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Financial Issues in Construction Companies: Bibliometric Analysis and Trends

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Abstract

The success of construction contractors largely depends on the specific terms and the availability of sufficient funds for realizing planned projects. Financial issues in construction have been discussed since mid 1970s, yet no consensus about progress has been reached in the construction finance literature. A systematic analysis of 259 finance related studies in construction is undertaken in order to identify research trends, critical topics and performance of journals and authors. In order to map the productivity in construction finance field, Scopus database was searched for the entire period for which this database provides online coverage. Results reveal that ‘financial health’ category, in particular one group of studies aiming to monitor and assess the financial performance of construction organizations for broader strategic issues pervaded the construction finance research. However, notably the “identification of capital structure, determinants and financing instruments” category received less and only recent attention from scholars, despite the significance of capital structure decisions under firm and country specific determinants in preventing company failures.

Key words: bibliometric analysis, construction, finance, financial management, research trends.

Introduction

As construction is regarded as an important sector in policy making due to its strong interactions with other sectors, improved efficiency in the sector should, in theory, further stimulate the overall economy. One of the critical factors in the efficiency of the construction sector is the successful management of construction contracting firms that largely depends on the extent to which a firm can adopt prudent practices in the management of financial resources. An important dimension of the problem for contractors stems from the availability of sufficient funds in appropriate terms and conditions. Experience to date has shown that poor financial management and lack of finance are the main causes of contractor failures (Gupta 1983; Russell 1991; Enshassi et al. 2006; Alavipour and Arditi 2018). The situation is exacerbated in particular for small-medium enterprises which have limited access to capital markets (Larcher 1999; Chiang and Cheng 2010). In addition, financing difficulties faced by construction contractors are recognized as the most significant obstacles to the improvement of innovation in construction industry (Chiang and Cheng 2010; Raftery et al. 1998; Pries and Janszen 1995; Fox and Skitmore 2007).

Debt and equity constitute the main external and internal capital sources in the construction sector. Equity consists of funds subscribed in a project by shareholders and of retained profits. Interest-bearing debt on the other hand is mainly provided by commercial banks through instruments such as short, medium and long term loans, leasing and lines of credit (Elazouni and Abido 2013). Several authors argue that resort to external financial sources in the construction sector is limited compared to other sectors in the economy (Ip and Hopewell 1987; Feidakis and Rovolis 2007; Chiang and Cheng 2010). In contrast, Hall et al. (2000), Kim (2009) and Tserng et al. (2012) argue that construction has a higher average leverage than many other sectors in the economy. Evidently, there are differences of opinion regarding the capital structure behavior or the preferred financing sources used by contracting firms in construction related literature.

Capital structure theories have long been used to explain the financing behavior of firms in various industries. The trade-off theory for example, states that firms trade off the benefits (i.e. debt tax shield) and costs (i.e. financial distress) of debt financing and define a target capital structure ratio, i.e. debt to

equity ratio. Pecking order theory (Myers 1984; Myers and Majluf 1984) on the other hand argues that firms follow a financing hierarchy, which is shaped by their preference to use internal funds over external sources. Although theoretical propositions on capital structure have been developed and tested in finance related literature since 1950s, the field has not gained a well-deserved place in construction research arena. As the studies are limited in number and a robust foundation has not yet been set, there is still inconsistency and confusion in literature. The present research is motivated by the desire to identify the productivity and performance of scholars in enlightening the financing behavior of construction contracting firms.

The primary purpose of this paper is to conduct a systematic analysis of research regarding financial issues in construction companies using the Scopus database. In this concept; a bibliometric analysis of research and theory development in construction finance is undertaken in order to:

- observe how publication and citation patterns have evolved throughout the years,
- map the evolution of core literature in the field, identify trends and patterns, and
- classify the major subjects and contextual themes in construction finance research.

To the best of authors' knowledge, no earlier study has taken stock of the state of the art in the construction finance literature. A comprehensive bibliometric analysis of construction finance fills a key gap in this respect.

Bibliometrics is a tool for tracking information on the scientific orientation and dynamism at a given level of specialization (Okubo 1997). The number of papers, citations, patents, co-publications and other more complex indicators are used as a proxy in determining the current state of science. Originating from the library and information sciences, bibliometric analysis provides an overall view of the intellectual structure in a given research area, through assessment of the contribution of different journals and authors to a specific field and through determining research trends (De Bakker et al. 2005; Gundes and Aydogan 2016). Moreover, as the primary method of quality measurement in research known as the peer review system has its own disadvantages, tracking scientific research through bibliometric analysis supports research progress (Van Raan 2014).

Method and Data

The publications were retrieved from the Scopus database. As one of the largest abstract and citation database of peer-reviewed literature, Scopus database covers more than 25.000 titles including journals, book series, conference proceedings and trade publications (Elsevier 2018).

In the first phase of the research, articles and reviews in the “title, abstract, keyword” section of the Scopus database were searched using the keywords; "capital structure", "finance", "financing", "financial structure", "financial ratio" and "financial performance". This was followed by integrating results using the Boolean logic “AND” with keywords related to the construction arena such as "construction projects", "construction firms", "construction organizations”, "construction companies", "contractors", "construction enterprises", "construction industry” and "construction sector”. As the financing mechanisms in project finance transactions have sharp boundaries defined by high debt to equity ratios and idiosyncratic borrowing conditions, studies focusing on project finance had to be left out of the scope of the present research. In order to eliminate the studies in project finance field, the Boolean operator “AND NOT” was used and keywords including “PPP”, "BOT", "BOOT", "PFI", "public private partnerships", "build operate transfer", "private finance initiative” and "build own operate transfer" were excluded from the search. The starting time of the search was not limited to a particular year in order to include a more comprehensive body of research. However, papers published in 2018 were excluded as not all journal papers from 2018 onwards were yet included in this database at the time of data collection. Roughly, this covers a period of 43 years as the earliest study in the dataset was published in 1974. The first phase of search with the following code generated 1247 results.

```
(TITLE-ABS-KEY ("capital structure" OR "finance" OR "financing" OR "financial structure" OR "financial ratio" OR "financial performance") AND TITLE-ABS-KEY ("construction projects" OR "construction firms" OR "construction organizations" OR "construction companies" OR "contractors" OR "construction enterprises" OR "construction industry" OR "construction sector") AND NOT TITLE-ABS-KEY ("PPP" OR "BOT" OR "BOOT" OR "PFI" OR "public private partnerships" OR "build operate transfer" OR "private finance initiative" OR "build own operate transfer" ) ) AND DOCTYPE ( ar OR re ) AND PUBYEAR < 2018
```

Despite the limitations in the search code, resulting publications in the first phase included a considerable amount of irrelevant papers. An examination of the abstracts revealed that these papers belonged to inapplicable subject areas such as medicine, psychology, agricultural and biological sciences. Therefore, the results were restricted to specific subject areas in the second phase of the research. These are “engineering”, “business, management and accounting” and “economics, econometrics and finance”. Documents written in English made up 90.2% of total publications, followed by German (2.48%), Chinese (1.60%) and Spanish (1.04%). Finally, the search was restricted to papers published in English and 608 documents were generated. The full search code was as follows (16.02.2018).

```
(TITLE-ABS-KEY ("capital structure" OR "finance" OR "financing" OR "financial structure" OR
"financial ratio" OR "financial performance") AND TITLE-ABS-KEY ("construction projects" OR
"construction firms" OR "construction organizations" OR "construction companies" OR "contractors"
OR "construction enterprises" OR "construction industry" OR "construction sector") AND NOT TITLE-
ABS-KEY ("PPP" OR "BOT" OR "BOOT" OR "PFI" OR "public private partnerships" OR "build
operate transfer" OR "private finance initiative" OR "build own operate transfer")) AND DOCTYPE (
ar OR re ) AND PUBYEAR < 2018 AND ( LIMIT-TO ( LANGUAGE , "English" ) ) AND ( LIMIT-
TO ( SRCTYPE , "j" ) ) AND ( LIMIT-TO ( SUBJAREA , "ENGI" ) OR LIMIT-TO ( SUBJAREA ,
"BUSI" ) OR LIMIT-TO ( SUBJAREA , "ECON" ) )
```

The total of 608 publications was entered into an Excel worksheet for further assessment, where the names of publications, authors, journals and dates of publications were recorded. Manual review of the titles and abstracts of 608 documents revealed that several papers were still irrelevant although they contained the keywords in the search. For example, studies in areas such as intellectual capital, corporate internet reporting or mentoring were completely unrelated to construction financing. Moreover, studies focusing on project finance, in particular privately financed infrastructure development still appeared in results. Where it was not possible to make the decision to exclude or include a publication based on title and abstract alone, full text versions were retrieved for detailed assessment against the inclusion criteria.

As a result, publications that had no apparent relationship to the topic at hand were eliminated and 259 documents were selected within the scope of the present research.

In the final round of the analysis, the number of papers that appeared across time, the journals in which these papers were published, the most productive authors in the field and the papers most cited were obtained.

Next, the papers in construction finance research were categorized according to major subjects and contextual themes through a careful full text reading and analysis of publications. The term finance is utilized so broadly that it is quite difficult to designate whether a paper retrieved by using the search term “finance” indeed addresses issues of contractors’ financing, only mentions finance issues slightly, or does not do so at all. Thus five different categories of themes, which have their own sub-categories, were identified. These are “financial health”, “finance based project management”, “capital structure”, “finance factor” and “risk”. “Financial health” category includes studies assessing the financial performance of construction organizations, providing contractor default prediction models and evaluating the use of financial ratios. “Finance based project management” category deals with managerial issues at operational level such as the integration of scheduling and financing functions, cash flows and financing costs. “Capital structure” category focuses on the financial decisions of contractors with an emphasis on the capital structure choices of contractors, determinants and decision making models. Finally, “finance factor” and “risk” categories include studies that have no direct relation to construction finance topic, in which the term finance is either used as a factor affecting corporate and operational strategies or the allocation and management of risks.

Analysis and Findings

Table 1 shows the research outputs of 11 most productive journals in the field and the total number of papers according to published periods. Journals that have published five or more papers are included in the table as the most productive journals. The first 11 columns of the table show the journals which have contributed at least five papers, namely Journal of Construction Engineering and Management (JCEM),

Construction Management and Economics (CME), Journal of Management in Engineering (JME), International Journal of Project Management (IJPM), Engineering Construction and Architectural Management (ECAM), Journal of Financial Management of Property and Construction (JFMPC), Canadian Journal of Civil Engineering (CJCE), Automation in Construction (AIC), Journal of Engineering, Design and Technology (JEDT), KSCE Journal of Civil Engineering (KSCE) and International Journal of Construction Management (IJCM). The column entitled “others” demonstrates the number of papers published in the remaining 79 journals.

Insert Table 1 about here.

The aim was to group the data into 5 year periods. This grouping was possible for the first eight periods except the last period which spans only four years. Therefore, the dataset could be grouped into the following time periods: 1974-1978 (2 publications), 1979-1983 (0 publications), 1984-1988 (5 publications), 1989-1993 (10 publications), 1994-1998 (18 publications), 1999-2003 (16 publications), 2004-2008 (58 publications), 2009-2013 (73 publications) and 2014-2017 (77 publications).

A closer look at the column entitled ‘total’ reveals that the number of papers is very few until about late 1980s. After 2000s, a steady rate of increase in interest can be observed in the total number of papers produced. Investigation into the reasons behind this trend reveals that the increase in the number of studies is predominantly caused by articles focusing on the financial health and insolvency of contractors in Asian countries. Increased interest in these topics may be attributable to the reduced demand and liquidity problems encountered by contractors after the Asian economic crisis in late 1990s.

Considering that the total of 259 papers is published in 90 different journals, it is difficult to state that the majority of articles in the field are centered around a number of core journals. Therefore, the rapid growth was general and not the result of any one journal. The first publication appeared in 1974 in “Engineering Economist”. This is followed by an article focusing on financial ratios in 1977, published in “Journal of Business Finance & Accounting”. Indeed, the only publications that were published from 1974 to 1986 comprised of these two articles. Therefore, it can be stated that only after 1986, themes about construction finance started to be published regularly in the relevant body of literature.

Looking at the whole period JCEM (14.7%) followed by CME (13.1%) appear to be the most productive journals in construction financing arena. Regarding the intensity of papers in selected journals, it can be observed that very few journals have consistently published articles concerning construction finance in the majority of periods. However, it should be noted that many journals in the list were launched only after 1990s.

Insert Table 2 about here.

Table 2 shows the number of papers published by selected journals for the five subject categories identified in the present research. Similar to previous findings, JCEM and CME appear to be the most productive journals in “financial health” and “finance based project management” categories. “Capital structure” category on the other hand is dominated by papers published in CME. However, these results should be interpreted with caution as the launch dates of the journals are different.

Research trends

In Figure 1, the relationship between number of publications in the five subject categories and their publication years has been presented in order to understand publication trends in construction finance literature. The analysis of the publication trends revealed that the key subject categories in the search during this period were as follows: ‘financial health’ (TP=85), ‘finance factor’ (TP = 66), ‘finance based project management’ (TP = 43), ‘capital structure’ (TP = 40) and ‘risk’ (TP = 25).

Insert Figure 1 about here.

Starting from just one article in 1974-1978, the rate of publication output under the subject category of ‘financial health’ increased to 27 articles by 2014-2017 period. Similar incremental trends in the rate of publication of construction finance research articles were witnessed under the subject category of ‘finance factor’ (from 1 article in 1984-1988 period up to 25 articles in 2014-2017 period) and, to a limited extent, in ‘finance based project management’ and ‘capital structure’. These trends appeared to affirm that financial health has almost always been a central theme in construction finance research during the period of analysis.

Although the studies in “finance factor” and “risk” categories contained the search keywords; they could hardly meet the selection criteria as the term “finance” was only used as a factor. As these publications do not carry the merits of a complete finance based study, they will not be examined in further detail.

Financial Health

Studies under this topic were evaluated under three sub-categories. First, one group of studies aimed to monitor and assess the financial performance of construction organizations for various purposes. For example, to evaluate their ability to survive through economic crises, to measure contractors’ financial stability during the prequalification phase or to make decisions for broader strategic issues such as international construction market entry. These studies were grouped under the sub-category of “measuring performance”. Second group of studies under “financial health” category includes articles focusing on contractor default prediction models based on financial ratio analysis and to a limited extent on the causes of construction business failures. Therefore, the second group was classified under “default causes and prediction” sub-category. Third group of studies which are very few in number concerns the evaluation and use of financial ratios in construction firms. These are grouped under the “financial ratio tools” sub-category.

Published in 1977, the first study in the “financial health” category focused on financial ratio tools. Nevertheless, publication patterns in this sub-category were quite irregular as the next paper on financial ratio tools could only be published towards the end of the century. Indeed, this is the breaking point after which the articles on the two other sub-categories “measuring performance” and “default causes and prediction” gained momentum, causing “financial health” to burst into prominence.

While researchers have consistently published articles within “measuring performance” and “default causes and prediction” sub-categories, studies aiming to assess the suitability of using traditional financial ratio tools in the construction industry seem to have clearly reached a saturation point in 2007. These publications mainly focused on debating the theoretical background of various tools and their applicability in the construction industry. Therefore, it can be stated that early works clearly formed a firm basis for subsequent and more comprehensive studies in construction finance literature. In the last

decade, research is no longer focused on evaluating the shortcomings of existing ratio tools or on emphasizing the need for standardizing the assessment criteria. Rather, ratio tools have advanced to become the basis for measuring performance of construction organizations, in particular for evaluating the consequences of various corporate strategies such as internationalization or diversification and to a lesser extent for modeling the behavior of firms under volatile economic circumstances.

In late 1980s there was also recognition of the importance of predicting defaults of construction contractors. The emergence of default prediction studies during this period can be attributable to the increased number of business failures in the 1980s and the critical rise of failure rates among construction companies as stated by Kangari et al. (1992). Studies were limited in number in the first twenty years, however they started to accelerate rapidly after 2008. The 2007-2008 global financial crisis that hit the major economies in particular the US, Europe and Japan (Khoo and Mah-Hui 2010) and the subsequent company failures may explain the reason behind the renewed interest in company default prediction studies. Accordingly, the results from the present research reveal that US appears to be followed by European countries and Japan in the geographical distribution of studies regarding corporate default studies in construction. The prominence of US based studies and authors is a remarkable implication that could further be explained by the arguments put forward by Altman and Hotchkiss (2010). The authors, who also draw attention to the recent developments in the techniques used for corporate financial distress prediction, state that one important factor stimulating these developments include “the enormous amounts and rates of defaults and bankruptcies in the United States in the years just following the turn of the twenty-first century” (Altman and Hotchkiss 2010, p. 231). Increased research interest into these areas after the financial turmoil can also be observed in the general finance research. Our results are in line with findings by Brooks and Schopohl (2018) who point to an increase in research around bankruptcy, default and credit risk following the global financial crisis.

As far as the measurement tools are concerned, one can state that financial ratio analysis has once again been used in models and scores for estimating contractor default probabilities, albeit almost always in combination with statistical techniques such as multivariate and linear discriminant analysis or with neural networks.

Finance Based Project Management

“Finance based project management” category consists of three sub-categories: “finance-based scheduling”, “cash-flow forecasting and management” and “financing costs”. Studies in the “finance-based scheduling” sub-category, which focus on the integration of scheduling and financing functions, outnumbered the latter two sub-categories. While “cash-flow forecasting and management” focuses on strategies and models for planning and controlling contractor cash-flows, “financing costs” sub-category includes publications regarding the estimation of costs borne from financial burden.

Management of cash flows is of crucial importance for contractors as the difference between insolvency and survival could depend on how the company handles the movement of money in and out of the firm. A total of 17 studies have been obtained in the search regarding cash flow management strategies of contracting firms. Main effort in cash flow studies in construction regards the planning and control of contractor cash flows under finance or project related risks, which also help contractors in defining the quantity and timing of required funds. In more recent studies however, (e.g. Görög 2009; Jiang 2012; Lu et al. 2016) researchers have developed models for forecasting cash flows at an early stage so that contractors are not caught in a cash trap during execution.

In many cases contractors benefit from bank loans for covering cash shortages in the construction stage. One of the main challenges here is finding a balance between cash requirements and credit limits. Researchers have tried to find an optimum solution to this problem since late 1990s through developing financially feasible schedules using a variety of mathematical models. Initial studies concerning finance-based scheduling considered single objective optimization approach for single projects. The techniques used include; integer programming (Elazouni and Gab-Allah 2004), and genetic algorithms (Elazouni and Metwally 2005). Finance-based scheduling problem for single projects has also been approached by the consideration of multiple objectives using genetic algorithms (e.g. Fathi and Afshar 2010; Elazouni and Abido 2014). In line with the aforementioned objectives, efforts in this area are also undertaken for multiple project environments (Elazouni 2009; Liu and Wang 2010; Abido and Elazouni 2011). Notably; Ashraf M. Elazouni is either the senior or co-author of more than half of the total of 23 papers in this sub-category.

Only three articles that appeared in the search focus on the estimation of financing cost of projects. The study by Warszawski (2003) for example, aimed to identify the financing cost of a project at initial stage and the impact of any changes in various parameters (project duration, cost and availability of various financing sources etc.). A more recent study undertaken by Elkassas et al. (2009) proposed a model that would assist contractors in estimating the financing cost and the maximum capital requirements for new projects at pre-tendering stage.

Capital Structure

Another wave of research approached the financing problem by dealing with the capital structure, its determinants and financial decision making in construction organizations. “Capital structure” theme includes “borrowing and lending decision making” and “identification of capital structure, determinants and financing instruments” sub-categories.

Much of the early work focused on defining financing sources that are used in the construction industry such as bank loans, new share issues, retained profits, factoring and trade credits. Studies on financing instruments aimed to identify the behavior of contractor finance through the assessment of contractor perceptions on various instruments and on their pros and cons. While initial publications examined instruments from a broader perspective, studies undertaken in particular after 2000s adopted a more profound approach by focusing on either the financing modes in a single country, or on the use of a particular instrument. Studies on the use of trade credits in the construction industry appeared only after 2012.

In conjunction with the practical nuances of various instruments, researchers also started to address the construction finance optimization problems by developing a number of mathematical models for borrowing decisions of contractors.

By the beginning of the 21st century, research has clearly shifted in some respects. Researchers started to publish papers that aim to characterize the capital structure of construction firms using theoretical propositions that emerged from corporate finance literature. However, theory testing could only become a major issue in the last decade in which a more regular publishing pattern can be observed.

The first detailed study on the examination of capital structure in construction organizations appeared in 1997. Punwani (1997) analyzed five contracting and house building company accounts from the UK in order to compare their capital structures in the period from 1980 to 1991. Later in 2002, Chiang et al. (2002) compared the profitability, asset base, cost of capital and capital structure of property developers and contractors in Hong Kong. Although objectives may be different, the first steps towards the examination of the impacts of various factors on capital structure of construction firms have been taken in these two studies.

Despite the importance of topics regarding the determinants of capital structure and congruence of construction sector to the capital structure theories, there have been very few rigorous studies in related literature. Moreover, these subject areas have only appeared more recently in the publications. For example, Feidakis and Rovolis (2007) examined the determinants of capital structure using balance sheet and income statements of 66 large construction firms from 13 EU countries. The effects of capital structure determinants on firm leverage have also been examined for various countries, such as Malaysia (Wan Mahmood and Zakaria 2007; Ramezanalivaloujerdi et al. 2015), Taiwan (Chen and Hsu 2008), Ghana (Owusu and Badu 2009), Hong Kong (Chiang et al. 2010) and South Korea (Choi et al. 2014).

Similar trends could also be observed in the overall field of finance, where capital structure studies increased considerably after 2007 (e.g. see Borokhovic et al. 2016). However, it should be noted that while capital structure is a relatively new category in construction, it has always been an important area of research in general corporate finance literature since the second half of 20th century.

One group of studies investigated the relationships between investment, credits and output from a macroeconomic perspective using country level statistical data rather than firm base data. For example, Arce et al. (2013) provides a model that explains how the financing conditions in the construction industry affects aggregate investment, credit and output composition. Bickerton and Gruneberg (2013) examine the relationship between LIBOR and construction industry output in order to identify if a change in LIBOR had a significant influence on construction output.

Financial health of a construction company largely depends on the way with which financing sources are selected. In order to deal with this issue, researchers have proposed several types of “borrowing decision making models”. Studies on financing decisions of construction firms first appeared in mid 1980s. Au and Hendricson (1986) presented a framework for analyzing the impacts of various financing mechanisms, changing operating conditions and inflation on the profit of a construction project. Lam et al. (1998) introduced a model for solving borrowing decision problems which assists in the selection of funding sources using “fuzzy multiple-objective linear programming”. However, in the proposed model it was assumed that contractors did not face any problems in obtaining funds and that they relied only on self-assessment of financial capability. Based on this deficiency, Tang et al. (2006) attempted to optimize both qualitative and quantitative factors using an adaptive generic algorithm (AGA) approach. Their model avoided the problems faced by construction firms in obtaining funds by introducing the possibility of selecting funding sources. Moreover, the model can also overcome the self-assessment problem by taking sovereignty, creditability and networking into consideration. Lam et al. (2009) have developed a multi objective decision support (MFDS) model for Chinese construction firms taking into account the government guanxi factor peculiar to the Chinese culture. For this purpose, four objective functions namely; profit margin, risk factors, government relationship and market share are employed.

Aiming to minimize the cost of capital, Chiang et al. (2011) introduced a three-phased model for construction borrowing decisions. In the first two phases, relative efficiencies of banks were identified using data provided by Lam et al. (1998) and Tang et al. (2006). The weights for qualitative factors such as relations with the bank and past cooperation were generated, followed by ranking of available financial sources using the Data Envelopment Analysis (DEA) method. In the third phase, timing of financial source use is determined by a dynamic model.

In the previous construction finance literature, studies on bank lending decisions for contractors are quite limited compared to borrowing decision making models offered for contractors. The most comprehensive research in this field has been undertaken by Chiang and Cheng (2011). The authors aim to provide a better understanding on lenders’ perceptions about construction borrowing. In order to reach this objective, a survey and interviews were conducted with banks in Hong Kong.

Although efforts have been put towards the development of borrowing decision models, the search results provided only 11 publications in this respect. Considering the increasing need for more realistic financial decision making frameworks under volatile economic conditions, this area could present a potential for future studies.

Performance of authors and journals in construction finance

This section provides an overview of the productivity of authors and journals through the enumeration of their research outputs. Furthermore, in order to assess the influence of contributions a citation analysis has also been undertaken. Note that, although citations are used as a quality factor in bibliometrics, the extent to which it reflects scientific quality is limited (Seglen 1992).

Publication trends of researchers

The 259 papers in the dataset are written by 494 different authors (1.9 authors per paper). Table 3 demonstrates the names of authors involved in at least four papers. Most productive authors are analyzed and ranked by total output of articles with two indicators showing single country articles (SP) and internationally collaborative articles (CP). Ashraf Elazouni from King Fahd University of Petroleum and Minerals is the most productive author by 15 papers, eight of which are internationally collaborative. Elazouni is followed by Seung Heon Han from the Yonsei University with six papers, four of which are internationally collaborative. Results reveal that four authors have contributed to existing literature with five papers. These are; Jieh Haur Chen from National Central University in Taiwan (4 SP, 1 CP), Yat Hung Chiang from Hong Kong Polytechnic University (5 SP), Ka Chi Lam from City University of Hong Kong (5 CP) and Hui Ping Tserng from National Taiwan University (2 SP, 3 CP).

Insert Table 3 about here.

Most frequently cited papers in construction finance

In order to gain further insight into the subjects that bore significance to construction finance research during the whole period, the top five most cited articles from the 'capital structure', 'finance based project management' and 'financial health' categories were analyzed. The information about number of

times a paper has been cited is obtained from the Scopus Database. Table 4 outlines the citations according to subject classification adopted by the authors. Note that, 'risk' and 'finance factor' topics that have no direct relation to 'construction finance field' have been excluded from the list. There are several reasons for excluding these topics. First, these categories are mainly composed of studies focusing on themes other than finance. Second, the term "finance" in these studies has been used only as a factor that interacts with other distant issues, such as construction delays or cost overruns. Therefore, they were not included in the most frequently cited papers in order to avoid conceptual unclarity.

113 papers (43.63%) were cited more than ten times and 42 papers (16%) were never cited. Closer examination of the three contextual categories suggests that "financial health" is the most cited among others. Article entitled "Corporate distress diagnosis: Comparisons using linear discriminant analysis and neural networks (the Italian experience)" by Altman et al. (1994) has been the top cited article within both financial health category and the whole dataset. Indeed, studies focusing on contractor default causes and prediction in the construction industry similar to the study by Altman et al. (1994) constitute the majority of top 5 cited articles in the "financial health" category. The total of 23 articles in this sub-category have obtained 712 cites (30.9 cites per article). However, looking at the cites per article values in this category, it can be observed that "financial ratio tools" sub-category obtained the highest number of cites per article (51.6).

Insert Table 4 about here.

The second most cited articles appear in the "finance based project management" category with a total of 726 cites. The article entitled "Finance-based scheduling: Tool to maximize project profit using improved genetic algorithms" has been the most cited article in this category. As it can be seen from Table 5 the most cited articles in this category are studies concerning schedule models that aim to incorporate financial data in order to control credit requirements, and thus minimizing financing costs. The total of 23 articles in this sub-category have obtained 421 cites (in average 18.30 cites per article). Cash flow forecasting and management is the second most cited sub-category with 296 cites for 17 articles (17.41 cites per article). Financing costs in the "finance based project management" category have obtained only 9 cites for 3 articles (3 cites per article).

The most frequently cited article in the “capital structure” category was “Capital structure and profitability of the property and construction sectors in Hong Kong” published by Journal of Property Investment and Finance. Looking at both total times cited and cites per paper values in Table 4, it can be observed that “capital structure” category almost invariably has the lowest values among others. This can be attributed to the fact that the number of publications has accelerated only after mid-2000s. The low attractiveness of the subject for researchers might be posing an obstacle in getting citations from subsequent publications.

Insert Table 5 and Table 6 about here.

Most frequently cited journals in construction finance

Table 6 exhibits the most frequently cited journals in construction finance research. “Journal of Construction Engineering and Management”, followed by “International Journal of Project Management”, “Construction Management and Economics”, “Journal of Management in Engineering”, “Journal of Banking and Finance”, “Engineering, Construction and Architectural Management” and “Automation in Construction” has been the top cited journals among the total of 90 journals. The cites per paper column however shows a very different pattern. Journal of Banking and Finance has the highest number of cites per paper, as the only publication from this journal has been the most cited publication among 259 publications. The remaining journals fall far behind the latter in terms of cites per paper.

Conclusions

Although finance has received a considerable attention in general finance and management literature, the concept of construction finance has not still gained a prominent position among studies as a fundamental research theme. The present paper was based on a detailed analysis of 259 documents with the aim of revealing trends, patterns and productivity in almost half a century on construction finance research.

Looking at the whole period, it can be observed that the number of publications has consistently increased. The growing pattern in particular becomes evident starting from the beginning of the 21st century. A closer examination into the trends of subject categories reveals that “financial health” has almost always been a central research theme. However, the domination of “financial health” category is mainly caused by sharp increases in publications aiming to measure the financial performance of construction firms for strategic decision making rather than to provide a better understanding on construction finance issues.

Indeed, only slight increases have been observed in the number of publications that focus on the real world problems of contractor finance and related challenges; reflected in the capital structure category. The number of papers testing the capital structure theories for which debates are ongoing in finance literature since 1950s is still very limited. This could partly be attributable to the difficulties associated with obtaining finance based information from contractors. With very few publications in hand, it is difficult to draw any strong conclusions concerning which of the capital structure theories provides a better view of financial decisions in the construction industry or which determinants play a major role in financing behavior. Indeed, this area is dominated by studies investigating the determinants of capital structure and their impacts on financing choices in construction firms of mainly Asian countries.

The review on the productivity of authors in the whole dataset shows that construction finance research is mainly dominated by Asian authors. This can be attributable to increased need for finance, as average construction output in Asian countries is higher than their counterparts. Moreover, financial markets are still developing in many Asian states, leading to the continuous emergence of new financial instruments and improved opportunities for borrowers. This proposition could also explain why Asian authors pioneer publications that propose models for financing decisions. However, there is still a need for reliable borrowing decision making models, in particular under volatile economic conditions.

These findings should be evaluated in the light of recent developments such as the massive infrastructure investment programs and the founding of the Asian Infrastructure Investment Bank in China, as they may play a prominent role in the development of construction finance literature in the near future. Finally, it should be emphasized that the findings from the present research are limited to Scopus

indexed articles written in English. Thus, further investigation into the construction finance debate in journals that are not Scopus indexed or the inclusion of publications in other languages could have substantial impacts on the trends presented in this paper.

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TABLES AND FIGURE

Table 1. Number of research outputs of journals and total publications by year

	JCEM	CME	JME	IJPM	ECAM	JFMPC	CJCE	AIC	JEDT	KSCE	IJCM	Others	Total
1974 - 1978	0	0	0	0	0	0	0	0	0	0	0	2	2
1979 - 1983	0	0	0	0	0	0	0	0	0	0	0	0	0
1984 - 1988	4	1	0	0	0	0	0	0	0	0	0	0	5
1989 - 1993	3	3	1	0	0	0	0	0	0	0	0	3	10
1994 - 1998	1	4	3	1	1	0	0	0	0	0	0	8	18
1999 - 2003	2	7	1	3	1	0	0	0	0	0	0	2	16
2004 - 2008	14	7	8	3	4	3	4	2	2	0	0	11	58
2009 - 2013	10	9	2	6	1	3	2	2	1	3	4	30	73
2014 - 2017	4	3	1	1	5	4	1	2	3	2	1	50	77
Total	38	34	16	14	12	10	7	6	6	5	5	106	259

Table 2. Research outputs of journals according to subject categories.

	JCEM	CME	JME	IJPM	ECAM	JFMPC	CJCE	AIC	JEDT	KSCE	IJCM	Others	Total
Financial Health	14	12	5	0	4	6	4	0	2	0	2	36	85
Finance Based Project Management	9	6	1	4	2	1	1	3	0	3	1	12	43
Capital Structure	2	9	2	1	1	2	1	1	1	0	1	19	40
Finance Factor	7	6	7	7	5	0	1	1	2	1	1	28	66
Risk	6	1	1	2	0	1	0	1	1	1	0	11	25

Table 3. Researchers involved in at least four papers.

Researcher	TP	SP	CP
Elazouni, AM	15	7	8
Han, SH	6	2	4
Chen, JH	5	4	1
Chiang, YH	5	5	0
Lam, KC	5	0	5
Tsemg, HP	5	2	3
Abido, MA	4	4	0
Badu, E	4	1	3
Chen, PC	4	2	2
Cheng, EWL	4	4	0
Edwards, DJ	4	0	4
Konno, Y	4	4	0
Russell, JS	4	2	2

Table 4. Number of total citations according to construction finance subject categories.

Subject Areas and Sub-fields	Total times cited	Number of papers	Cites per paper
Financial Health	1480	85	17.41
Default causes and prediction	712	23	30.96
Measuring performance	510	57	8.95
Financial ratio tools	258	5	51.60
Finance Based Project Management	726	43	16.88
Finance-based scheduling	421	23	18.30
Cash-flow forecasting and management	296	17	17.41
Financing costs	9	3	3.00
Capital Structure (CS)	246	40	6.15
Identification of CS, determinants and financing instruments	189	29	6.52
Borrowing and lending decision making	57	11	5.18

Table 5. Most frequently cited papers according to subject classification

Author (published year)	Title of publication	Times cited
Capital Structure		
Chiang Y.H. et al. (2002)	Capital structure and profitability of the property and construction sectors in Hong Kong	40
Au and Hendrickson (1986)	Profit measures for construction projects	25
Eyiah and Cook (2003)	Financing small and medium-scale contractors in developing countries: A Ghana case study	23
Feidakis and Rovolis (2007)	Capital structure choice in European Union: Evidence from the construction industry	15
Chen et al. (2009)	Local operations of Chinese construction firms in africa: An empirical survey	14
Financial Health		
Altman et al. (1994)	Corporate distress diagnosis: Comparisons using linear discriminant analysis and neural networks	366
Bassioni et al. (2004)	Performance measurement in construction	143
Kangari (1988)	Business failure in construction industry	63
Kangari et al. (1992)	Financial performance analysis for construction industry	58
Abidali and Harris (1995)	A methodology for predicting company failure in the construction industry	53
Finance Based Project Management		
Elazouni and Metwally (2005)	Finance-based scheduling: Tool to maximize project profit using improved genetic algorithms	64
Liu and Wang (2008)	Resource-constrained construction project scheduling model for profit maximization considering cash flow	63
Park et al. (2005)	Cash flow forecasting model for general contractors using moving weights of cost categories	56
Dayanand and Padman (2001)	Project contracts and payment schedules: The client's problem	55
Elazouni and Gab-Allah (2004)	Finance-based scheduling of construction projects using integer programming	54

Table 6. Most frequently cited journals in construction finance.

Journal	Total times cited	Times per paper
Journal of Construction Engineering and Management	1213	31.92
International Journal of Project Management	983	70.21
Construction Management and Economics	589	17.32
Journal of Management in Engineering	551	34.44
Journal of Banking and Finance	366	366
Engineering Construction and Architectural Management	159	13.25
Automation in Construction	141	23.50

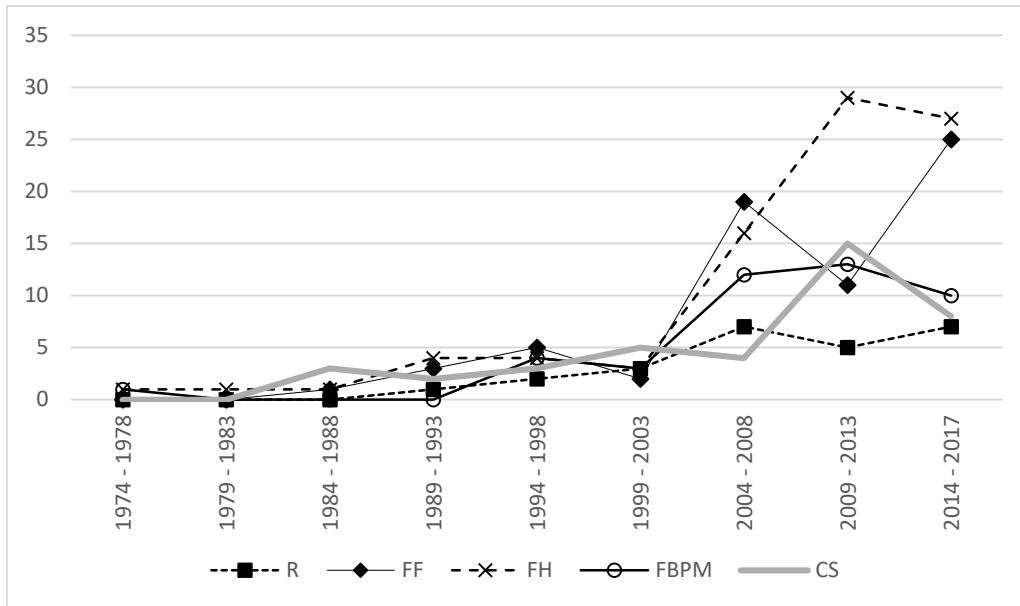


Figure 1. The development of research in construction finance subject categories

Note: R, risk; FF, finance factor; FH, financial health; FBPM, finance based project management; CS, capital structure.