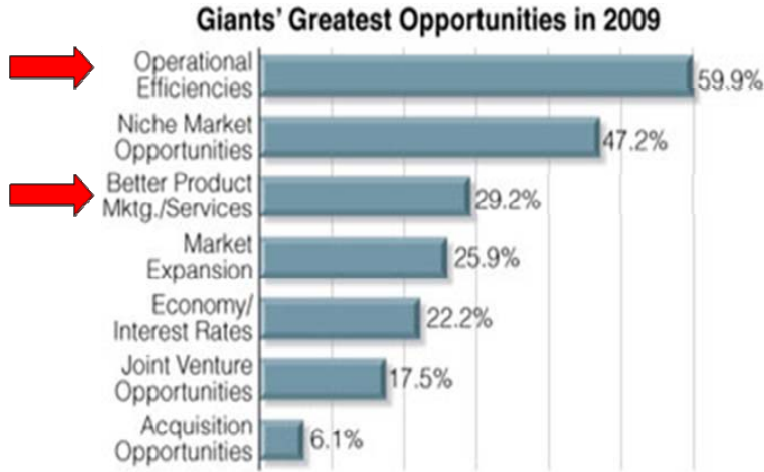
Due to the construction industry’s uniquely complex and personal nature, understanding and meeting client requirements is key to success. Quality management processes in the construction industry have improved product quality and customer satisfaction, and reduced costs and employee injuries (*Hoonakker, 2006*). While many in the industry are attempting to improve quality, progress has been slow and fragmented (*Low and Hong, 2005, Haupt and Whiteman, 2003*). Further complicating the integration of quality processes is the unique aspects of the industry as *Low and Tan (1996)* point out, “the construction industry is characterized by activities which are discontinuous, dispersed, diverse and distinct in nature.” Yet, the successful application of quality management in the industry is proven (*Bayfield and Roberts, 2005*).

Another unique aspect to new home construction is the use of trade contractors. Where quality methods are employed in the industry, the principles are often applied only at the management level and not successfully transferred into field operations (*Haupt and Whiteman, 2003*). The issue is complicated by the industry’s use of trade contractors, which undertake 90% to 100% of job site construction (*Abdul-Rashid and Abdul-Aziz, 2002*). No doubt, client satisfaction and contractor performance are “positively and strongly associated with their relationships with sub-contractors,” (*Xiao and Proverbs, 2003*). Therefore, the best way to improve relationships and quality with trade contractors is to focus on building partnerships (*Mathews, et al., 2000*) which involves collaborating on resource efficiency, financial issues, and combined goals (*Bayfield and Roberts, 2005*). Barratt (2000) concludes that a combination of “sound formal systems and strong relationships is essential to achieve high quality in the project environment of construction.”

According to *Xiao and Proverbs (2002)*, “quality tends to suffer from attitudinal rather than technological problems; there is a need to create a culture of quality.” Creating this culture requires behavioral changes and, therefore, commitment from company leaders may be the primary factor for successful implementation, (*Salem, et. al, 2005*). It is only a mind shift by senior management that will lead to the industry fully embracing quality management (*Low and Hong, 2005; Haupt and Whiteman, 2003*). Yet, to be successful, the programs must be pervasive not just among managers, but also throughout the company and in the field.

The Impact of Quality for Home Building Companies

So what impacts are possible if quality management is applied to homebuilding? A 2008 study by *Professional Builder* magazine ranked the issues that its “Giants” of homebuilding report as the greatest opportunities for home building companies. At the top of this list was operational efficiency and third ranked was better product and services. Both of these top-ranked improvement opportunities can be addressed using quality tools and techniques (see Figure 6).



Source: *Professional Builder* 2009

Figure 6. Opportunities for builders (*Professional Builder Magazine*, May 2009)

Considering the potential for operational efficiencies outlined in the economics of quality section, and profits from Figure 7, it becomes apparent that substantial financial impacts can be made by implementing a quality program. Using 2008 data from Figure 7 with *Rodchua's* (2002) average numbers for the cost of quality, 3.5% of revenue is cost of quality and of that 75% of cost of quality is failure costs. Therefore 2.62% of revenue is failure costs.

% of Average Home Sales Price			
	2008	2007	% Change
Land/Entitlement/ Financing Expenses			
Raw Land	9.97%	9.92%	0.50%
Land Improvement	4.15%	3.77%	10.08%
Improved Lot Costs	7.99%	7.46%	7.10%
Fees	2.09%	2.04%	2.45%
Financing Costs	3.41%	3.19%	6.90%
Hard Costs			
Materials	28.93%	27.57%	4.93%
Construction Labor	23.12%	22.97%	0.65%
Indirect Construction Costs	3.96%	3.58%	10.61%
Sales and Marketing Costs			
Advertising	1.45%	1.20%	20.83%
Marketing	1.50%	1.50%	0.00%
Model Merchandising	0.95%	0.85%	11.76%
Sales Commissions	3.25%	3.13%	3.83%
Overhead/Profit/Misc.			
Overhead Expenses	6.21%	5.56%	11.69%
Profit	1.22%	6.15%	-80.16%
Miscellaneous	1.80%	1.11%	62.16%
Total	100%	100%	

Source: Professional Builder 2008, 2009

Figure 7. Component costs of the average home sales price (Professional Builder magazine, May 2009)

For example, if a builder constructs 50 homes per year which sell for \$150,000 each:

At 2.62% of revenue being failure cost:
 $2.62\% \times \$150,000 = \$3,930$ failure cost/house

At 1.22% profit per house:
 $1.22\% \times \$150,000 = \$1,830$ profit/house

Therefore for 50 homes per year, failure cost per year:
 $50 \times \$3,930 = \$196,500$ failure cost/yr
 The equivalent of 1 home per year is the failure cost/yr

A 2006 study of nearly 32,000 homes by Quality Built supports these levels of failure costs. The study revealed the average cost to correct defects in new single-family homes was \$5,400 and more than \$4,500 for multifamily and light commercial construction (Quality Built, 2006).

The potential positive impact of quality improvement was illustrated by JD Power study (JD Power, 2006). An average JD Power builder with a JD Power index score of 112 receives 3.96 positive recommendations per homebuyer. At an index score of 122, the same builder would receive 4.62 positive recommendations per homebuyer. This increase in recommendations, using JD Power’s customer-based data for return rates, average sales price, and other indicators, would ultimately translate to \$175,000 increased profit.

0.66 Additional Recommendation per Buyer	X	128 Average Number of Returned Questionnaires per Builder	=	84 Potential Customers	X	15% Convert to Sales	=	12 Additional Home Sales
					X	\$292,000 Average Sale Price		
					=	\$3,504,000 Revenue		
					X	5% Average Profit Margin		
					=	\$175,000		
					=	Additional Profit from additional recommendations		

Figure 8. JD Power example of increased profits due to increased customer satisfaction.

In another study by the Department of Energy on a modular home building company showed a 59% gain in labor productivity and a simultaneous 22% cycle time reduction due to the implementation of a quality management program (U.S. DOE, 2005).

The NAHB Research Center’s National Housing Quality (NHQ) program has also shown the impact of quality implementation with traditional residential home builders. A 2007 survey by the NAHB Research Center’s National Housing Quality (NHQ) program builders revealed that, after achieving NHQ certification:

- 80% of NHQ certified trade contractors reported a reduction in callbacks
- 88% achieved an increase in employee accountability
- 79% improved relationships with builders
- 65% overall improved their bottom line
- 70% of NHQ certified builders improved their bottom line
- 75 % reported a reduction in callbacks and improved relationships with trades
- Up to 25% reduction in cycle time for certified trade contractors (NAHBRC, 2007)

National Housing Quality Award (NHQA) winning builders have noted tremendous impacts from implementing quality management systems. A sampling of results includes:

- 98% homes zero defects at closing, net profit increased 9% (Grayson Homes, MD)
- Reduced cycle time by 15% (Pringle Homes, FL)
- 95% of trades list builder as the best to work for (Estes Homes, WA)
- 33% of homeowner recommendations resulting in sale (TS Lewis, AZ).
- (Professional Builder Magazine, 2009)

Finally, and perhaps most compellingly, a 1997 NAHB study reported the average builder net income before taxes of 5.1% and gross margin of 18.5%; NHQA builders, on the other hand, achieved an average net income of 11.2% and gross margin of 25.5%. (NAHB, 1997)

Business Results of Implementing Quality Management

Builders that have successfully implemented quality management reap excellent rewards in profitability, product quality, customer satisfaction, and employee satisfaction. Between 1993 and 2009, National Housing Quality Award-winning builders report the following impacts and performance indicators, many of which are a direct result of implementing effective quality management:

Category	NHQA Winning Builder Benefit from Quality
Profits (Gross Margins)	12-20%
Revenue	15-100% increase/yr
Construction Costs vs. Budget	+/- 1%
Customer Satisfaction	93-97%
Referral Rates (Sales made through referral)	29%
Cycle Time Reductions	15-50%
Zero Defects at Closing	98%
Defect Reductions	11-75%
Employee Satisfaction	94%
Trade Satisfaction	95%
Customer Endorsements/ Thank You Letters	73%
Warranty Requests	1 per every 15.5 homes

Winners of the National Housing Quality Award do not adhere to quality management to win awards. Instead, they cite cost savings, reduced defects, job satisfaction, customer satisfaction, and profitability as the motivation for quality management. As an example, the following are quotes from NHQ award-winning builders and *Professional Builder* magazine regarding the value of quality.

“Quality and satisfaction save money. You save a lot of money getting it right the first time. Make one trip [to the site], and you don't have to go back.” –K. Hovnanian Virginia, 2009 NHQ silver award winner

“About 400 to 500 Opportunities for Improvement are suggested a year and about 80 percent of them are implemented, **saving thousands of dollars and improving the customer experience.**” –Wayne Homes, 2010 NHQ silver award winner

““Our most recent ‘Cost Walk’ generated over 500 ideas for improvement. Many of them were implemented, and **we documented savings of over \$150,000 a year.**” –Pringle Development, 2008 NHQ silver award winner

It's also about getting the performance that you measure. We started posting the trade contractors' relative performance and letting them all see where they stood. It seemed to really spur them on to greater things.” –Pringle Development, 2008 NHQ silver award winner

Kevin Egan, president and COO, **“The reason we've been successful** is it starts with our mission and our vision, **We're disciplined in our processes and operations, setting goals and objectives**

and tracking key performance indicators and communicating that information.” –TW Lewis, 2009 NHQ gold award winner

“We decided that **we wanted to start having fun. We wanted to make money. And we wanted a good name.** That is when we started to turn things around.” –Don Simon Homes, 2002 NHQ gold award winner

From "**maximizing customer satisfaction with final product and overall building experience**" to "**designing, integrating and aligning all business functions to maximize efficiency and profits throughout the organization,**" these success drivers are the genesis of the company's strategic plan. –Don Simon Homes, 2001 NHQ silver award winner

"We don't build a single home. We are managers. We create schedules. We obtain the materials, locations, plans, et cetera, but we don't build a thing. We deal with contractors, many of whom have been in business a long time. They have experience that we don't." –Pulte Homes Minnesota, 2003 NHQ silver award winner

Quality leadership is like that. It's not passed down, layer by layer, until the folks that do the work "**understand. Quality leadership rises to the top. Common values become company values, and company values become a culture that nurtures success.**" –Winans Construction, 2001 NHQ gold award winner

"Any company that embarks upon the NHQ process constantly seeks improvement. For us, that meant growing not necessarily in volume but in ways that would actually accomplish something for us, **make us more efficient and create more opportunities for my employees.**" –Boardwalk Builders, 2004 NHQ silver award winner

"We felt that we really needed to have **good communication with our customer,** which mostly means no surprises. We have checklists and systems in place [to ensure] this happens with every single customer in every single home. **I see a lot of companies winging everything, including the repetitive-type tasks, and I see that as a huge waste of time and resources.**" –Estes Builders, 2005 NHQ silver award winner

"We have certain **success drivers: business profitability, customer loyalty, operating efficiency and employee department loyalty.** Every other week, everyone in the organization comes together --all 140 of us. We start every meeting with our vision or mission. **It's how you communicate effectively with your team about what's important.** You need to be part of that process." Veridian Homes, 2005 NHQ silver award winner

"**Efficiency and profitability drive decisions.** A mindset to constantly improve processes and procedures helps the company overcome any obstacles. The company strives to clearly communicate its goals and objectives to employees to make sure they're aware of changes to the company's strategic plan." As one of the first contractors in the nation to achieve NHQ Certified Framing Trade Contractor status, the company recognizes the need to **minimize risk associated with construction defect litigation and rising insurance premiums.**" – Schuck & Sons, 2007 NHQ silver award winner

“Partnerships with trade contractors and suppliers are an industry best practice with systematic integration addressing the goals and objectives of the organization.” Shea Homes, *2006 NHQ gold award winner*

“When times are tough—and no one is immune to our economy's downfall—it's easy to forgo routines and strategy critical to business success. But Simonini Builders **maintained its business rhythm and devotion to employees as the challenges mounted.**” – Simonini Builders, *2010 NHQ gold award winner*

“Performance and progress are closely monitored with daily "dashboard" reports and monthly "scorecards." **Color coded scorecards allow managers to be quickly alerted to problem spots so changes can be made to address any deficiencies or variances from the established business plans.**” –Fireside Hearth & Home, *2008 NHQ Silver Award winner*

These references show the dramatic positive impacts that quality management can provide on a wide range of performance indicators including ultimately, profitability.

The Impact of High Performing Homes

Beyond implementing quality management in general, as well as specifically in homes, adding the goal of high performance homes can also lead to improved customer satisfaction. A 2007 NAHB survey revealed that home buyers want energy efficient, low-maintenance, well-insulated and well-sealed homes and they are willing to pay a premium for them (Figures 9 & 10). Indeed, homeowners are not simply attracted to high performing homes; they are more satisfied with these homes. According to McGraw-Hill (2007), 63% of green home buyers are attracted to high performing homes due to lower operating and maintenance costs. Yet, 85% reported being more satisfied with their new green homes than with their previous, traditionally-built homes. By coupling quality management systems with high performance home building techniques, builders are likely to create satisfied customers and, hence, increased profit.

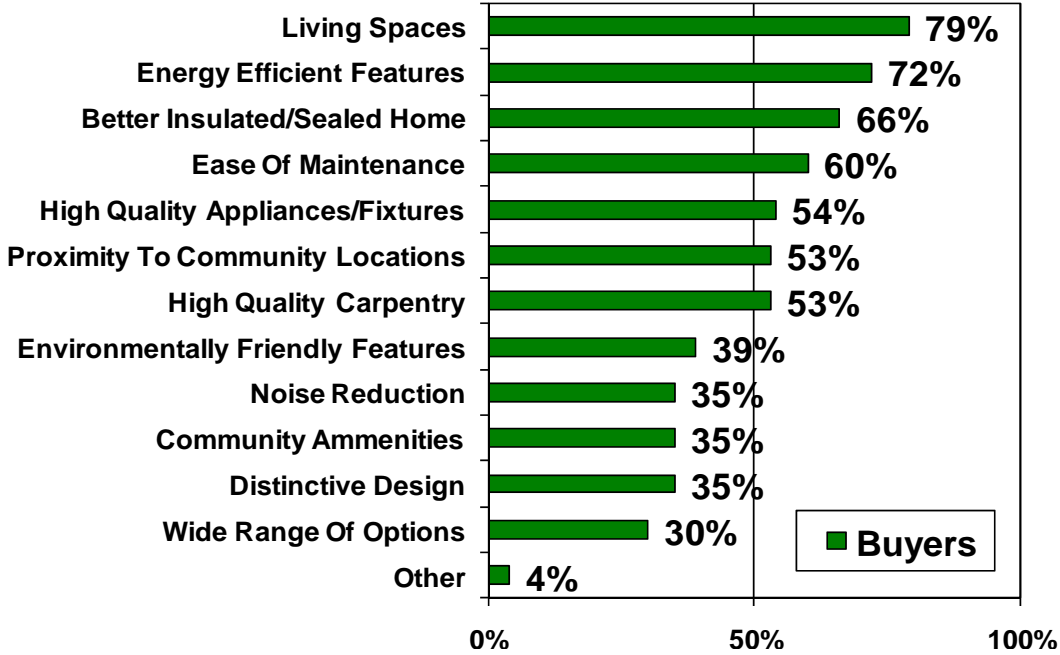


Figure 9. What homeowners want (NAHB, 2007)

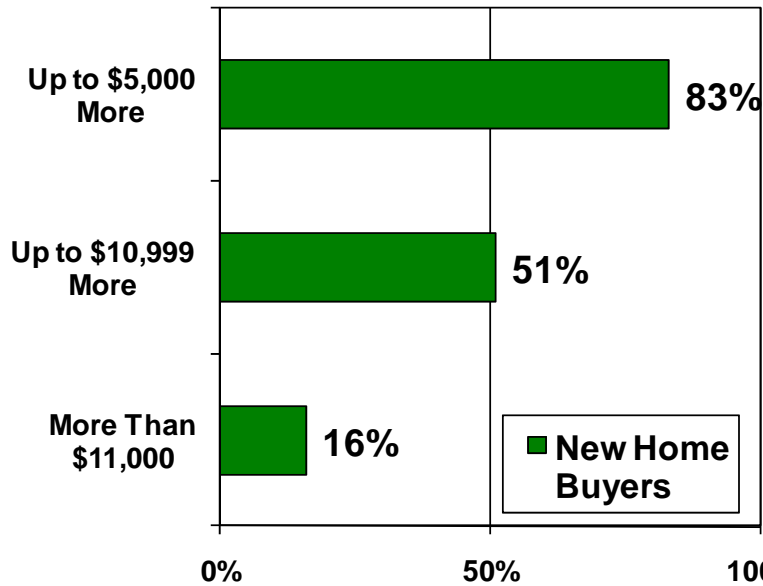


Figure 10. What homeowners are willing to pay for the energy efficient features they want in homes (NAHB, 2007)

Quality Management Tools & Techniques

The motivation for quality management for high performance homes makes sense based on value, costs, revenue, and customer service. In addition, quality management has the most impact when strategically coordinated, driven and aligned throughout the organization. From the strategic level, coordination flows through a tactical and then operational level. (Figure 11)

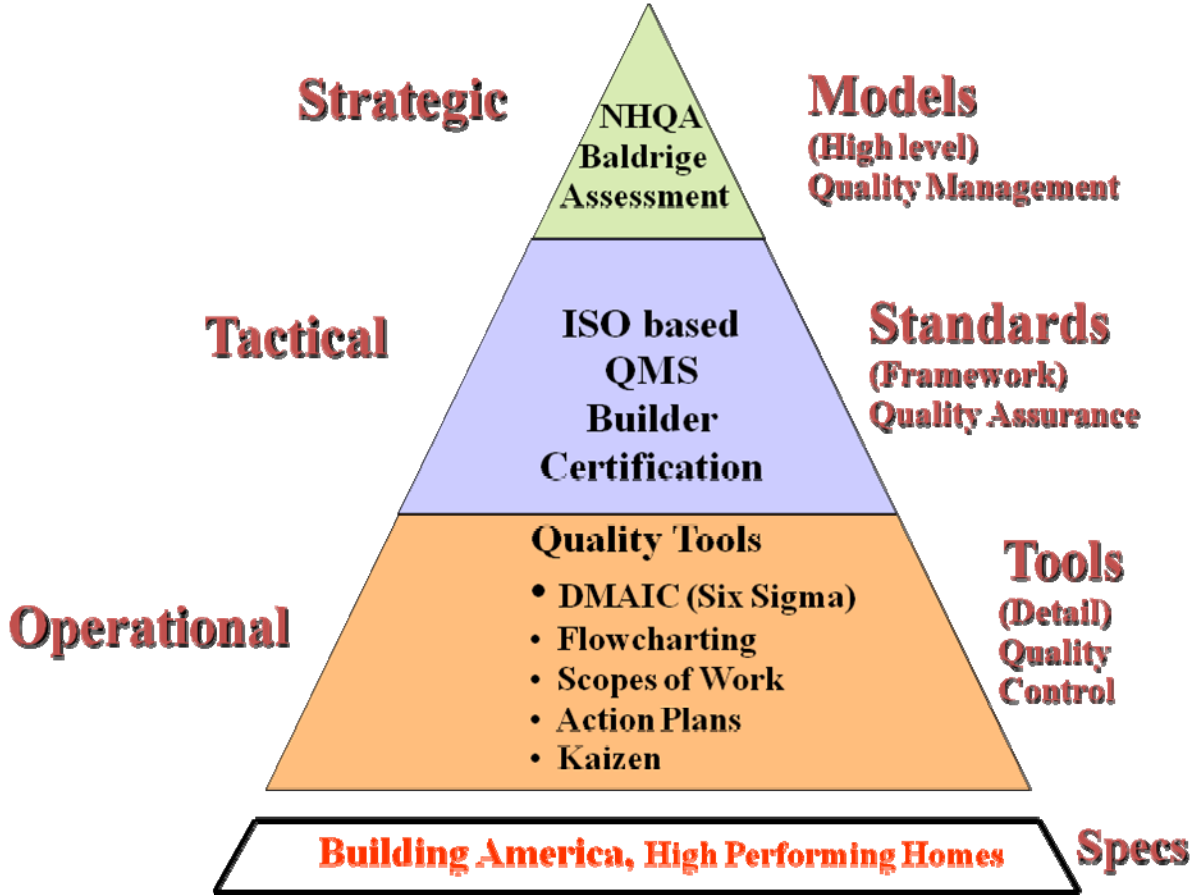


Figure 11. Strategic, tactical and operational layering of quality management.

Strategic Models

As the strategic level, the NHQA application process helps builders self-assess their quality management program, identify gaps, and coordinate improvement of factors critical to business success. The NHQA Criteria for Performance Excellence has served as an important tool for hundreds of home builders and trade contractors. The criteria help to:

- Align resources
- Improve communication
- Increase productivity
- Boost effectiveness
- Achieve strategic goals

The NHQA Criteria for Performance Excellence includes the following categories:

1. Leadership
How do your company's senior leaders guide the organization toward a common purpose based on shared values and priorities?
2. Strategic Planning

- How do you create and implement a strategic plan to achieve a vision for the future, enhance your competitive position, and improve overall performance?
3. Performance Management
How are your company's business processes developed, managed, measured, and improved to achieve performance excellence?
 4. Customer Satisfaction
How does your company manage the design and delivery of products and services that promise a high level of customer satisfaction?
 5. Human Resources
How do your employee selection and development practices, as well as staff performance management, well-being, motivation, satisfaction, and compensation contribute to the growth of your organization?
 6. Construction Quality
What methods does your company use to drive quality in the home construction process and ensure high performing, trouble free products and services?
 7. Trade Partnerships
How do you create high performance relationship with your independent trade partners?
 8. Business Results
What are the tangible measurements of the business benefits resulting from your high performance practices in the financial, operational, customer satisfaction, and product and service quality areas?

Using the criteria, self-assessment can identify strengths and target opportunities for improvement that impact customers, employees, owners, suppliers, and the public. The NHQ self-assessment process is not only a first step toward driving improvement throughout an organization, but also toward submitting an application for the NHQA award process annually. Writing an application, in fact, is in itself a method of self-assessment.

When an award application is submitted, it undergoes review by a team of expert judges. Finalists further receive a site visit by a judging team that may last several days. In either case, applicants receive detailed, actionable feedback reports to support continued improvement.

The NHQA process is an ideal strategic tool for organizations. It helps companies learn quality concepts, begin self-assessment, implement improvement, submit an application, and gain valuable independent feedback for improvement.

Tactical Standards

The NAHB Research Center's NHQ Certified Builder and NHQ Certified Trade Contractor programs can represent tactical quality management systems (QMS) for the construction industry. These programs based on ISO 9000, ISO 14000, and OSHA 18000 focus on driving quality assurance through a QMS. These programs set criteria for quality, safety, and environmental management in the homebuilding industry.

Both certification programs, which involve annual third-party audits, incorporate the critical issues of continual improvement and corrective and preventive with a unique focus on homebuilding industry issues. Companies that go through the process of certification must demonstrate quality management

systems throughout the company—from scheduling work and creating jobsite inspection lists to ensuring job ready conditions and partnering with trades on quality initiatives.

In fact, NHQ certified builders are strongly encouraging trade partners to seek NHQ certification, since contractors provide nearly all of the skilled labor used to construct homes. Some NHQ certified builders pay for over 12 hours of training and support the development of quality manuals required for certification. The emphasis has been to ensure that a complete chain of quality processes is achieved with all partners.

During the NHQ certification process, builders and trade contractors must develop a quality manual and set of procedures that cover the following encompassing areas:

General

- Scope
- Leadership
- Quality statements
- Quality manual
- Responsibilities
- Organizational chart
- Training
- Performance management
- Process flow

Management System

- Committee
- Audits
- Annual reviews
- Changes
- Document control
- Records
- Reference documents

Procedures

- Scopes
- Procedures
- Codes
- Standards
- Manufacturers' instructions
- Contracts
- Schedules
- Approval of trades
- Control of specifications and plans
- Job ready, in process and complete inspection
- Corrective and preventive action
- Training

Operational

Operational tools are those that make improvements happen. The NAHB Research Center has developed many tools, specific to the home building industry, to support quality improvement. These and other quality specific tools include:

- Scopes of Work
- Procedure Documents
- Checklists
- Six Sigma DMAIC process
- Process Mapping
- Value stream mapping
- Failure mode effects analysis (FMEA)
- 5S
- 8D
- Fishbone Charts
- 80/20 rule
- Brainstorming

One additional measure that the NAHB Research Center plans to address in future quality management work includes the design of high performance homes. To date, existing quality management programs have not addressed the need to design the house as a system which is vital in high performance homes.

Suggested Cost of Quality Metrics for Home Builders

Although the value for quality management was detailed above, in order for a builder to be able to quantify quality, it is necessary to have standard metrics and methodologies for measuring quality management. For the home building industry, cost of quality metrics for high performance homes should ideally follow the Prevention, Appraisal and Failure model. By measuring these metrics a homebuilder can establish their current levels of performance and then monitor year on year their performance, measure improvement and benchmark themselves against the best in the industry.

Quality performance metrics

There are many performance metrics to measure the success of a quality management system including scheduling, costs, etc. These are detailed further below.

Schedule

- *Construction Schedules* - (ideally this is in working days) This metric allows a builder to ensure 'on time' construction by milestone as well as firm timelines to focus on for improvement i.e. reducing cycle times. Some of the suggested categories are included below. However, the intent is that these are customized and each builder uses them to provide as much detail as possible to determine if the schedules are met or not.
 - Design

- Contract signing to closing
- Contract signing to excavation
- Excavation foundation
- Excavation back fill
- Weather days
- Framing
- Frame start to certificate of occupancy
- Rough mechanical
- Drywall
- Trim
- Pre-punch to closing
- Testing
- Inspections
- *Milestones* - This metric includes the date of the milestones to further detail the construction schedule above.
- *On Time Delivery* - To track this metric, a builder has to first determine when the when the builder considers the delivery to the customer (such as closing). Once this is defined, and based on the construction schedule, the on time delivery can be reported as a simple yes or no. Beyond this, a builder can then relate the on time delivery as a percentage of projects completed.

Energy Performance

- *Air Infiltration Testing* - This metric is the result of the blower door test to measure the air infiltration (leakage) of the home to the exterior.
- *Duct Leakage Testing* - This metric is the result of the duct blaster test to measure the leakage of the duct system to the exterior and the interior to determine heat loss and delivery efficiency of the duct system.
- *BA Benchmark/HERS Index* - This metric uses energy simulations, the air infiltration, and duct leakage measurements to estimate the energy use and costs of the home.

Costs

- *Profits* - This metric details the profits for the project including:
 - Gross Profit= net sales - cost of goods sold
 - Net Profit= gross profit - Total operating expenses
- *Inspection Costs* - This metric details all costs involved in checking and rechecking someone else's work (that they should have checked and done right the first time) this will include, labor, truck, fuel costs etc.
- *Verification Costs* - This metric details the costs to verify the performance of the home including the air infiltration testing, duct leakage testing, and any program verifications such as Builders Challenge, ENERGY STAR, green programs, etc.
- *Warranty Costs* - This metric can cover all costs including labor, fuel, trucks, material and time for rework and repair for customer call backs. In addition, it can also include litigation and insurance costs.

Training

- *Training Costs* - this would include all training courses, books and other materials and may include overhead for internal management time for training and even time taken from work to attend certain all company meetings.

Satisfaction - Customer, Employee, Trade, Etc.

- *Customer Satisfaction* - (challenges discussed following) This metric is a score reflecting for detailed aspects of the construction process and/or for the overall satisfaction of the client with the process and finished product. The higher the score the better the chance of referrals and return work in the future.
- *Warranty Customer Satisfaction Rating* - This metric can be a detailed customer satisfaction score or sub-score (from other questions) that allows a builder to focus on sub sections of their after construction/warranty process and key individuals in that process. This helps focus on specific areas of improvement.
- *Construction Manager Customer Satisfaction Rating* – This metric can be a detailed customer satisfaction score or sub-score (from other questions) that allows a builder to focus on sub sections of their construction process and key individuals in that process. This helps focus on specific areas of improvement.
- *Trade/Supplier Satisfaction* - This metric provides insights into the satisfaction of a builder's trades and/or suppliers. Finding potential new trade partners, evaluating them, training them to meet the builder's schedules, scopes of work, etc is time consuming and expensive. A builder wants to keep their well trained, experienced trade partners. A trade/supplier satisfaction survey allows a builder to uncover dissatisfaction they may have which they can address while also allowing them to suggested areas to improve that may save time or money on the job. Again there are various rating systems, survey approaches, and time periods for conducting trade/supplier satisfaction surveys and so its challenges are also very similar to that of customer satisfaction discussed earlier.
- *Employee Satisfaction* - This metric provides insights to the morale and culture of an organization and is focused on reducing the rate of employee turnover by gaining feedback on how the builder can make the work-life of their employees better. Hiring and training new employees is very expensive, ensuring a builder keeps their trained, experienced existing employees is a good investment. There are various rating systems, survey approaches and time periods for conducting employee satisfaction surveys and so its challenges are very similar to that of customer satisfaction discussed earlier.

Referral

- *Referral Rates* - This metric details the percentage of customers that actually did refer someone to a builder's business.

Productivity

- *Sales per Employee* - This metric is gross sales/revenue divided by the number of employees and provides an insight to how productive a builder is as an organization.
- *Units /projects per Employee/Trade* - This metric is another measure of how productivity.

Warranty/Defects

- *Number of Warranty Calls* - This metric can be measured as call backs per customer /home sold. Obviously the less of these the better. The fewer the higher the customer satisfaction and the higher the referral rates and of course the lower the unnecessary costs incurred by a builder which reduce their profit margins. This will reduce their customer satisfaction scores, chances for referrals and potentially result in the customer unfortunately promoting how bad their business is to other potential customers.

- *Time to Complete Warranty Calls* - This metric is measured in days from the day the customer called until the work is completed. If the customer calls back later on this same issue i.e. the issue was not adequately resolved then it gets added on to the original issue length in days. This reflects how well they respond and correct issues first time. The longer it takes to complete warranty issues will result in reduced customer satisfaction scores, chances for referrals and potentially result in the customer unfortunately promoting how bad business is to other potential customers.
- *Walk Through Pre Punch Defects* - This metric is the number of defects found by the inspector or superintendent on a final walk through of their home. This would be defects per square foot of home. The more defects found, the more rework needs to be done. This is unnecessary (it was not done correctly first time even though you paid for it) and further reduces your profit margin.
- *Customer Walk Through Defects* - This metric is the number of defects found by the customer on a final walk through of their home. This would be defects per square foot of home. This will reduce your customer satisfaction score and also the possibility of referrals.

One issue with the metrics is that looking at metrics across multiple builders can be difficult. A key challenge that needs to be recognized and addressed is that every builder uses different metrics to monitor its operations. To look at multiple builders, the metrics need to be standardized so that there is an agreed set of 'master metrics' which builders would ideally use or which would be used to 'convert' various builder metric formats. This would ensure that all data would be presented in one consistent and coherent manner to compare 'apples to apples'.

Examples of challenges due to the range of ways in which different organizations collect their data include:

Challenges: Cost

- Warranty costs as a % of gross sales/revenue
- Warranty costs \$ per home
- Warranty costs \$ per year per home sold

In addition, some include staff costs and some do not.

Challenges: Customer Satisfaction

- 3rd party customer satisfaction survey companies
- Their own internal surveys
- Customers surveyed after move in / completion of project after
 - 30 days,
 - 45 days,
 - 11 months,
 - 12 months, and/or
 - 18 months
- Rating scales for surveys
 - Range 1-6,
 - Range 1-5, or

- Range 1-10
- Satisfaction
 - Recommendations to a friend or family member
 - Direct question about satisfaction
 - Sub survey answers to create a combined satisfaction score

Customer satisfaction can also be survey and measured for key steps and by department i.e. construction manager/supervisor or warranty for example.

Challenges: Defects

- Square foot per defect
- Defect per square foot
- Defect per room
- Defect count per home (regardless of square footage per home)

In addition, some count every paint scratch others paint defects on a per room basis

Challenges: Other issues

Similar problems relate to employee satisfaction and supplier/partner/sub-contractor surveys. Problems also arise with production or even cycle time measures for example some use working days others use days (that include weekends).

Start and finish of project also creates problems for example some start the project cycle times based on contract signing, arrival on site, work starting and finishing times as work completed by contractor or sign off by home owner or certificate of occupancy.

Conclusion

The value of quality management can have an impact on the economics of quality management. Determining the costs of quality allow a high performance home builder to optimize their costs through optimizing the prevention of defects through appraisals and the number of failures. In addition, there is a direct connection between quality management and increased customer satisfaction. Numerous manufacturers, builders, high performance home builders, Malcolm Baldrige National Quality Award winners, National Housing Quality Award (NHQA) winners have documented value of quality management, cost savings, increased customer satisfaction, and other benefits of implementing quality management systems. To help builders implement quality management, there are many tools available including the NHQA application process.

One necessary step to quantifying quality is measuring the success of quality management. It is important to document schedules, energy performance, costs, training, satisfaction, referrals, productivity, and warranty/defects. Consistently measuring these metrics will allow a builder to determine where they are at and places for improvements. In addition, this will allow a larger study of the impact of quality including value, costs, energy and quality performance, customer satisfaction, and the impact in the construction industry. Those builders that have already adopted these practices have seen significant improvements in the performance of their businesses.

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