

Value Engineering Trends in the Construction Industry

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Abstract

Value Engineering (VE) was developed during World War II as a method to find alternative methods and materials for processes and products that were limited and challenged by rationing. Since its creation, the use of the VE process has extended to the construction industry as a way to maximize the value of a project. This research is being conducted to aid future VE brainstorming efforts by studying past VE studies and looking for trends. 14 VE studies from four construction companies were obtained. One significant finding was that electric, HVAC, plumbing and wall finishes are the best categories to propose VE in because they had a large sample size (20 or more VE items), and the percent of VE items approved in these categories was around or above 70%. This success rate was consistent when looking at the quantity of approved VE items and at the dollar value of the items. The categories that are not recommended for VE are elevators, fire protection, foundations, roof openings, canopies, stair construction, fixed furnishings, general and specialties. One reason for this conclusion is that the monetary value of these categories is less significant. Also, for elevators, fire protection, foundations, canopies, roof openings, canopies and stair construction, they are often specially engineered systems and specialized so there is little that is able to be changed. Fixed furnishings, general and specialties cover so many different topics that there is little consistency among VE items.

Value Engineering Trend in the Construction Industry

World War II was a time when many resources were in short supply. To cope with these deficiencies rationing was implemented; originally with food, but eventually extended to items like rubber and gasoline. Lawrence Miles of General Electric accepted the challenges that rationing presented and sought to overcome the challenges they presented to his business by finding alternative products and methods of production. It was from Miles' innovation in the 1940's that the Value Engineering (VE) process was created. (Sperling, 2001)

Overtime VE has transformed from a process used for preserving limited resources, into a dynamic approach that has "demonstrated [an] ability to reduce project cost, improve quality and productivity, foster innovation, and eliminate unnecessary and costly design elements (Borkenhagen, 1999)." These benefits of VE have not been overlooked by those in the construction industry. Since the conception of the VE process by the manufacturing industry, the construction industry has adopted it and further demonstrated its worth. Over a five year period from 1993 to 1998 Florida's Department of Transportation (DOT) program accomplished over 320 VE studies, and accumulated more than \$100 million in savings each year (Borkenhagen, 1999). During that same time period California DOT saved over \$400 million by completing more than 200 VE studies (Borkenhagen, 1999). In fiscal year 1998 alone 421 VE studies were done on state highway and transportation projects across the United States which resulted in 735 approved alternates and \$750 million of savings (Borkenhagen, 1999). The results of VE are so exceptional that the use of the VE process has been federally mandated on some projects. In 1995 Congress passed the National Highway System Designation Act which required a VE analysis for National Highway System projects that are estimated to cost more the \$25 million (Borkenhagen, 1999).

Whether VE is a requirement or not, it is a valuable tool for contractors in satisfying the owner's needs and ensuring money is wisely spent. On one U.S. Army Corps of Engineers waste water treatment plant project, VE lowered the cost of the project construction by \$200,000 and the cost of operating and maintaining the facility for two years by \$4.4 million (Acharya, Pfrommer, & Zirbel, 1995). The HVAC system of the Ritz Carlton in Miami also received a VE makeover and saved over \$700,000 through the modification of materials for faster installation and the substituting of equipment. This VE study was especially significant to the owner because the project had been delayed for a year after construction started due to lack of funds (Value Engineering put on the Ritz, 2001). Another benefit of VE to contractors is that often part of their contract with the owner, states that VE savings will be distributed between the two parties (Jergeas, Cooke, & Hartman, 1999).

In the construction industry the VE process generally begins with the selection of the VE team who will seek and discuss all information about the project. At this point, the team is informed of the owner's intent for the project and will brainstorm alternative ways (VE items) to satisfy the owner's needs. Each VE item is then evaluated and developed with factual support such as technical evaluations, cost ramifications and life cycle costs. This information gets presented to the owner, and the VE items chosen by the owner are implemented. (Acharya, Pfrommer, & Zirbel, 1995)

As successful as VE is, further improvement can be made. Currently, the brainstorming step can be general and unfocused, this research aims to enhance and provide direction to future VE efforts, specifically in regards to the brainstorming step.

Construction encompasses all the work involved to complete a project, whether that project is a building, park, bridge, etc. and that work can be organized into categories such as site work, plumbing, doors, wall finishes, etc. This research will seek to discover trends across the studies by analyzing which VE items were approved or rejected; which divisions of work the VE items belonged to; and other trends. With this knowledge, contractors can focus their energy and attention on those areas during the brainstorming step and receive the maximum value VE has to offer.

This research will utilize VE studies of projects completed within the last five years or currently in progress. 14 useable studies were obtained from four construction management companies. The characteristics of the projects these studies were based on varied greatly, including the project size, type (school, hospital, residential, etc.), participants (owners, architects, engineers, contractors, suppliers, manufacturers, etc.), and VE items proposed.

The size of the VE studies ranges; the smallest study contains just 12 VE items and the largest has 135. The average number of VE items per study is 38 and the median is 30. Between all 14 studies there were 532 VE items. With the information contained within these studies different trends will be explored by performing a data analysis.

Part of this data analysis involves comparing the VE items belonging to different categories and looking for trends within each category. Before this can be done it is necessary to split the VE items into their respective categories. There are two institutions that have developed categories for the elements of construction; they are the Construction Specifications Institute (CSI) and the National Institute of Standards and Technology (NIST). CSI divisions are organized based on trade such as concrete, masonry and finishes (MasterFormat Numbers and Titles, 2011). On the other hand, NIST Unifomat divisions are created to group elements of a

project; foundation, substructure and interior construction are examples of its divisions (Charette & Marshall, 1999). Each has its benefits, for example, doors all belong to the same CSI division however in Unifomat, interior and exterior doors are in separate groups, in this case CSI divisions are better. On the other hand, a VE item might propose substituting a curtain wall for a brick masonry wall, in CSI divisions these options would be in different divisions, but under the Unifomat divisions they both belong to the exterior walls section making it the better choice for categorizing. For the purposes of this research, a combination of these categorical systems will be utilized. The 24 categories this research will use are: site, electrical, HVAC, exterior walls, flooring finishes, casework, wall finishes, plumbing, windows, ceiling finishes, partitions, doors, roofing, equipment, specialties, general, fixed furnishings, roof construction, stairs construction, canopy, roof opening, foundation, fire protection and elevators.

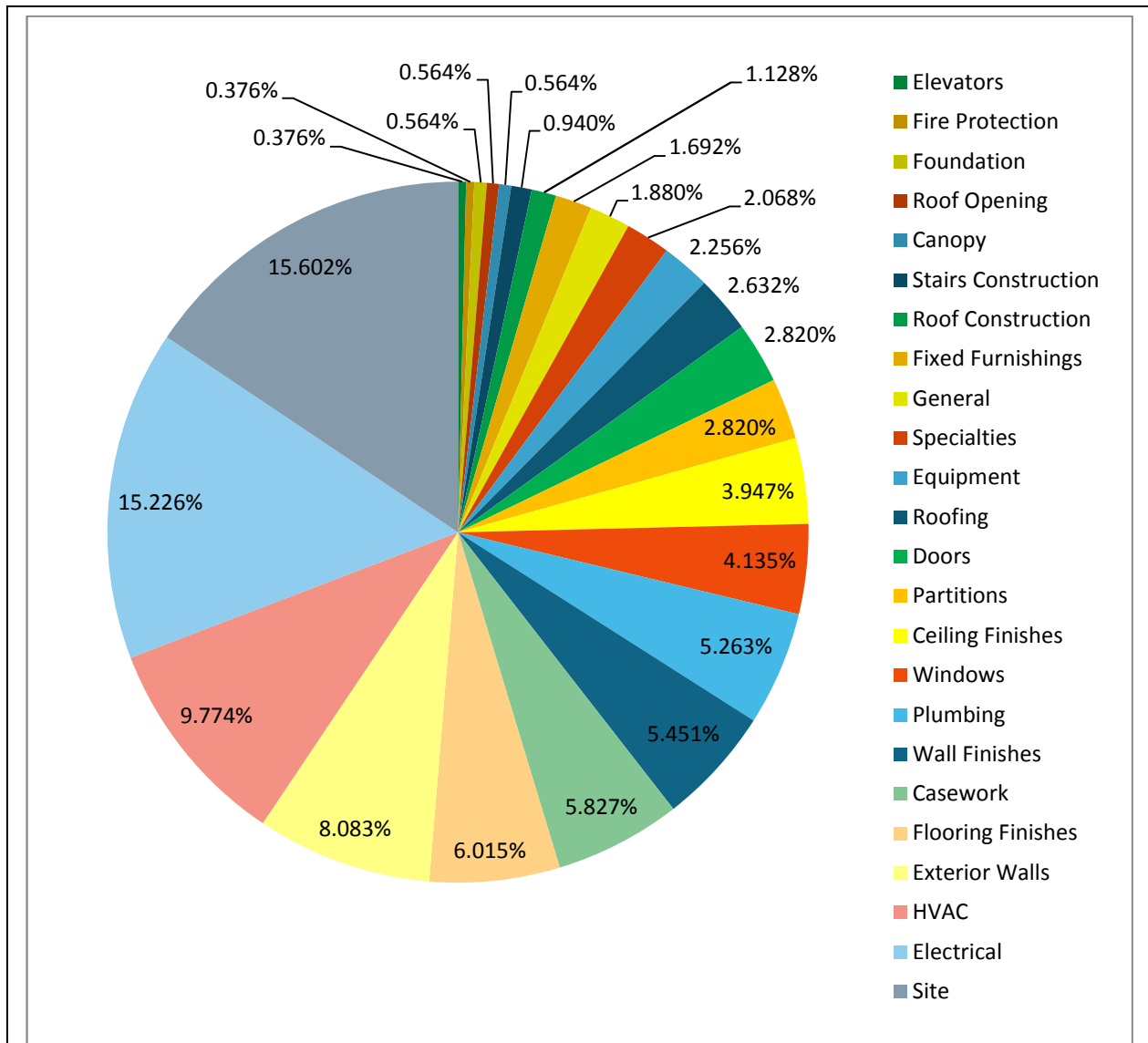
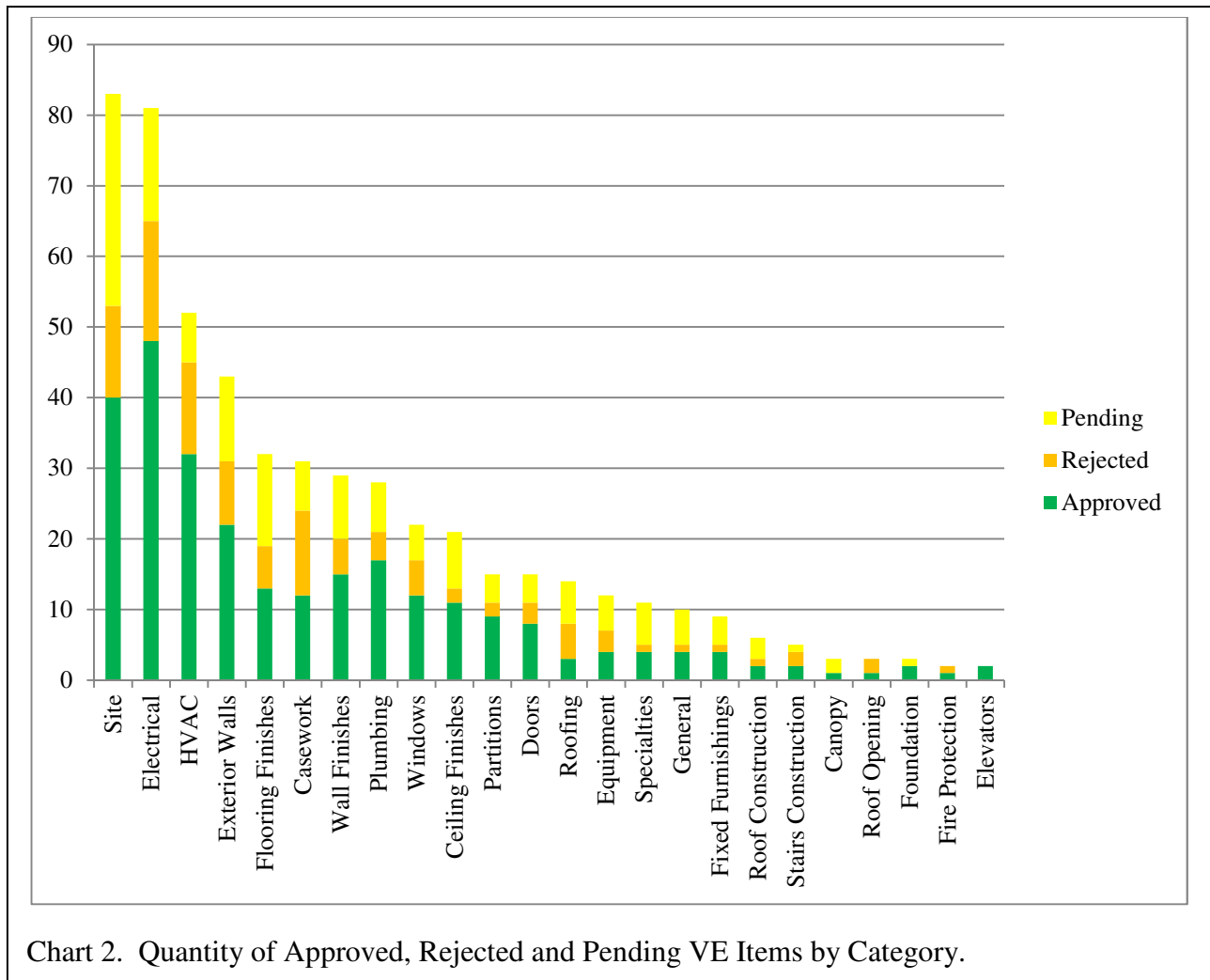


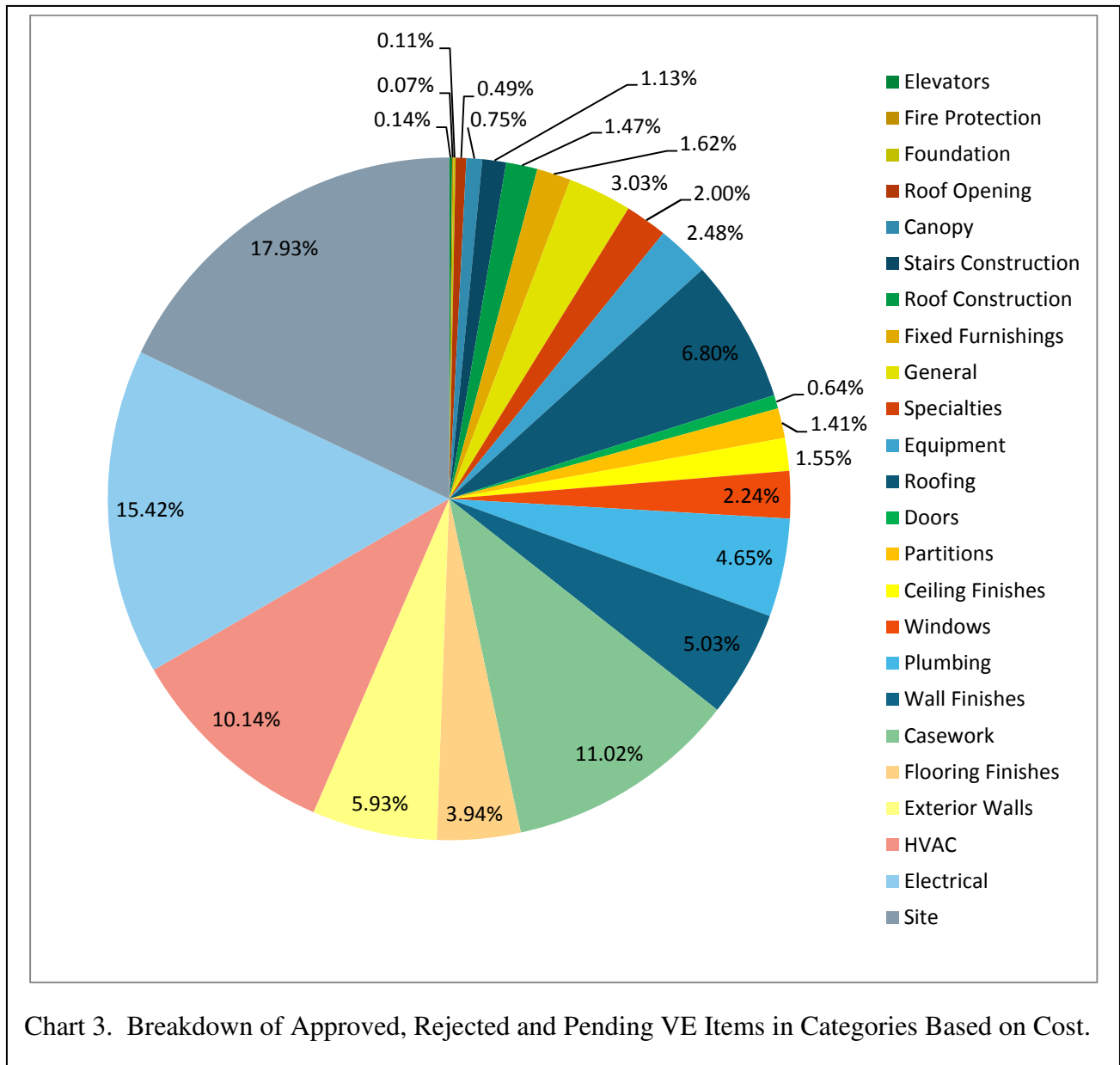
Chart 1. Breakdown of Approved, Rejected and Pending VE Items in Categories Based on Quantity.

Chart 1 shows the distribution of the 532 VE items across the various categories, the categories where the most and least amount of VE items come from are easily illustrated. The top five frequently value engineered categories are site, electrical, HVAC, exterior walls and flooring finishes, each with more than 30 VE items and together they encompass more than 50% of the VE items. The five least often value engineered categories are elevators, fire protection,

foundation, roof opening and canopy; in each of these categories there were only two or three VE items.



This same information is demonstrated in Chart 2, but this chart also shows the distribution of approved, pending or rejected items within each category. Although the pending items cannot be used to find trends within categories, it is useful to see them in this table. Without the pending VE items the electrical category would seem to be the largest, but with them the site category is larger by two items.



The monetary breakdown of categories is represented in Chart 3. This is similar information to Chart 1, but instead of the categories being made up of the number of VE items in them, they are made up of the cost associated with the VE items. By comparing the two pie charts it is easily seen that while some divisions have more VE items, the monetary value of them makes them less significant and vice versa. For example; casework is below HVAC, exterior walls and flooring finishes in number of VE items, but the monetary value of the items

within it put it in the top five for cost categories.

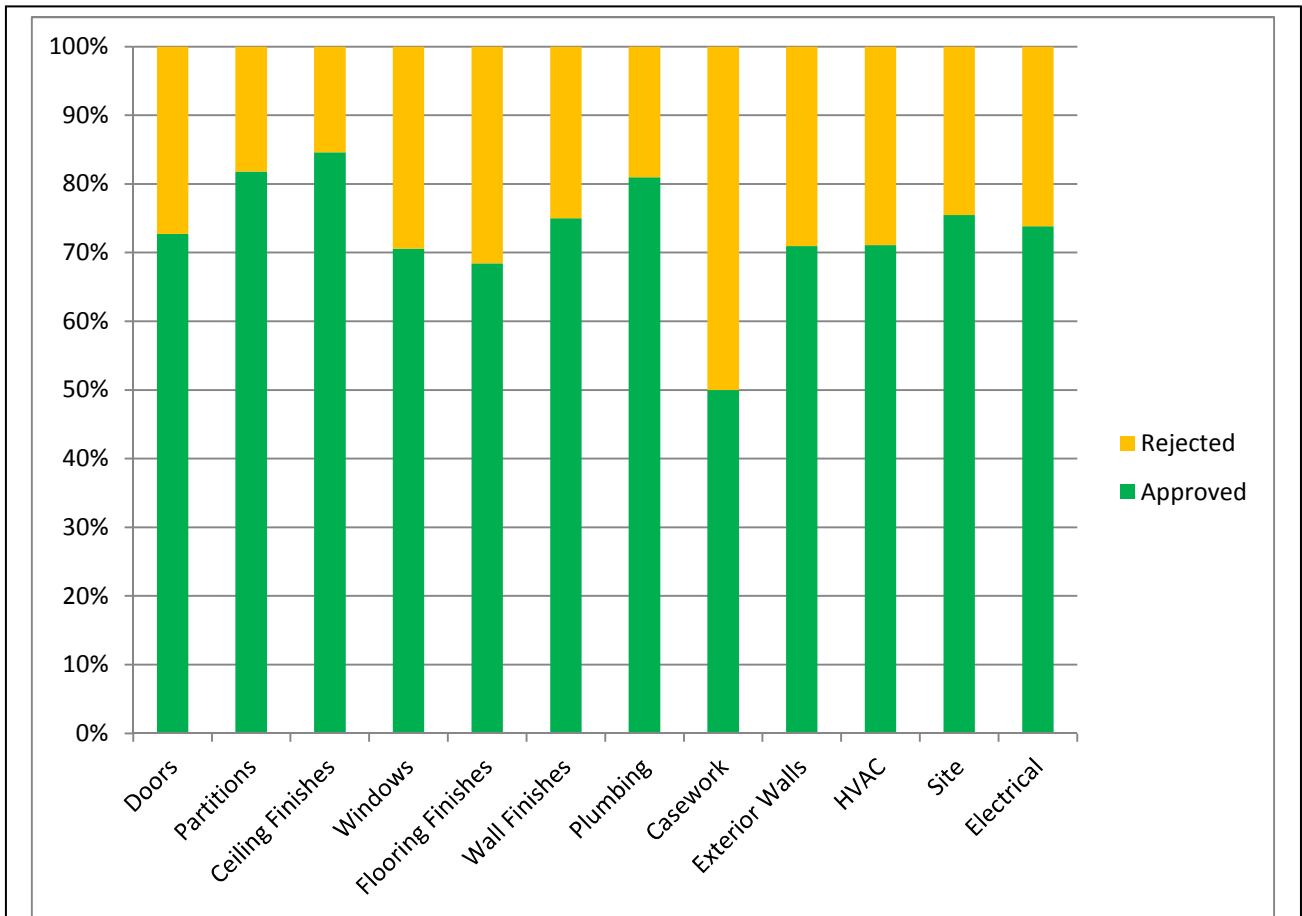


Chart 4. Percentage Distribution of Approved and Rejected VE Items in Categories Containing Ten or More Items Based on Count.

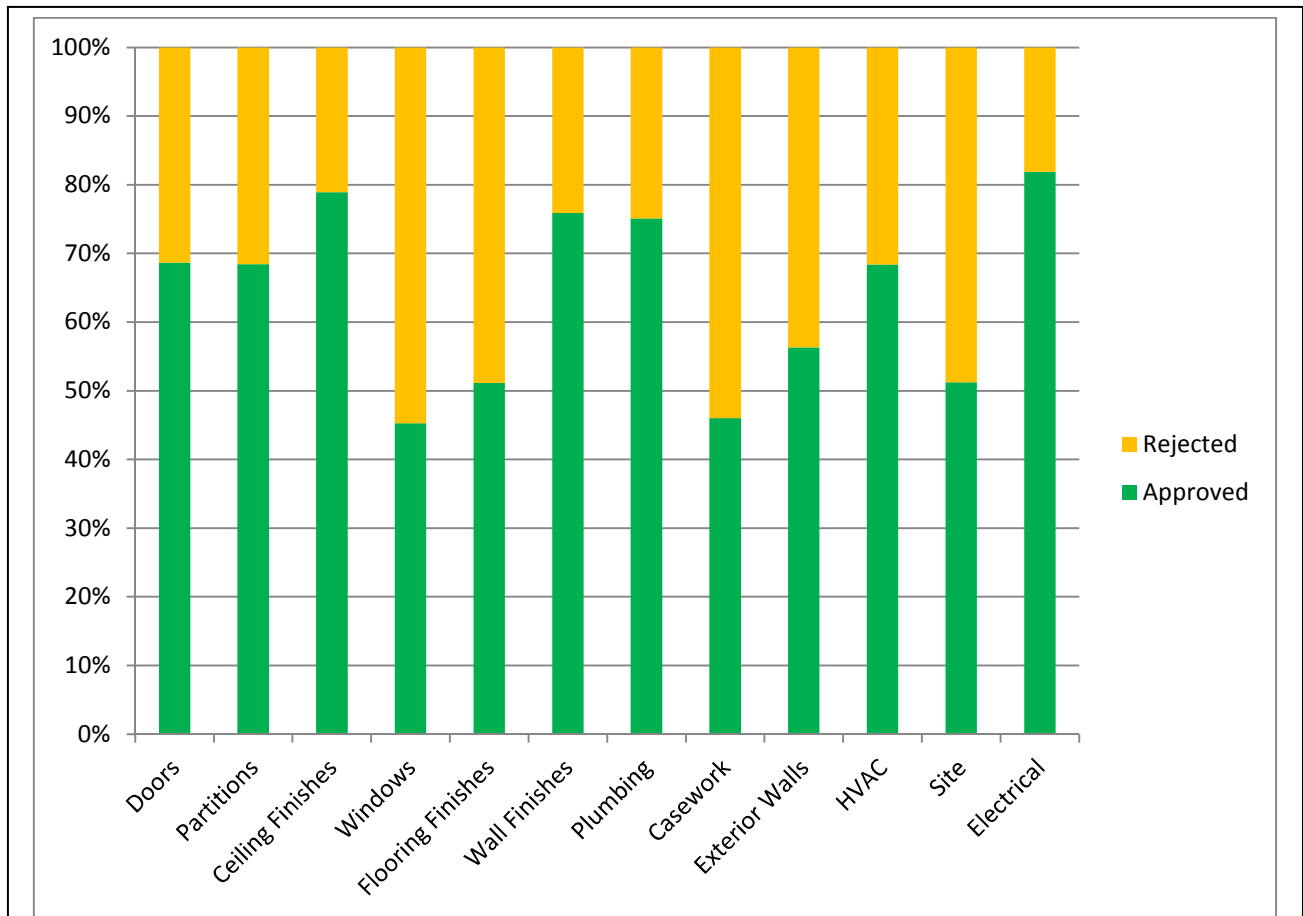


Chart 5. Percentage Distribution of Approved and Rejected VE Items in Categories Containing Ten or More Items Based on Cost.

Charts 4 and 5 show the success rate of each category that have ten or more approved or rejected items in it, the other categories are not included because the size of those categories were deemed too small to yield secure results. The more VE items in the category the more stable the results will be, the categories are sorted by the number of VE items in the with the smallest on the left. It is also important to note the difference between the two charts, Chart 4 shows the percent success rate based on the number of VE items, whereas Chart 5 is based on the dollar value of the VE items. In categories where the percentage rate drops from Chart 4 to 5,

the average monetary value of the rejected VE items was greater than the average monetary value of the approved items, the site category is a good example of this.

Discussion

From these analyses, the success rate of doors, ceiling finishes, wall finishes, plumbing, HVAC, and electrical is fairly certain because the two percentage rates do not vary greatly from Chart 4 to 5. The success rates are roughly as follows: doors 70%, ceiling finishes 82%, wall finishes 75%, plumbing 78%, HVAC 70% and electrical 82%. Because electrical, HVAC, wall finishes and plumbing all have good success rates, have sample sizes of more than ten VE items (actually around 20 or more) and are in the top ten cost categories, they would be good areas of focus for future VE studies.

Conversely, categories such as elevators, fire protection, foundation, roof opening, canopy, stairs construction, roof construction, fixed furnishings, general and specialties do not generally lend themselves well to value engineering. For categories such as elevators, fire protection, foundation, roof opening, stairs construction, roof construction and canopy this is probably due to the elements being engineered and specialized so there is little to change. In fire protection, roof opening and canopy the VE items suggested removing part or all of the elements, for projects that have fire protection systems that satisfy the code minimum or do not have roof openings or canopies there is nothing to VE. Other categories such as fixed furnishings, general and specialties cover so many different topics that it is difficult to find patterns across various projects.

This study was heavily dependent on the information provided by the construction management companies. Some studies did not include whether the VE items were approved or rejected, some only included approved items, and some VE items were just a fraction of the VE

items proposed to the owner. Future studies can improve accuracy by having all the VE information from every project. Not only would accuracy improve because of the larger pool of VE items, but without the holes in the studies, the categories would be complete as well.

Also, by obtaining the cost of each project and determining the percent saved by each VE item, it would account for a large amount of the difference in monetary value between VE items that vary greatly in size. The VE item that suggested the smallest cost savings was \$50, and the largest was \$559,215; depending on the size of the projects these two items were proposed for, they could offer the same savings, or the \$50 could even offer more. Accounting for these differences could significantly increase accuracy in the future.

Along the same lines, projects have varying magnitudes of each category in them. One project may have casework on every wall and another might have a reception desk and nothing else. In the first case a \$100 casework VE item would mean very little, but in the second it could mean getting rid of the casework all together, this could greatly impact the approval rate of the VE item.

The results of this study are good primary findings, but to account for other factors future exploration is recommended.

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