

Punch List Items Relationships on a Hospitality Project

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This paper presents the quantitative analysis of a punch list in a hospitality project with respect to the number of punch items. There are two different types of punch list and 24 trades involved in them. The contribution of this study is to give contractors an insight into punch lists in terms of characteristics, factors, durations to completion of the list per unit, and the frequency of the trades recorded on the list. The study also helps contractors in better managing items on the list and improving their performance on future punch lists. Three factors that affect the number of punch list items are: floor, type of plan, and interior finish scheme. Based on the results of an ANOVA test, only the interior finish scheme influences the number of punch list items. The regression output shows the relationship between the number of punch list items and the duration to clear them off the punch list is nonlinear. Stepwise regression is used to find out the trades that most contributed to the length of the duration. This information will be useful for the practitioners in managing and improving their performance toward the successful completion of punch lists and their associated projects.

Key Words: Defects, Rework, Punch List, Quality Management, Project Performance

Introduction

A punch list is a required step in the process of completing a construction project and is created toward the end of a project. Every project has to go through this procedure before final hand over to an owner. Each project has to address a certain number of punch list items before its completion. The way a punch list is developed is different based on project type. A base configuration of a punch list would be by trade, floor or a base unit itself such as by classroom for schools and apartment units for apartment complexes. A project will be finally completed as soon as the punch lists of all the base units are cleared off. What does a punch list contain? Boyle (1993) addressed the items found on the list as “items that are not in accordance with the plans, or where the owner considers the workmanship and quality unacceptable” (p. 70). Defects or nonconformance items to the contract documents are on the list even though the degree of severity may vary from minor to major.

There may be many items on the list of a base unit and many more items on the list for a whole project. Although a punch list is created to clear off items before completion, as Carman and Conrad (2000) suggested, a punch list has to be a measure to improve on in terms of performance and quality as well. Based on the perspective of a punch list as measures to complete, there is no study on what is found on a punch list and how long it takes to clear it off. Smith (1993) mentioned that any performance measurements focusing on short-term considerations are against investment which brings reward in the long run. Once a base unit is completed then the punch list ends its life cycle. What else can be done with a punch list? It is important to see a punch list as a measurement of performance and quality management. The information on a punch list is very useful in terms of completing a project and also could be beneficial for future similar projects. One of the hardest activities involved in the completion of a punch list is the coordination among project participants to clear their items of the punch list. The issue here is how long it takes to finish the punch list of one base unit and how that affects the overall project schedule at the end. It takes a lot of time to develop and clear off a punch list and a lot of labor hours to finish it (Boyle 1993). Using advanced technology such as Building Information Modeling (BIM) may aid in reducing the rework (design error or omissions) on a project but there will almost always be a set of punch list items to complete at the end of a project because they relate to a management system and labor skills. Therefore it is worth studying a project punch list as a performance and quality indicator of a project.

The purpose of this study is to address the quantitative analysis of the punch list of a hospitality project in terms of the number of punch list items and the duration to clear items off of the list. The objectives are to: 1) Identify the most common jobs on a punch list; 2) Assess the duration for completing a punch list; 3) Identify the most influenced trades on the punch list; and 4) Define the characteristic of a punch list and the relationship among project participants. The literature review describes the past and current research on rework to justify this paper. The methodologies used in this paper are descriptive statistics, ANOVA test, linear multiple regression, and stepwise linear multiple regression analysis which determines an optimum combination of trades affecting the duration for clearing off the list. Finally, the findings are presented in the conclusions.

Literature Review

There is a commonality between rework and punch list which is to correct something even though each has its own causes and reasons with different degrees of impacts on projects. Unlike punch list, there have been many studies done on rework and defects with respect to cost, schedule, quality, and main causes. Every project is unique in nature and it is inevitable for mistakes to occur and for rework to be required (Rosenfeld 2009). According to Love (2002), there is no direct relationship between rework costs and project type or procurement method. Fayek et al. (2004) noted that the range of rework costs found by previous research ranged from 2-12% of the contract value (4% (Mills et al. 2009), 4.4% (Josephson et al. 2002), 5% (Abdul-Rahman 1995; Josephson and Hammarlund 1999), 10% (Love 2002), 12% (Love and Smith 2003), and 12.4% (Burati et al. 1992)). Love et al. (2004) asserted that the rework cost is a major source of cost growth on a project. The impact of rework cost varies depending upon each project. Some other issues related to cost of rework are the indirect impact cost and the practice of using contingencies for contractors to handle the rework cost. The rework cost with respect to the indirect impact costs of schedule delays, litigation costs, other costs related to poor quality, could be more significant than the direct field costs (Burati et al. 1992; Love 2002; Fayek et al. 2004). The contingencies are used to cover up the cost overrun related to rework if necessary (Love and Smith 2003; Love and Edward 2004). Many researchers noted that rework cost are a main reason for cost growth on projects and is related to schedule growth as well. Regarding punch lists, Boyle (1993) noted that it is hard to measure the cost of a punch list. The cost of a punch list is probably included in the contract dollar amount between a general contract and subcontracts as a provision or as contingencies based on each party's past experience. It could be a substantial amount like Boyle (1993) noted or just a certain amount to meet their target expectation.

Regarding rework, cost, schedule, and quality are three of the most common areas addressed in research. Love and Edward (2004) asserted that rework has a negative impact on cost and schedule growth. Love (2002) found that schedule growth is significantly related to direct rework cost. It is evident that the increase in cost due to rework influences the schedule growth in general. For example, Josephson et al. (2002) found that 7.1% of the total work time is spent on rework during the observational period. Love and Li (2000) found that the projects they studied are delayed by 3 and 4 weeks due to rework. Even though some of the aforementioned research showed that rework influences schedule growth on projects, the impact of schedule growth is not as clear as that of cost growth. Fayek et al. (2004) mentioned that rework does not result in schedule delay. Love (2002) found cases where there is no schedule delay even though there are significant rework costs generated. Sometimes the contractor is able to catch up for the schedule loss caused by rework or the rework items may not be on a project critical path. Hegazy et al. (2011) showed how to integrate rework into the on-going schedule. The punch list can be a separated schedule activity or may not be one even though every project participant knows that there is one at the end to finish up the project. The duration of punch lists depends on the size and character of a project as well as its contractual duration. To reduce and prevent rework, Fayek et al. (2004) asserted that rework has to be quantified and measured with its root causes identified. The punch list has to be quantified and used to improve performance on future punch list, so it is necessary to determine punch list items in order to understand the characteristics of those items.

There are many definitions of rework in the literature (Fayek et al. 2004; Love et al. 1999; Love 2002). Fayek et al. (2004) defined rework as "Activities in the field that have to be done more than once in the field, or activities that remove work previously installed as part of the project regardless of source, where no change order has been issued and no change of scope has been identified by the owner" (p. 1079). Based on the definition by Fayek et al. (2004), punch list items are considered as rework. However there are subtle differences between rework and punch list items in terms of time and root causes. Rework may exist from the preconstruction phase through the construction phase. The preconstruction phase includes preplanning, design, and/or procurement. Rework has a full range of impacts on a project life cycle. On the other hand, a punch list almost exclusively exists at the end of project and affects only the duration of the final completion phase of a project. The root causes of rework are design changes and errors and omissions (Love and Li 2000), inappropriate contract documents (Love et al. 2004), poor management (Love and Sohal 2003; Josephson and Hammarlund 1999), and/or poor skill (Josephson and Hammarlund 1999). Even though rework has all types of causes, most of them are owner/architect-related such as design errors/changes and inappropriate documents. But the punch list is more contractor/subcontractor related in terms of a poor management system and less skilled execution of work by subcontractors. For example, Josephson et al. (2002) identified that the rework cost caused by poor workmanship is 20 percent of the overall rework cost. Even though subcontractors have good workmanship, if there is no proper management system on site, it is very hard to maximize their project performance. Josephson and Hammarlund (1999) noted that "The direct causes of defects can primarily be attributed to individuals. However, every action by an individual is influenced by conditions" (p. 682). They stressed the importance of the management system or working environment on site. A few items related to the owner/architect may belong to the punch list but it is very rare because all the owner/architect related problems have to be clarified before the end of project to complete the project. Rework is mainly a contractual obligation between an owner/architect and a general contractor. Punch list is a contractual obligation between a general contractor and subcontractors (Boyle 1993) even though both a general contractor and subcontractors have contractual obligations to an owner.

Total Quality Management System (TQM)

So how do contractors and subcontractors avoid having a punch list or at least minimize the items on the punch list? Many researchers assert that a Total Quality Management (TQM) system can help reduce rework. Boyle (1993) noted that every project participant must consider the quality management process to avoid a punch list. Love and Li (2000) stressed that it is very hard to identify and measure performance improvement without any quality system and pointed out that contractors can have a prevention mechanism and early detection of poor quality with their quality assurance (QA) systems. Rosenfeld (2009) mentioned that a company will spend less on quality failure if a company invests more in prevention. TQM enables organizational learning at both an individual and group level if it is applied properly (Garvin 1993). Having a quality system on site is very important for contractors and subcontractors to minimize rework and punch list items, because they allow contractors and subcontractors to act as quality buffers (Love and Li 2000; Love and Edwards 2004). To improve project quality and minimize rework and punch list items, it is better to have a quality system on site among project participants.

In this section, the issues with rework and punch list have been reviewed in terms of cost, schedule, causes, and quality. There have been many studies conducted on rework but not enough studies on punch list items as defects. Even though rework and punch lists share some of their characteristics, they are two different things from the onset. Every project must go through these two steps or processes to reach completion. The impacts on the cost and schedule growth of punch list may not be as much as those of rework. However it is very important for contractors and subcontractors to know how much effort they spent in clearing punch items off of the list under a given circumstance when the budget and time are limited. Punch lists are related to the quality of the project itself. If there is a good quality system on site, the punch list items would be expected to be minimal so that the contractors and subcontractors spend less money and time to clear them off of the list. Love et al. (1999) noted that "Rework, however, has become an accepted part of the construction process" (p 507). So is punch list. Contractors and subcontractors consider a punch list as a part of a project. This may be why there has not been enough research in this particular area. There may be an opportunity not to have rework on a project if all the causes were resolved or prevented. There, however, will be a punch list at the end of a project no matter what. To improve the performance on a project and to minimize the punch list items, contractors and subcontractors have to know what items are on the list the most and their characteristics, because without knowing these, it is hard to improve or prepare the punch list.

Methodology

Data Collection

Project Description, Limitations, and Assumptions

The project used in this study is a hospitality project in the southern part of the States which consists of 36 buildings on a job site over a 2-year construction period. Each 4-storey building has 14 apartment units. The buildings have two types of floor plans designated as 'A' and 'B' and five different interior finish schemes designated as Scheme '1', '2', '3', '4', and '5'. Each unit has a balcony with concrete handrails. The gross area of each building is 9,300 sqft. The main structure of the building consisted of a concrete panel slab and concrete block walls. The main final finishes were stucco and painting of exterior and interior walls. This project had a total of nine turnovers through the project execution.

All the punch list items are based on the interior of each unit and the exterior balcony area belonging to each unit. Other than these areas, the data do not include exterior, roof, and public areas such as hallway and stairs. A punch list is created based on each unit. The punch list shows the number of defective items in each unit but does not show the degree of severity of the defect. There were two types of punch list created for this project. One is P_1 and the other is P_2. P_1 is prepared by the project owner's representative, while P_2 is prepared by a unit owner. Since this is a hospitality project, there is a project owner and a unit owner. Items on both P_1 and P_2 are corrected by a contractor and inspected by a project owner's representative for P_1 and/or a unit owner for P_2. P_1 has to be completed before P_2 starts. The computation of the duration to clear off the list items for P_1 runs from the day the list is generated to the day the list is inspected by the project owner's representative. There are no specific starting dates available for P_2. An assumption was made that work on P_2 starts the day after completion of P_1. The finish day for P_2 is the day the list is inspected by a unit owner or the project owner's representative. Punch list P represents the combination of P_1 and P_2 for analysis purposes. The number of days to clear off punch list items for P_1 and P_2 are based on calendar days not work days. It is very difficult to use work days for the clearing of punch list items. If there is a unit without any punch list items, the unit will be excluded from the study. There was only one unit that did not have any punch list items among the study samples.

Analysis of Results

This study is based on data collected for 15 out of 36 buildings. Table 1 shows the sample size of this study with brief statistics for the data. P_1 had 2,592 defective items in 195 apartment units and P_2 had 2,711 defective items in 157 apartment units. P shows a total number derived from combining P_1 and P_2. The actual total number of apartment units is 199, with 153 apartment units having both P_1 and P_2 and some of the units having only had P_1 (42 units) or only P_2 (4 units). The average number of defective items was between 13 and 17 per unit. The highest total number of defective items in P is 87 and the lowest is 1. There are a total of 24 trades that were involved in the sample data collected. In P_2, there are no defects related to concrete block walls and the security system, so the participating trades in this study are 24 for P_1 and P, and 22 for P_2.

Table 1

Sample size of study

Description		Punch List		
		P	**P_1**	**P_2**
Number of Buildings		15	15	15
Apartment Units		352	195	157
Punch List Defective Items	Total	5,303	2,592	2,711
	Mean/Unit	15.07	13.29	17.27
	Max/Unit	87	61	87
	Min/Unit	1	2	1
Participating Trades		24	24	22

The most common questions or concerns on the punch list would be what items are on the list, how many of them there are on the list, and how long it takes to clear them off the list. Once the list is cleared off, the defective items on the list will be no longer useful. Many project participants may be able to guess what the punch items are but nobody sees them in terms of a real number or data. This study looks at the detailed number of defective items on the list and their frequency. This information will be very useful for contractors and subcontractors. During the project execution, the punch list may not be available, but once the data on the punch list items are available, the practitioners are able to analyze the data and look for solutions to improve their performance on the next project.

Table 2 shows the top 10 most frequently occurring punch items on P, P_1, and P_2 in descending order. In P, interior paint is the number one defective punch item with 861 items and is followed by tile with 588 items. On the other hand, in P_1, tile is the most frequently occurring defective item with 323 items and dry wall is the second highest item with 317 items. Interior paint is the number one in P_2 as well and the second highest item is cleaning with 279 items. Nine out of 10 trades are on all three punch lists – P, P_1, and P_2. P_1 does not have interior paint within the top 10 but P and P_2 do. P_1 has waterproof within the top 10 but P and P_2 do not. The difference in number of items between the highest and the second highest is not that much in P_1 but is high in P and P_2 because, in P_2, interior paint is the top item with 743 items and cleaning is the second highest with 279 items. The difference is almost 500 items. It puts interior paint at the top spot in P and P_2 but not in P_1. The sums of the top 10 trades on P, P_1, and P_2 are 4,533, 2,189, and 2,399 respectively. If this sum is divided by the total number of punch items, the percent of the top 10 items on each punch list is over 85 percent. It means that among the 24 trades, the top 10 trades cover almost 85% of all punch items.

Table 2

Top 10 most frequent punch list items for P, P_1 and P_2

P		P_1		P_2	
Trades	**Number of Items**	**Trades**	**Number of Items**	**Trades**	**Number of Items**
Interior Paint	861	Tile	323	Interior Paint	743
Tile	588	Dry Walls	317	Cleaning	279
Cleaning	511	Doors	292	Tile	265
Doors	486	Plumbing	234	Electrical Work	198
Dry Walls	461	Cleaning	232	Doors	194
Plumbing	409	Windows	202	Plumbing	175
Electrical Work	324	Waterproof	173	Kitchen Cabinet	171
Windows	318	Carpet	163	Dry Walls	144
Kitchen Cabinet	298	Kitchen Cabinet	127	Windows	116
Carpet	277	Electrical Work	126	Carpet	114
Sub Total	4,533	Sub Total	2,189	Sub Total	2,399
Grand Total in P	5,303	Grand Total in P_1	2,592	Grand Total in P_2	2,711
%	85.48	%	84.45	%	88.49

ANOVA Test

There are three factors that may affect the number of punch list items: Floor, Plan, and Scheme. The buildings in this project have 4 floors with two different floor plans finished using one of five different interior schemes. The average of each type of punch list item is shown in Table 1. In this section, the influence of these factors on the punch list items will be addressed using the analysis of variance (ANOVA) test. If the number of punch list items is affected by the factors of Floor, Plan, and/or Scheme, then the mean value of the number of punch list items will be different statistically. ANOVA tests were performed using IBM SPSS 21 (Pallant 2010). The means of the total for Plan A and B are 16.37 and 14.06 respectively. Plan A has a slightly higher value than Plan B. The means of the total for Floor 1, 2, 3, and 4 are 14.78, 15.23, 15.62, and 14.71 respectively. Floor 3 has the highest value and Floor 4 has the lowest value. The means of the total for Scheme 1, 2, 3, 4, and 5 are 12.01, 16.77, 14.40, 13.94, and 18.73 respectively. Scheme 5 has the highest value and Scheme 1 has the lowest value. The difference in mean value between Scheme 1 and 5 is large (6.72). There is no big difference in the means of the totals for Floor and Plan, only for Scheme. The null hypothesis for each factor is that there is no difference among the mean values of each factor. It depicts that there is no influence on the number of punch list items from each factor. In this case, the null hypothesis will fail to be rejected because the computed p value is larger than 0.05 at $\alpha = 0.05$. To reject the null hypothesis, the computed p-value has to be less than 0.05 at $\alpha = 0.05$ and this would represent that the mean value of the number of punch list items are different and that the number of punch list items are influenced by that factor. The computed p values for each of the Floor, Plan, and Scheme variables are 0.908, 0.080, and 0.032 respectively. The computed p values of Floor and Plan are greater than 0.05. Thus the null hypothesis at $\alpha = 0.05$ cannot be rejected. The mean numbers of punch list items are statistically equal for Floor and Plan. Floor and Plan do not influence the number of punch list items. However, the computed p value for Scheme is 0.032 which is smaller than 0.05.

Punch List Completion Duration

The number of punch list items has been discussed so far. In this section, the relationship between the number of days to clear off the items of the punch list and the number of punch list items will be analyzed using regression. Table 3 shows the longest, shortest, and mean values of the days it took to clear off the punch list per apartment unit with respect to P, P_1, and P_2. The longest duration to finish off the list in P_1 is 61 days and the shortest is 1 day. The mean number of days in P_1 is 21.65. On the other hand, the longest number of days to complete the list in P_2 is 246 and the shortest number of days is 6. The mean of the number of days in P_2 is 89.99. P is just combining P_1 and P_2. The mean number of days in P is 52.13. The P_1 durations are, in general, way shorter than those of P_2. This is due to the number of participants in the punch list process. The P_1 process involves participants who are on site while the P_2 process involves a unit owner who usually is not available as much as participants on site. The practitioners involved with unit owners in the punch list process should consider how to manage the punch list with potential unit owners.

Table 3

Duration for clearing off the punch list

Description	**P**	**P_1**	**P_2**
Number of Buildings	15	15	15
Apartment Units	352	195	157
Average/Unit (Days)	52.13	21.65	89.99
Longest/Unit (Days)	246	61	246
Shortest/Unit (days)	1	1	6

Regression Analysis

What is the relationship between the number of punch list items and the number of days to clear off the list? In general, there is no linear relationship between the number of days and the number of punch list items. Using a total of 352 data sets with number of days and punch list items, a regression analysis is performed using IBM SPSS 21 (Pallant 2010). The 24 trades represent the independent variable and the number of days to completion represents the dependent variable in this study. There are two regression models. Model 1 has a constant but Model 2 does not have a constant. If there are no punch list items, the number of days to completion has to be zero (0). From this perspective, it is more reasonable to have a regression model without a constant. The R square values are 0.319 (31.9%) and 0.334 (33.4%) for Model 1 and 2 respectively. Model 2 has a slightly higher R square value than Model 1. The linear relationship between the number of days and punch list items is useful in understanding the characteristics of the punch list itself and it can be used for future reference in quality management.

Stepwise Regression

There are 24 independent variables as represented by trades and one dependent variable as represented by duration in the previous regression models and it is hard to filter out which ones of the 24 independent variables really influence the number of days to completion. Stepwise regression is a useful technique to answer this question. It is a process to find a best fit model using an original data set and aids in screening out comparable unnecessary variables from a set of a large number of variables. Based on the original data set of 24 independent variables and one dependent variable, the stepwise regression is performed using IBM SPSS 21 (Pallant 2010). This study used a default setup of stepwise function in IBM SPSS 21 and the constant was set to be zero (0) in the stepwise process. Table 4 shows the outputs of the stepwise regression model. According to the stepwise regression model, the best fit model is Model 3 with an R square value of 0.292 (Howell 2006). The chosen independent variable for Model 1 is interior paint. The two chosen independent variables for Model 2 are interior paint and electrical work. In Model 3, the chosen independent variables are interior paint, electrical work, and dry walls. The stepwise regression equation for Model 3 is shown in Eq. (1).

$$Days = 4.386interior\_paint + 10.676electrical\_work + 4.303dry\_walls \quad (1)$$

Table 4

Model summary of stepwise regression

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.487	0.237	0.235	64.452
2	0.531	0.282	0.278	62.595
3	0.540	0.292	0.286	62.246

Conclusions

Three different types of punch list were analyzed: P, P_1, and P_2. P_1 looked at all defects. A tendency toward certain trades in the defects was found in P_2. The most frequent trades on the punch list were interior paints, tile, cleaning, dry walls, doors and windows, plumbing, electrical work, and carpet. There are three possible factors that affect the number of punch list items such as floor, plan, and interior finish scheme. Based on the ANOVA tests conducted, there is no influence on the number of punch list items from floor and plan. However the type of interior finish scheme influences the number of punch list items. The three factors are not correlated to each other. Differences in floor plans were not found to influence the number of punch list items in this study. The average number of days to clear off the punch list items was 52.13, 21.65, and 89.99 for P, P_1, and P_2 respectively. Due to involvement of the unit owner in the punch list process, the duration of P_1 is much shorter than that of P_2. The relationship between the duration (days) and the number of punch list items is not linear based on the regression outputs. Using the stepwise regression model, three trades, interior paint, electrical work, and dry walls, were screened out from the 24 trades as impacting the duration to complete the punch list. These three trades are very similar with the top 10 most frequent trades shown in Table 2. This information will be very beneficial to the practitioners because these trades have the most impact on the time it takes to clear items off the punch list. Since the relationship between the punch list items and the number of days is towards qualitative, the implementation of TQM/QM could help minimize the defects and improve the quality and performance of the project as some researchers have stressed (Boyle 1993; Love and Li 2000; Love ad Sohal 2003; Rosenfeld 2009). It is evident that, to improve the punch list process, the project participants have to share their ideas for preventing defects on the jobsite and have more interaction time to discuss the job site situation. This study mainly focuses on the quantitative analysis of punch list with respect to the number of defective items and completion durations. The study on the duration and impact of a punch list on a schedule should be addressed in more detail in the future.

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