Critical Factors for Insolvency Prediction- Towards a Theoretical Model for the Construction Industry

Abstract

Many construction industry insolvency prediction model (CI-IPM) studies have arbitrarily employed or simply adopted from previous studies different insolvency factors in their works, without justifications, leading to poorly performing CI-IPMs. This is due to the absence of a framework for selection of relevant factors. To identify the most important insolvency factors for a high performance CI-IPM, this study used three approaches. Firstly, systematic review was used to identify all existing factors. Secondly, frequency of factor use and accuracy of models in the reviewed studies were analysed to establish the important factors. Finally, using questionnaire survey of CI professionals, importance level of factors were validated using Cronbach alpha reliability coefficient and significant index ranking. The findings show that the important quantitative factors are profitability, liquidity, leverage, management efficiency and cash flow. While important qualitative are management/owner characteristics, internal strategy, management decision making, firm characteristics macroeconomic and sustainability factors. These factors, which align with existing insolvency related theories, including Porter's five competitive forces and Mintzberg's 5Ps (plan, ploy, pattern, position and perspective) of strategy, were used to develop a theoretical framework. This study contributes to the debate of the need to amalgamate qualitative and quantitative factors to develop a valid CI-IPM.

Keywords: Construction industry, insolvency prediction model, construction industry insolvency factors, financial ratios, failure

1.0 Introduction

As much as owners and major stakeholders do not like to hear it, the prospect of construction business insolvency in any case is a real one. The negative impact of such insolvencies on the economy and society in general has led to the development of many insolvency prediction models. However, the effectiveness of an insolvency prediction model (IPM) is dependent on, amongst other elements, the variables that are chosen to develop it. These variables are used to measure various factors that may affect the insolvency of a construction firm. Many construction industry (CI) studies have employed different variables in their works, chosen either arbitrarily (Chen 2012), by statistical analysis (Abidali and Harris, 1995; Ng et al., 2011; Bal et al. 2013) or by adoption from previous studies which is more common with non-construction studies (Wilson and Sharda, 1994; Boritz and Kennedy, 1995). This is because there was, and is still, no clear theoretical framework for choosing insolvency factors or variables (Du Jardin, 2012); a defect that is restraining scientific advances towards a highly effective insolvency prediction for the CI (Balcaen and Ooghe 2006). At this early junction, it is imperative to distinguish between variables and factors as referred to in this study.

Variables: A variable is a measurable quantity that represents a certain characteristic of a firm, usually in the form of a numeric value. Financial ratios are the most common variables in IPM research. Variables can also be gotten through Likert scale questionnaire. Example variables include current ratio, quick ratio, age of firm, turnover (size) of firm, etc.

Factor: This is the characteristic being measured by a variable. There are always many variables that can be used to measure a particular factor. Variables that measure the same factor belong to the same group; the group here is what is termed as factor. The aforementioned current ratio

and quick ratio belong to the 'liquidity' factor while age and turnover (size) of firm of firm belong to 'firm characteristics' factor.

Pioneering prediction studies normally employed a number of factors with a large number of quantitative variables to measure them, usually in the form of financial ratios, based on experience and presence in financial statement of sample firms, before using statistical analysis to select limited number of ratios for the prediction model (Beaver, 1966; Altman, 1968). "A financial ratio is a quotient of two numbers, where both numbers consist of financial statement items" (Beaver, 1966, pp. 71-72). Old and recent construction industry insolvency prediction models (CI-IPM) studies (e.g. Mason and Harris, 1979; Abidali and Harris, 1995; Ng et al., 2011; Bal et al., 2013; Horta and Camanho, 2013) have erroneously simply copied the methods of early IPM studies. This is because the CI-IPM literature, has not provided any real coherent theory underpinning the use of financial ratios along with the insolvency factors they measure (Du Jardin, 2012). Factors chosen because of their presence in financial statements of sample firms as done by virtually all IPM studies are generally sample specific (Balcaen and Ooghe, 2006; Hafiz et al. 2015) thus making them unfit for generalization and consequently inappropriate for adoption.

Although their exclusive use is common with an overriding percentage of existing CI-IPMs due to blind copying of past methods (Ng et al., 2011; Huang, 2009; Chen, 2012; Bal et al. 2013 among others), using quantitative factors alone to develop a prediction model for the CI is insufficient since financial distress only tends to be noticeable when the failure process is almost complete (Abidali and Harris, 1995). Though many failure related theories are finance centred, there are as many non-financial failure related theories which are well known to be very viable. These (non-financial theories) include Michael Porter's five forces of competitive position model

and Mintzberg's five Ps of Strategy, which are employed in this study, among others. As Argenti (1976, p.138) rightly said: "while these (financial) ratios may show that there is something wrong. I doubt whether one would dare to predict collapse or failure on the evidence of these ratios alone." In fact it is adverse managerial actions, poor company strategy, etc. (qualitative factors) that normally lead to poor financial standing of construction businesses and in turn cause insolvency. Hence to achieve early prediction, which is required in any robust prediction model to allow enough time for remedy, the use of qualitative factors is important and has been aggressively encouraged (Arditi et al., 2000; Koksal and Arditi, 2004; Horta and Camanho 2013; Alaka et al., 2015 among others). However, the use of qualitative factors in developing CI-IPMs have been hampered by their being unreadily available and the absence of a theoretical framework which encompasses qualitative and quantitative insolvency factors for construction firms.

Dissimilar to just finding the causes of failure of construction firms as done by Holt (2013), this study seeks to establish the CI insolvency factors that can help create more valid CI-IPMs. The main goal is to create a comprehensive theoretical framework that will form the platform for selection of the most important CI insolvency factors and explain the relative importance of each in relation to solvency of construction businesses. To achieve this aim, the following objectives are required:

1. To identify the CI insolvency factors that largely influence the performance of CI-IPMs through a systematic review of literature.

2. To analyse the summary of findings table of the systematic review and rank the identified factors in order to establish the most important ones

3. To validate the importance level of the factors by using statistical analysis of questionnaire data from experienced CI professional to triangulate the review analysis.

This study will contribute to knowledge by presenting and justifying the most important CI insolvency factors required to build a high performance CI-IPM, omission of such factors which can easily lead to a poor CI-IPM. This study will also eliminate the problem of analysing variables under all existing factors in order to identify the important ones before building a CI-IPM. With the results, only variables under the identified factors will become necessary to analyse. This will highly improve efficiency of the CI-IPM development process. The scope of this work is limited to identifying and verifying the most important factors for developing CI-IPMs. The validation is via questionnaire data with responses from well exposed and experienced CI professionals. Developing a CI-IPM by collecting numerous construction firms' historic data and checking its accuracy is out of the scope of this study as this study does not seek to build a CI-IPM.

The next section describes the methodology by first explaining the systematic review for the quantitative and qualitative factors before describing the questionnaire methods for both factor types. The data analysis section then follows, describing step by step analysis of data gotten from the systematic reviews and questionnaires. This is followed with the results of the analysis. The discussion and proposed framework section follows; it discusses how the results relate to existing theories and construction world hierarchy while the conclusion section finally rounds up the work.

2.0 Methodology

The philosophical paradigm adopted in this study is pragmatism. This is because it advocates using a combination of any set of methods that best answers the research questions or best achieve the research objectives rather than rigidly dictating specific methods (Johnson and Onwuegbuzie, 2004). It allows the researcher to "study what interests you and is of value to you, study in the different ways in which you deem appropriate, and use the results in ways that can bring about positive consequences within your value system" (Tashakkori and Teddlie, 1998, p.30).

This study uses a mixed method approach to identify the important qualitative and quantitative factors required to develop a high performance CI-IPM. In each case, the factors are initially aggregated using systematic literature review and ranked based on the frequency of usage. For quantitative factors, the accuracy of CI-IPMs that have used them are also considered in the ranking. For validation purposes, Cronbach alpha reliability coefficient and significant index ranking of survey of construction industry professionals were used to triangulate the results gotten from the systematic review analysis. Triangulation is defined as the "use of two or more independent sources of data or data collection methods to corroborate research findings within a study" (Saunders and Paul, 2013, p.154).

2.1 Systematic Review for Quantitative Factors

"A systematic review is a summary of the research literature that is focused on a single question. It is conducted in a manner that tries to identify, select, appraise and synthesize all high quality research evidence relevant to that question." (Bettany-Saltikov 2012, p.5). The systematic literature review method obligates a broad search of literature (Smith et al., 2011) with

136 unambiguous expression of exclusion and inclusion criteria (Nicolás and Toval, 2009).
137 Systematic review is renowned for yielding valid and repeatable/reliable results because it
138 reduces bias to a minimum hence its high recognition and frequent use in the all-important
139 medical research world (Tranfield et al., 2003; Schlosser, 2007) and its embracement in other
140 research areas like IPM (Appiah et al., 2015). The general review of various existing
141 knowledge and synthesizing them is also a recognised method which contributes immensely to
142 the progression and expansion of knowledge (Aveyard, 2007; Fink, 2010). This is the reason it
143 has been widely employed as methodology in various research areas including insolvency
144 prediction (Balcaen and Ooghe 2006; Adnan Aziz and Dar, 2006) and construction business
145 failures (Edum-Fotwe et al., 1996; Mahamid, 2012).

146 The single research question the systematic review of this study focuses on is 'which are the
147 most important insolvency prediction factors (quantitative and qualitative) for construction
148 firms?' Since results from peer reviewed journals are generally considered to be of high quality
149 and validity (Schlosser, 2007), this systematic review employs only peer reviewed journals. This
150 will ensure a high validity of the review results

151 The databases searched for this review include Google Scholar (GS); Wiley Interscience (WI);
152 Science Direct (SD); Web of Science UK (WoS); and Business Source Complete (BSC). This is
153 done in tandem with the latest published systematic review article on IPM (i.e. Appiah et al.,
154 2015). Observations revealed that GS, WoS and BSC contained all the journal articles provided
155 in Wiley and Science Direct since the later are publishers while the former are general databases.
156 To further broaden the search, the Engineering Village (EV) database was added to the GS, WoS
157 and BSC databases to perform the final search.

158 Pilot searches revealed that studies use bankruptcy, insolvency and financial distress
159 interchangeably to depict failure of firms. A search structure which included all these words was
160 subsequently designed with the following defined string ("Forecasting" OR "Prediction" OR
161 "Predicting") AND ("Bankruptcy" OR "Insolvency" OR "Distress" OR "Default" OR "Failure")
162 AND ("Construction" OR "Contractor"). A process flow of the systematic review methodology
163 for quantitative factors is presented in Figure 1.

164

165 **Insert Figure 1: A process flow of the systematic review methodology for quantitative**
166 **factors**

167

168 To avoid database bias, ensure high repeatability and consistency of this study, and consequently
169 high reliability and quality, all the relevant studies that emerged from searching the databases
170 were employed in the review (Schlosser, 2007). Since the databases host studies from around
171 the globe, geographic bias was readily averted. Considering that the first set of IPM studies
172 emerged in the 1960s (Beaver, 1966; Altman, 1968), a period of 1960-2015 (the current year)
173 was used for the search

174 One of the inclusion criteria was for the IPM study to focus solely, or mainly, on the CI. Another
175 is that the study must employ quantitative factors (i.e. financial ratios as variables). The titles and
176 abstracts of the studies that the search returned were typically adequate to decide the ones
177 qualified for use in this study. Where otherwise, articles' introduction and/or conclusion were
178 read to determine their suitability. The extent of reading was dependent on the information

179 gotten from initial readings. In exceptional cases, the full length article was read. At the end, GS
180 produced 31 results, EV (14), BSC (11) and WoS (7). Most of the articles returned in searching
181 EV, BSC and WoS were present in the GS search results. In fact all EV results were present in
182 the GS result, while BSC and WoS were only able to produce four and one unique articles
183 respectively

184 The exclusion criteria included, among others, articles that were not written in English language.
185 Although language constraint is not favoured in systematic review, it is unavoidable and thus
186 acceptable when there is lack of funds to pay for interpretation services (Smith et al., 2011). An
187 example of study excluded based on language is Wedzki (2005) which is written in Polish.
188 Review studies were not considered as they contained only factors taken from other studies.
189 After taking out unsuitable articles with titles like 'default prediction for surety bonding' (e.g.
190 Awad and Fayek, 2012) and 'contractor default prediction prior to contract award' which fixate
191 on a contractor's capability to successfully execute a specific kind of project (e.g. Russell and
192 Jaselskis, 1992), only 28 studies were left. Note that 'contractor default prediction prior to
193 contract award' articles that fixated on insolvency probability as the main/only judging criteria
194 were not excluded as the studies effectively built a form of CI-IPM.

195 In the final 28 articles reviewed in this study, where multiple accuracy results are presented for
196 multiple CI-IPMs, only the accuracy result of the technique proposed in the article is presented in
197 this study. Where no particular technique is proposed, the highest accuracy result is presented
198 here. Where the results for training and validation samples are given, the validation result is used
199 here, otherwise the training result is adopted. Where error types are calculated independent of
200 accuracy values and the Receiver Operating Characteristic (ROC) curve is used to determine
201 performance, the area under the curve (AUC) value in percentage is taken as the accuracy result.

Where accuracy results of multiple years are given, the result of the first year is adopted to allow fair comparison since the first year result is the most commonly presented result in IPM studies. As required for systematic review, a meta-analysis was done with data synthesised through the use of 'Summary of Findings' tables, statistical methods and charts (Higgins, 2008; Smith et al., 2011) (see analysis of data section)

2.2 Systematic Review for Qualitative Factors

The systematic review for the qualitative factors was quite similar to that of the quantitative factors except for a few differences which are explained here. Pilot searches revealed that there are very few studies that used qualitative factors for their CI-IPM. The quantitative factors review search structure already revealed three studies (i.e. Abidali and Harris, 1995; Koksal and Arditi, 2004; Horta and Camanho 2013) with qualitative factors, two of which combined quantitative with qualitative factors, and are thus present in this review. Since it is clear that studies that used qualitative factors for CI-IPM are scarce, a new search structure was developed to identify studies that provide factors that lead to insolvency of construction firms. A search structure with the following defined string was designed: ("Business" OR "Firm" OR "Company") AND ("Bankruptcy" OR "Insolvency" OR "Distress" OR "Default" OR "Failure") AND ("Construction" OR "Contractor"). A process flow of the systematic review methodology for qualitative factors is presented in Figure 2.

Insert Figure 2: A process flow of the systematic review methodology for qualitative factors

After various pilot searches and the use of the structured search led to very few and usually unsuitable results in the databases except GS, the search was limited to GS. Only eight suitable articles were found, in addition to the previously identified three, after a strenuous inspection of more than 500 articles. The result was improved by checking review articles and checking through their citations/references. Three more studies were added using this method (Jannadi, 1997; Robinson and Maguire, 2001; Arslan et al., 2006). With no resulting article identifying the role of environmental, social and governance (ESG) in failure of construction firms, the search words 'sustainability practices and failure of construction companies' was used on google and the first suitable article (i.e. Siew et al. 2013) was selected. As a result, a total of 15 primary studies was reviewed altogether.

2.3 Questionnaire Data for Quantitative and Qualitative Factors

The factors identified from the analysis of the systematic review were used to formulate a very simple preliminary questionnaire to determine how important each identified factor is in terms of predicting failure/survival of a construction firm. A Likert scale of one to five was used where five represents 'most important' and one represents 'least important'. In the case of the qualitative factors, example qualitative variables were given in bracket for each qualitative factor. The preliminary questionnaire served as a pilot study with the aim of evaluating the relevance, complexity, length, and layout of the questionnaire

Since the quantitative factor represent accounting ratios, the target respondents were insolvency practitioners (normally accountants), who specialize in dealing with construction firms that go into administration or file for bankruptcy. Using the UK government insolvency practitioner directory online, 500 insolvency practitioners were randomly selected and sent the final questionnaire via e-mail. The questionnaires carried a clear note saying only practitioners with

246 vast experience in dealing with construction firms' insolvency should fill them. Following
247 numerous reminder emails, 106 usable questionnaires were obtained. This was considered a good
248 response rate and was probably down to the simplicity and very short length of the questionnaire.

249 For the qualitative factors, the target respondents were managerial level staff of insolvent and
250 existing construction firms. Contact for insolvent construction firms were gotten in two major
251 ways. First was to use the FAME Bureau Van Dijk UK financial database to identify failed
252 construction firms' directors, and subsequently identify existing firms where those directors
253 currently work. Questionnaires were then posted to those directors at the address of the existing
254 firms, if such information was available. The second was to liaise with college lecturers that
255 teach on construction apprentice programmes to allow sharing the questionnaires to the students.
256 Some students were, by themselves, suitable respondents while others volunteered to give it to
257 their colleagues and/or bosses at work who have once worked in a now defunct construction
258 firm. The contacts for existing firms were gotten from FAME Bureau Van Dijk UK financial
259 database and questionnaires were sent out through post and emails. This method of sampling is
260 known as convenience sampling and has been used in a number of construction studies (e.g. Li et
261 al., 2005; Spillane et al., 2011a; Oyedele, 2013). This sampling method became necessary
262 because of the hardship involved in finding employees of failed firms. Overall, over 500
263 questionnaires were distributed. Following numerous reminder emails, only 76 usable
264 questionnaires were returned. The demographics of the survey respondents for the quantitative
265 and qualitative factors questionnaires are presented in Table 1.

266

267 **Insert Table 1: Demographics of survey respondents**

3.0 Analysis of Data

In an effort to achieve the main study objective, which included identifying the most important CI insolvency factors in order to create a comprehensive theoretical framework that will form the platform for selection of important CI insolvency factors a rigorous statistical process was employed. First a ranking of the factors is done based on frequency of usage in CI-IPM studies, and accuracy of models that used each factor in the case of quantitative variables. These were done using information from the summary of findings tables of the systematic reviews. CI-IPM studies normally use sample construction firms data and various statistical techniques to identify the best factors (and variables) for their models, and the selected factors are usually susceptible to sample specificity (Balcaen and Ooghe, 2006; Agarwal and Taffler, 2008; Jackson and Wood, 2013 among others). This implies that the most used factors are definitely the ones that have been consistently selected using different samples and statistical methods; they are thus fit to most samples and are consequently the most important factors.

The questionnaire responses were analysed by doing some reliability test and then calculating significance index (SGI). The SI was then used to rank the factors in terms of level of importance and validate the result from the review analysis by triangulation. The rankings helped to identify the most important factors from the least important factors. The questionnaire responses are a measure of the importance of the factors using experienced practitioners that deal with these factors on almost daily basis and can make very reliable judgement of their importance.

3.1 Quantitative Factors Analysis

The summary of findings table from the systematic review of quantitative factors is presented in Table 2. The quantitative variables (i.e. financial ratios) used in all the primary (i.e.

systematically reviewed) studies are presented as well as the factors/categories the variables fall under. The factors were taken directly from the studies where available. Where otherwise, the variables were correctly categorised by the accountant amongst the authors using accounting literature. The frequency of use of each factor by study is plotted on the chart in Figure 3. Figure 4 presents the 'average accuracy by factor' plot of the CI-IPM of studies that employed each factor. The cash flow and interest coverage had too little data to give fair comparative result. For example, only two studies used cash flow factor and only one of them provided the accuracy result which was 96.9%; using this figure will clearly lead to unfair advantage for the factor.

Insert Table 2: Summary of findings table for quantitative factors

Insert Figure 3: Figure 3: Frequency of use of quantitative factors by study

Insert Figure 4: 'Average accuracy by factor' plot of CI-IPMs that used each factor

The factors are ranked in Table 3 according to charts in Figures 3 and 4. In both cases, profitability, liquidity, leverage, management efficiency and trend factors occupy the first five positons but in alternating ways. This already gives an indication that these factors are important based on usage frequency and accuracy of CI-IPMs. However, the use of the trend factor is well below 50% (Figure 3) among CI-IPM studies hence, its level of importance is doubtful on the frequency scale.

Insert Table 3: Quantitative factors from review and associated rankings from statistical charts

To validate the results gotten from the analysis of the systematic review, the questionnaire responses were analysed. As advised by numerous social scientist (Spector, 1992; Field, 2005;

316 Nunnally and Bernstein, 2007 among others) this study conducts a reliability test of the Likert
317 scale questionnaire responses by calculating Cronbach's alpha coefficient. Mathematically,
318 Cronbach's a is written as

319 $$\alpha = \frac{N^2 \overline{COV}}{\sum S^2_{factor} + \sum COV_{factor}}$$
320

321 The main aim of the test is to check whether the factors and their associated Likert scale are
322 actually measuring the construct they were intended to measure, which is the level of importance
323 of the factors in relation to the insolvency of construction firms, by checking the consistency of
324 the data. The value of Cronbach's alpha coefficient ranges from 0 to 1 and as a thumb rule,
325 George and Mallery (2003) suggested 0.7 as the lowest score and 0.8 as an indication of good
326 internal consistency. The SPSS (Statistical Package for Social Sciences) computer package was
327 used to calculate the Cronbach's alpha coefficient. The results are presented in Table 4. A score
328 of 0.149 was achieved, depicting a very low consistency and reliability of the questionnaire
329 responses. To examine the data and establish if there are some factors in particular that led to the
330 poor result, the third column of Table 4 titled 'Cronbach's Alpha if Item Deleted' was inspected.
331 According to Field (2005), if a factor is reducing/worsening the overall reliability and
332 consistency of data, and therefore is not a good measure of the construct, its associated
333 Cronbach's alpha coefficient would be higher than the overall coefficient (0.149). From Table 4,
334 trend, interest coverage and turnover factors have higher associated Cronbach's alpha coefficient.
335 What this implies is that there is no consistency in the responses given to these factors in the
336 questionnaires. Simply put, the respondents are far from a consensus on whether these factors
337 highly contribute to insolvency of construction firms or not. This portends that these factors are
338 not important in measuring this construct and should be removed. After removing these three

factors, Cronbach's alpha coefficient jumped up to 0.874. This means data for the remaining factors have a high consistency and reliability and do actually measure the construct. None of the remaining factors also had an associated Cronbach's alpha coefficient that is greater than the overall Cronbach's alpha coefficient (0.874).

Insert Table 4: Quantitative factors from questionnaire and associated statistical analysis

In order to measure respondent's perception of the importance of each factor in predicting insolvency of construction firms, a significance index (SGI) score was calculated using the formula below. The equation was derived from similar formula computed in previous construction studies (e.g. Kometa et al., 1994; Spillane et al., 2011b; Oyedele, 2013). Significance index is

$$SGI = \left[\frac{\sum_{n=1}^{N} (S_n)}{NS} \right] \times 100\%$$

Where the s in S_n represents the significance/importance rating from 1 to 5 given by the n^{th} respondent; n = 1, 2, 3, 4, 5.....N; N is the total number of respondents for that particular factor; and S is the highest possible significance/importance rating, which is 5. The 6th column in Table 4 shows the SGI values for each factor while the last column shows the ranking of the factor based on the SGI values.

The three factors with unreliable questionnaire data i.e. Trend, Interest coverage and Turnover, also happen to have the least significance index and are thus not very important for use in CI-IPMs. This validates the review analysis result in the case of Interest coverage and Turnover not being important but falsifies the idea that trend factor is important. The case of the trend factor is

364 not too surprising as it has already been highlighted under the review analysis that its importance
365 status is doubtful because its frequency of use is less than 50%. The profitability, liquidity,
366 leverage and management efficiency are confirmed to be important as they are in the top ranks of
367 1 to 5 with over 60% SGI value each. The main surprise factor here is the cash flow. It ranks
368 second with a reliable data and SGI value of 77%, this means many practitioners agree that this
369 is a very important factor that influences the insolvency of a construction firm even though it has
370 not been frequently employed by CI-IPM developers. This will be discussed further in the results
371 section.

372 ***3.2 Qualitative Factors Analysis***

373 The summary of findings table from the systematic review of qualitative factors is presented in
374 Table 5. The qualitative variables used in all the primary (i.e. systematically reviewed) studies
375 are presented as well as the factors/categories the variables fall under. The factors were correctly
376 categorised according to what is popular in construction management literature. The frequency
377 of use of each factor by study is presented in Figure 5. Since most of the primary studies did not
378 build a CI-IPM, an average accuracy chart was not provided here. None of the factors was
379 present in up to 50% of the studies hence the chart in Figure 5 was plotted according to the actual
380 frequency (first bars in the chart), and based on the most used factor being considered as 100%
381 frequency of use (second bars in the chart). The discussion here is based on the second bars in
382 the chart.

383 The factors are ranked in Table 6 according to the chart (Figure 5). Based on the second bars in
384 the chart, only the first six factors out of ten had above 50% frequency of use and are considered
385 to be the most important according to this simple analysis. They are management decision
386 making, firm characteristics, management/owner characteristics, internal strategy,

macroeconomic and skill of workforce factors, in that order. Of the six, only the skill of workforce factor (57.1%) has a percentage below 70%. It should also be noted that of the remaining four factors, only the external strategy factor (42.9%) is quite close to the 50% mark. Also, it was obvious that the sustainability and health and safety factors would achieve a low frequency rating right from the methodology stage since an extra effort had to be made to find just one study that used them. They are thus excluded from the ranking in Table 6. The questionnaire response analysis presented next can however shed more light on their importance.

Insert Figure 5: Frequency of use of qualitative factors by study/article

Insert Table 6: Qualitative factors from review and associated rankings from statistical chart

To validatethe results gotten from the analysis of the systematic review, the qualitative factors questionnaire responses were analysed in the same way as quantitative factors responses. The results of the analysis are presented in Table 7. The Cronbach's alpha coefficient of the data was -0.946, indicating a very inconsistent and highly unreliable data. Since many factors had associated Cronbach's alpha that was higher than the overall coefficient, factors were removed one at a time until an acceptable or good Cronbach's alpha was achieved. The factor with the highest associated Cronbach's alpha was removed in each case and the analysis was rerun.

By the time the Cronbach's alpha coefficient reached the acceptable figure of 0.755, skill of workforce, health and safety, motivation and external strategy factors had been removed. The skill of workforce factor which was noted to be the only important factor having a frequency of

use value below 70% from the review analysis had the least reliable data here. It also ranked nine out of 10 factors with an SGI value below 50% hence its 'important' status was falsified. The result for the other three factors is just a validation of their 'unimportant' status as realized from the review analysis.

At the acceptable Cronbach's alpha coefficient of 0.755, the sustainability factor (0.862) still possessed a higher associated Cronbach's alpha coefficient. This means the sustainability factor is reliable but only 'just', and is not contributing to the overall reliability (Field, 2005); its removal led to a better Cronbach's alpha coefficient 0.862, which can be considered as good. At this point, only internal strategy (0.863) had a higher associated Cronbach's alpha; however the difference was negligible (0.863 – 0.862 = 0.001) hence data for all other factors (inclusive of internal strategy factor) are very consistent and reliable.

The management/owner characteristics, internal strategy, management decision making, firm characteristics and macroeconomic factors are confirmed in this result as being very important as they rank 1st to 5th, in that order, and all have an SGI score above 75%. Although the external strategy factor has an SGI score above 50% and ranked 6th next to the aforementioned factors, its data is not reliable. The case of the sustainability factor, which similarly has a SGI score above 50% but with a contentious data reliability will be discussed further in the results section.

Insert Table 7: Qualitative factors from questionnaire and associated statistical analysis

4.0 Results

4.1 Result of the Quantitative Factors Analysis

From the two major analysis done, it is clear that the profitability, liquidity, leverage and management efficiency factors are very important to the prediction of insolvency of construction firms. However, as against the review analysis, the questionnaire data analysis shows cash flow factor to be very important as it ranked second with an SGI score of 77% using a reliable data. This is a result from industry experts who have dealt with the accounts of multiple insolvent construction firms, especially during the period they go into administration hence this result is highly valid. The verdict here is that CI-IPM studies need to consider the cash flow factor if they are to build a very sound model. The importance of cash flow management in ensuring the survival of construction firms have been highlighted by many construction management non-CI-IPM studies (Robinson and Maguire, 2001; Arslan et al., 2006; Holt, 2013 among others). Recall that the only primary study that used a cash flow factor and presented its result had a CI-IPM with an accuracy result of 96.9%. One reason the cash flow factor has not been commonly used is because cash flow variables (i.e. financial ratios) are not very common in financial statements of firms. The additional task CI-IPM developers will need to take on is to calculate cash flow ratios from available ratios in the financial statements. The five important quantitative factors are briefly explained below.

Liquidity Factor: Liquidity is an important factor which interests a lot of construction firm's stakeholders like material suppliers, site employees and staff in general since it shows to what extent a firm can meet its commitments without 'liquidating the non-liquid assets' (Horta et al., 2012; Ng et al., 2011; Horta and Camanho, 2013); inability to cover such liabilities which generally leads to insolvency. Generally, the more liquid a construction firm is, the healthier

(Edum-Fotwe et al. 1996). Liquidity might be poor for early warning systems [Bilderbeek (1977) as cited by Altman (1984)] but is very good for near immediate and immediate predictions. A fairly high liquidity level is very important for construction firms as cash availability is vital for execution of construction projects.

Cash-Flow Factor: A construction firm is substantially reliant upon the success of its construction projects hence for a construction firm to be more solvent, a reasonable size of the firm's cash flow should be employed in operations with a reduced cash flow in investment (Arditi et al., 2000; Enshassi, 2006; Chen, 2012). This is because of the cash flow conditions of firms in the CI where:

- Client only pays for completed work that has been financed by the firm, usually on a monthly basis

- A percentage (normally 10%) of payment is held back by client for potential omissions and/or defects

It is thus almost impossible for firms to recover expenses, not to mention make profit, before completion of projects. A robust cash flow plan for operations is thus necessary to avoid extreme leverage, being cash strapped or having a negative cash flow, all of which risk the survival of a construction firm (Kale and Arditi, 1999). The challenge is to achieve a positive cash flow from project(s) since a negative cash flow increases risk its survival

Management Efficiency Factor: Management efficiency factor, measured by asset utilization, activity ratio, working capital utilization ratio, etc. are used to check how efficient a management is using a firm's asset and leverage (Edum-Fotwe et al., 1996; Ng et al., 2011; Bal et al., 2013).

The CI is characterised by heavy operating expenses which become specifically onerous as firms 'need to shrink and expand in cycle with the job market and competitive conditions' (Arditi et al., 2000); improper management of this situation can lead to insolvency. Activity ratios are more concerned with management's ability to turn firm's assets into cash (Ng et al., 2011). This can help to reduce the possibility of insolvency that can result from liquidity problems.

Leverage Factor: As opposed to liquidity, leverage ratios measure long term solvency and thus contribute greatly to early warning systems for the CI (Horta et al., 2012). Because construction work is normally paid for only when they have been completed, usually on a monthly basis or longer when delayed, construction contractors are exposed to high debt (leverage) typically acquired to pay subcontractors and suppliers; these debts make construction firms more susceptible to failure from leverage (Arditi et al., 2000).

Profitability Factor: According to Arditi et al. (2000), the single most common budgetary factor that has led to the failure of construction firms is insufficient profit. This is because of extremely aggressive bidding with far from accurate estimates and the one-off and custom- made production systems that are synonymous with the CI. Ideally, the higher the profitability ratio of a construction firm the more solvent it is taken to be. However, developers using the multi-discriminant analysis (MDA) technique to develop CI-IPM need to be careful as the technique sometimes wrongly assign a negative sign to the profitability ratio (see Mason and Harris, 1979; Abidali and Harris, 1995). This problem is commonly known as the counter intuitive sign problem.

4.2 Result of the Quantitative factors Analysis

The verified most important factors from the two analyses are management/owner characteristics, internal strategy, management decision making, firm characteristics and macroeconomic factors. From the analysis results, the labelling of the sustainability factor as being important or not breeds controversy with a questionnaire data of 'acceptable' reliability and a mildly average SGI score of 54%. Tan et al.'s (2011, p.229) "comprehensive review of studies on the relationship between sustainability performance and business competitiveness finds that there is no unique relationship between the two variables". This, according to Wagner and Schaltegger (2003), is due to lack of data. However competitiveness and (in)solvency are not even exactly the same thing, though they are highly correlated. The verdict here is that sustainability is an important factor to consider for CI-IPM developers but not as important as the aforementioned factors. The external strategic factor has an even higher SGI score compared to sustainability albeit with an unreliable data. The unreliability makes it hard to consider it a very important factor. The identified important qualitative factors are briefly explained below.

Management/Owner Characteristics (MOC): Certain MOCs of a construction firm have negative effects on its solvency. These include inertia, unfounded optimism, taking unworthy risks with relatively large construction projects, autocracy of managers/CEO/president, a person holding multiple executive positions, an executive with too much power, etc. (Abidali and Harris, 1995).

Autocracy leads the race in this factor and is synonymous with an executive with too much power or a person holding multiple executive positions, all which cause failure of construction firms. A very powerful dual-position CEO/chairman, nullifying the all-important managerial power of the chairman being able to sack a defective CEO, is a common feature of failed

construction firms (Hall 1994). On the reverse, a balanced board which efficiently controls managers' actions help improve the solvency. The inertia of a construction company's owner/management leads to not realising the available opportunities and threats to the business (Gilbert, 2005). When business is slow, a construction firm specialized in pile foundation installation, for example, should be able to identify opportunities of excavation projects and make use of its excavators.

Internal Strategic factors: The inclusion of internal strategic factor for developing CI-IPM is vital if a robust CI-IPM is to be achieved (Henricsson et al., 2004; Dangerfield et al., 2010). Key strategic factors, according to Arditi et al. (2000), include sales/bids, competitiveness, planning etc., all which are based on the adaptability of a firm. The more successful bids a construction firm gets, the more it grows and the more solvent it becomes; lack of successful bids is tantamount to failure (Bal et al. 2013). Bidding in an area of expertise ensures a competitive low bid thus a firm must have an, or identify its, area of strength where it is unique over competitors. The importance of competitiveness cannot be over emphasized and efforts have been made to measure it in the CI (Henricsson et al., 2004; Dangerfield et al., 2010) in order to establish the state of solvency of a firm. Having the correct knowledge of itself and competitors can help a construction firm in designing the right strategy.

Management decision making: This factor is usually a result of MOC and directly influences internal strategy. However, the resources at the firm's disposal and some other elements do affect this factor. Decisions on project should be based on what is best for the firm rather than ego, friendship etc. For example, project selection should be based on what the firm is comfortable with and be, as much as possible, limited to a familiar geographic area to keep detrimental surprises to a minimum. Taking on a project at a long distance away can lead to managing from a

distance, procuring and engaging unfamiliar subcontractors of unknown quality and running into unexpected geological conditions (Denyer and Tranfield, 2006). Generally, construction firm managers that carefully go through the firm's financial statement before making decisions have been known to be more successful (Hall, 1994).

Firm Characteristics: Firm characteristics such as size, age, experience, maturity, flexibility, etc. can have a reasonable effect on a firm's solvency (Ng et al., 2011; Bal et al. 2013). Age is the most important of these because it has been proven that a lot of young firms fail due to their newness (Kale and Arditi, 1999). The possibility of a construction firm piling up business knowledge and skills through organizational learning is largely dependent on its age (Arditi et al., 2000). Such learning over time, and the resulting knowledge and skills, help a construction firm to identify favourable markets, create a positive image, establish the important partnership with construction materials suppliers and subcontractors, build positive relationship with financial institutions and potential clients, easily adapt to latest technologies (March, 1991), etc. all of which their combined absence can lead to a firm's failure. The ease of measuring of age of sample firms in months or years makes it easy for a CI-IPM developer to include this factor.

Macroeconomic: Macroeconomic factor include the amount of construction activities by existing firms, number of available construction contracts in a country at a time, interest rate, industry weakness, threat of new entrants, etc. and are considered part of the most important insolvency factors for developing IPM for the CI (Arditi et al., 2000; Sang et al., 2013). Construction firms are very susceptible to macroeconomic effects. However the susceptibility level of each construction firm differs (Ng et al., 2011; Sang et al., 2013). Industry weakness is not important when only one industry is being considered as in the case of CI-IPMs. Kangari (1988) suggested the 'construction-contract valuation index by F. W. Dodge' as a measure for

563 construction activity in the US while 'The Construction Index' can be used to measure the
564 number of new businesses in the industry in the UK.

565 ***Sustainability:*** The effect of sustainability on the solvency of construction firms is largely
566 dependent on government legislation and environmental standards as thy can help to bring about
567 innovations that lower cost and improve value. This will make a firm more competitive.
568 Practising sustainable construction will also improve the image of a firm and qualify it to bid for
569 contracts with strict sustainability requirements. However there are only a few of such projects
570 and many especially un-wealthy owners will put cost before sustainability. This is probably why
571 it is not too directly linked to insolvency of construction firms.

572

573 ## 5.0 Discussion and the Framework

574 The five most important quantitative factors i.e. profitability, liquidity, leverage management
575 efficiency and cash flow, one way or the other, all deal with sufficient availability of cash (for
576 projects). This is not surprising since the CI is operations based and construction firms generally
577 tend to take on projects that are financially larger than their financial worth or equity. Firms will
578 thus need all the money they can get to keep a project(s) running before the client pays back for
579 the completed portion according to contract terms. Without enough cash to run projects, a
580 construction firm can easily become insolvent. This aligns well with literature as clearly
581 identified by Chen (2012) that construction firms must allocate more cash to operations than
582 securing assets to avoid project failure because a single project failure can result in insolvency

583 The most important insolvency factors measured with qualitative variables include the
584 management/owner characteristics (MOC), internal strategy, management decision making
585 (MDM), firm characteristics macroeconomic and sustainability factors. The high importance of
586 managerial factors is evidence in the emergence of two management related factors in the result.
587 This, along with the internal strategic factor ranking, reconciles with Jennings and Beaver's
588 (1995) assertion that the major cause of company failure is almost perpetually a poor or lack of
589 management attention to strategic issues. Together with the macroeconomic (external) factor,
590 they corroborate Mahamid's (2012) findings as the most important agents for the survival of
591 construction contractors.

592 Without inclusion of any of these factors, important circumstances that lead to failure of
593 construction businesses, as in Porter's Five Forces and Mintzberg's five Ps of Strategy (among
594 other failure related theories), cannot be measured/represented in a CI-IPM making such CI-
595 IPMs suboptimal. This fact is in line with many studies (Arditi et al., 2000; Koksal and Arditi,
596 2004; Horta and Camanho 2013; Alaka et al., 2015 among others). Further, these factors cut well
597 across all the levels in the construction world hierarchy **(**Figure 6), making them more
598 exhaustive.

599 **Figure 6: Construction world hierarchy**

600 On the industry level of the construction world hierarchy the threat of new entrants
601 (macroeconomic factor), as in Porter's theory, is a big problem in the CI because there is almost
602 no requirement for new entrants. This normally results in influx and fierce competition, leading
603 to high firms-to-contract ratio and consequently high firms failure rate. It is well known that the
604 older or more established a firm is, the less susceptible it becomes to new entrants' threat (Hill et

al, 2014). The ‘age’ element of the firm characteristics factor and ‘managers’ experience’ element of the MOC can be used to take care of this area in a CI-IPM.

On the organization level, the construction material suppliers’ power (Porter’s theory) is quite low in the construction industry because of the high aggressiveness in the suppliers market (Muya et al., 1997), resulting in low material prices. The high competition levels in supplier selection is however starting to be seen as driver for negative effects on established supply chain relationships. Good relationships are known to improve prices, delivery time, supply preference etc. for the construction firm because of the opportunity of repeat business. Level of ‘business knowledge’, which is an element of MOC, and the internal strategy, are known to affect supply chain relationships and can thus be used to represent this area. A poor strategy would be to consistently buy randomly from any cheapest supplier rather than have preferences which could lead to better relationships as this will lead to no supplier giving the firm supply preference during materials scarcity for example.

Strategic pattern (Mintzberg's strategy theory) which results from managers’ experience can only be measured with qualitative variables like ‘construction managers experience’ (MDM). Other Mintzberg's Ps of Strategy, which are known to be key to the survival of firms include plan, ploy, position and perspective. Strategy as position is a matter of where a construction firm concentrates on in a market (i.e. new build, homes, pavement construction, renovations etc.) (Mintzberg, 2003) and can be represented by ‘company main activity’ (firm characteristic). Strategy as plan and perspective can be represented with elements like ‘emphasis on innovation, and headquarter geographic location’ under internal strategy and firm characteristic respectively(Mintzberg, 2003).

On the project level, employing 'skilful workers' and 'highly experienced foremen' (MDM), can affect the duration and cost of projects which are both major factors in deciding the Porter's competitive rivalry level of construction firms (Shash, 1993). Also, 'emphasis on innovation (internal strategy)' can measure how flexible a construction firm has been to adopting/creating innovating techniques for executing construction project. For instance, modular construction is what currently reigns in London and any firm not adopting this method faces a high threat of substitution from clients as in Porter's theory. 'General construction experience of owner/CEO, 'level of managerial experience in the CI' and 'education level of owner/CEO' (MOC) all represent the individual level of the construction world hierarchy

Basically, it is clear that the factors given in this study cut completely across construction world hierarchy and addresses most of the areas highlighted in business failure/survival related theories. Although CI-IPMs built solely on financial or quantitative variables do work, they do not really predict/foresee failure of construction firms. Rather they only reveal a company that is already failing; an act that might not leave enough time for remedy. It is the factors measured with qualitative variables (strategic, MOC, management, etc.) that can actually predict potential failure of a construction firm even when it is healthy since they consider actions and characteristics of a firm; in fact financial variables are only the result of the MOC, strategic, management, etc. steps of a construction firm as well proven in literature (Arditi et al., 2000; Koksal and Arditi, 2004; Horta et al., 2012; Horta and Camanho 2013; Alaka et al., 2015 among others). Both set of factors are thus key to developing a robust CI-IPM. This implies that considering all the important factors provided in this study's framework (Figure 7) in developing a CI-IPM will definitely result in a more accurate, more reliable and especially more valid early holistic prediction model as virtually all key areas that can lead to failure of construction firms

would have been considered. This framework (Figure 7) will benefit future CI-IPM researchers by providing an initial platform from which the important construction firms' insolvency factors and variables can be selected, omission of such important factors which can easily lead to a poor CI-IPM.

Figure 7: Framework of the important CI insolvency factors required to be in high performance IPMs for the CI

The practical implication of this study is that, having made the most important quantitative and qualitative factors for CI-IPM readily available, researchers in the CI-IPM area of study will increase the use of qualitative factors in tandem with quantitative factors in order to build much better CI-IPMs, having recognized that no real early insolvency predictions can be achieved without them. This is because the unreadily available challenge of qualitative factors and variables for CI-IPM is partly solved by this study. The study will also reduce the time spent on the statistical analysis of very many factors' variables for the purpose of selecting the best ones since such search can be narrowed down to variables of the important factors presented in the framework. Further, this study will ensure that no important factor (e.g. the frequently unconsidered/unused cash flow) is left out of building a CI-IPM.

6.0 Conclusion

Many IPMs have been developed for the CI but most of them have used solely quantitative (financial) insolvency factors simply because they are readily available. Unfortunately, these have led to non-robust models as they miss out some important CI insolvency factors that cannot

671 be measured with financial/quantitative variables. In fact financial factors positions are only a
672 result of qualitative factors (e.g. managerial, strategic, macroeconomic etc.) hence early
673 insolvency prediction of construction firms largely depend on these factors. This study set out to
674 create a comprehensive theoretical framework that will form the platform for selection of vital CI
675 insolvency factors and explain their relative importance in relation to solvency of construction
676 businesses.

677 The study used the systematic literature review research strategy, triangulated with questionnaire
678 data to create the theoretical framework. The framework highlighted the most important
679 quantitative and qualitative factors. Results showed profitability, liquidity, leverage,
680 management efficiency and cash flow to be the most important quantitative factors. Though not
681 common in the reviewed studies, cash flow is of dire importance to the survival of construction
682 firms and must be adequately represented on its own in any valuable CI-IPM. Results also
683 showed management/owner characteristics, internal strategy, management decision making, firm
684 characteristics and macroeconomic factors along with sustainability to be the most important
685 qualitative factors.

686 The study clearly showed that the highlighted factors cut across the entire construction world
687 hierarchy and are in line with firm insolvency/failure related theories like Porter's five forces and
688 Mintzberg's five Ps of Strategy, making them more significant to developing credible and valid
689 holistic CI-IPM. That is in addition to their effect on early insolvency prediction which will
690 allow time for remedies implementation. Overall, this study proposes the use of qualitative
691 factors, alongside quantitative factors, having shown their (i.e. qualitative) acute necessity and
692 partly solved their unreadily available nature challenge.

693 One limitation of this study is that the best variables for measuring the highlighted factors could
694 not be established because virtually every past study pointed at different variables as being the
695 best representative of a factor. Future studies should thus focus on establishing these best
696 variables. Future studies should also make effort in identifying more qualitative variables so that
697 the problem of unreadily availability could be solved further. This will benefit researchers who
698 prefer to have a pool of variables to analyse statistically for their choice rather than accept
699 established best variables. Further, future studies should attempt to implement the use of
700 highlighted factors in developing their CI-IPMs for assessment purpose.

701

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