sustainability

MDPI

Review

A Conceptual Development Framework for Prefabricated Construction Supply Chain Management: An Integrated Overview

Yang Liu, Jianjun Dong * and Ling Shen

College of Civil Engineering, Nanjing Tech University, Nanjing 211800, China; liuyang6154@163.com (Y.L.); shenling@njtech.edu.cn (L.S.)

* Correspondence: dongjj@njtech.edu.cn

Received: 6 January 2020; Accepted: 28 February 2020; Published: 2 March 2020

check for updates

Abstract: Prefabricated construction (PC), with the characteristics of green, environmentally friendly, energy saving and high production efficiency, is attracting more and more attention from all over the world. Supply chain management is closely related to the application efficiency of PC, but only in the last three years has this interdisciplinary research received due attention. The prefabricated construction supply chain management (PCSCM) have not received enough attention. Especially recently, the related literature shows explosive growth. This paper adopted the method of systematic literature review through the tool of bibliometric statistics. And we reviewed 152 articles from 2001 to 2018, with the goal of understanding the current situation, trends, and gaps in PCSCM research, and a framework is proposed to promote its development. First, the study discussed the four themes of clustering, concentrating mainly on strategic research and project evaluation, PC supply chain process design and optimization, supply chain integration and management, and the application of advanced technology. Then, the research gaps and conceptual development framework to promote PCSCM were reported. Only through the coordinated development of technology, market circumstances, and decision-making level of participants, can the PCSC form an integrated whole, so as to optimize the efficiency and sustainability of prefabricated construction industry and improve its level.

Keywords: Prefabricated construction; supply chain management; literature review; bibliometric analysis; thematic analysis; conceptual framework

1. Introduction

The traditional construction method is slow and inefficient, which brings great burden to the environment (e.g., visual intrusion, air pollution, waste pollution), social welfare (e.g., noise, public health), and sustainable development [1]. More than 40% of solid wastes are construction and demolition waste [2] and dust pollution seriously affects the living quality of residents near the construction site [3]. Obviously, the traditional construction method has brought great troubles to social development and human living quality.

The strong interaction between prefabricated construction (PC) and sustainable development has aroused widespread social concern. PC, a sustainable construction method, has the advantages of green, environmentally friendly, energy saving, and high production efficiency compared with on-site construction [4], and represents a new direction and way for the construction industry to cope with the serious environmental pollution and shortage of social resources [5]. Prefabricated construction supply chain management (PCSCM) is an important way for PC to improve production efficiency and competitiveness, achieve cost and schedule control and energy conservation [6]. PCSCM is a process of planning, organizing, coordinating and controlling the product flow, information flow, capital flow and decision flow of prefabricated components, which integrates the whole process of ordering, production, transportation, and assembly with advanced technology [7]. Improper transportation and storage of components, untimely progress control and inconvenient information transmission have made PCSCM the key factors restricting the promotion and development of PC [8].

The development of manufacturing supply chain management has been relatively perfect, while prefabricated construction supply chain management has not received a lot of attention until recent years. They are fundamentally different from each other [9]. For example, in technological coherence, concrete pouring and maintenance during the production of prefabricated components must be completed continuously without interruption [10]; in the transportation process, prefabricated components are of larger size, which have certain requirements for the transportation vehicles [11]; in the assembly process, prefabricated components are installed in accordance with the construction schedule [12]. Moreover, PCSCM has a large number of participants with different demand. Due to the advance of prefabricated construction design and the separation between off-site production and on-site installation, higher requirements are put forward for the coordination and management ability of the participants [13].

From several important literature reviews in PC field, it can be found that PCSCM plays an irreplaceable role in promoting the success of PC project [14]. However, there is no independent complete literature systemically evaluate the nature, influence, contribution and existing problems of PCSCM. To bridge these gaps, the study attempts to conduct a systematic literature review through the tool of bibliometric statistics to determine the status, trends, priorities and gaps of PCSCM. This paper aims to analyze three problems existing in PCSCM: (i) Key research topics of PCSCM; (ii) Research gaps and agendas; and (iii) Further obtain a research framework of promoting PCSCM. Strengthening the practical application of technology and the standardization of the market environment is the basis to promote the implementation of PCSCM. The decision optimization of participants based on the integration of the industrial chain can further optimize the PCSC efficiency. Only through the coordinated development of technology, market circumstances, and decision-making level of participants, can the PCSC form an integrated whole, so as to optimize the efficiency and sustainability of prefabricated construction industry and improve its level. The findings contribute to the acquisition of academic knowledge, research frontiers and emerging trends about PCSCM research, and promote the sustainable development of the PC industry.

2. A Brief Review of PC Research

The whole process of PC, first defined by United Nations Department of Economic and Social Affairs in 1974, includes manufacturing and pre-assembling a certain number of building components, modules and components, and shipping them to the construction site for installation [15]. The biggest difference between PC and traditional site construction is that the process and scope of construction management extend to the production source of components. The supply process which was not so important to the site construction has become the key work of PC. A lot of research has promoted the implementation and promotion of PC. Several literature reviews summarize and analyze the development and research trend of PC, focusing on the construction and production technology, as listed in Table 1.

Table 1. Previous literature reviews.

Authors	Object of Study	Article Number	Topics
Li et al. (2014) [1]	PC Management	100	Industry prospect; environment for technology application; design, production, transportation and assembly strategies; performance evaluation
Mostafa et al. (2015) [2]	Offsite construction	62	Offsite barriers and drivers; the integration of lean and agile principles; simulation
Boafo et al. (2016) [3]	Modular prefab	146	The performance of modular prefab considering acoustic constrain, thermal behavior, energy consumption; life cycle analysis
Kamali & Hewage (2016) [16]	Modular construction	104	Sustainability dimensions assessment (i.e., environmental, economic, and social)
Hosseini et al. (2018) [17]	Offsite construction	501	The product and technology of off-site construction
Jin et al. (2014) [18]	Offsite construction	349	Management practices; process; product; performance; research method; technology

From Table 1, four main aspects of PC research can be summarized.

(1) Performance and construction technology of prefabricated components.

Compared to site construction, PC has the advantages of lower safety hazard, higher production efficiency, lower cost and higher energy saving [19]. The production and installation technology of prefabricated components is quite mature [20]. Modular and standardized component design is basically realized [21]. Bearing capacity, rigidity, ductility, waterproofness, and the construction technology of connection points of prefabricated components are the mainstream of research [22]. The seismic performance of connections still needs to be further studied [23].

(2) Prefabrication buildings and PC development obstacles and drivers.

Generally speaking, PC has gained good market acceptance. Policies and regulations, technological innovation, industrial layout and other aspects all show the market potential and driving force of PC. However, the application of PC is still subject to local government policy preferences [24], high upfront investment [1], a lack of highly skilled workers [2], and insufficient transportation supply capacity [25], leading some to argue that PC is not the best choice despite its good performance.

(3) The implementation management of PC.

Many researches focus on the life cycle management of prefabricated construction, and systematically study the prefabricated buildings from the aspects of organizational mode [26], contract management [27], and cooperative innovation [28]. Although the PC technology has been developed relatively recently, its actual performance does not have a significant advantage over the traditional building, which is largely related to its weak organizational coordination and management ability in the implementation [29].

(4) Transportation and Supply chain management.

Koskela et al. (1990) [30] have long proposed the concept of supply chain management for a long time. Until the last three years, this interdisciplinary research has received its due attention in the PC field. However, in practice, the transportation of PC components still adopts the extensive mode of traditional construction industry [31]. The resulting delays, component damage, and cost overruns have seriously affected PC performance and people's evaluation [32].

Research on PCSCM can be divided into three levels: strategic analysis, supply chain optimization, and specific link design, which will be discussed at length in subsequent sections. Nevertheless, the research on PCSCM cannot meet the demand of market implementation on the whole. No article has summarized the research status quo to analyze the gap between theory and practice. Therefore, with the use of scientometrics technology, this study attempts to systematically review the present situation, trends and gaps of PCSCM, and to build a framework to promote PCSCM.

3. Method

The method of the systematic literature review through the tool of bibliometric statistics is an effective way to identify, examine and evaluate all relevant literature on a particular research topic at an early stage [33]. Bibliometric statistics refers to replacing manually coded articles with bibliometric analysis software (e.g., VOS Viewer and Citespace), which can visually display the statistical results of journals, cited literatures, and keywords, so as to facilitate researchers to understand the research status [34]. Systematic review is a basic and critical method for condensing topics, discovering research gaps, and building knowledge frameworks [35]. The combination of the two can effectively avoid the common subjectivity and unreliability in literature review.

The research framework is shown in Figure 1. In the step 1, a comprehensive literature search and descriptive statistics were made. Based on the statistical results, the four research topics were discussed in the second phase. Finally, a research framework to promote the development of PCSCM is proposed.

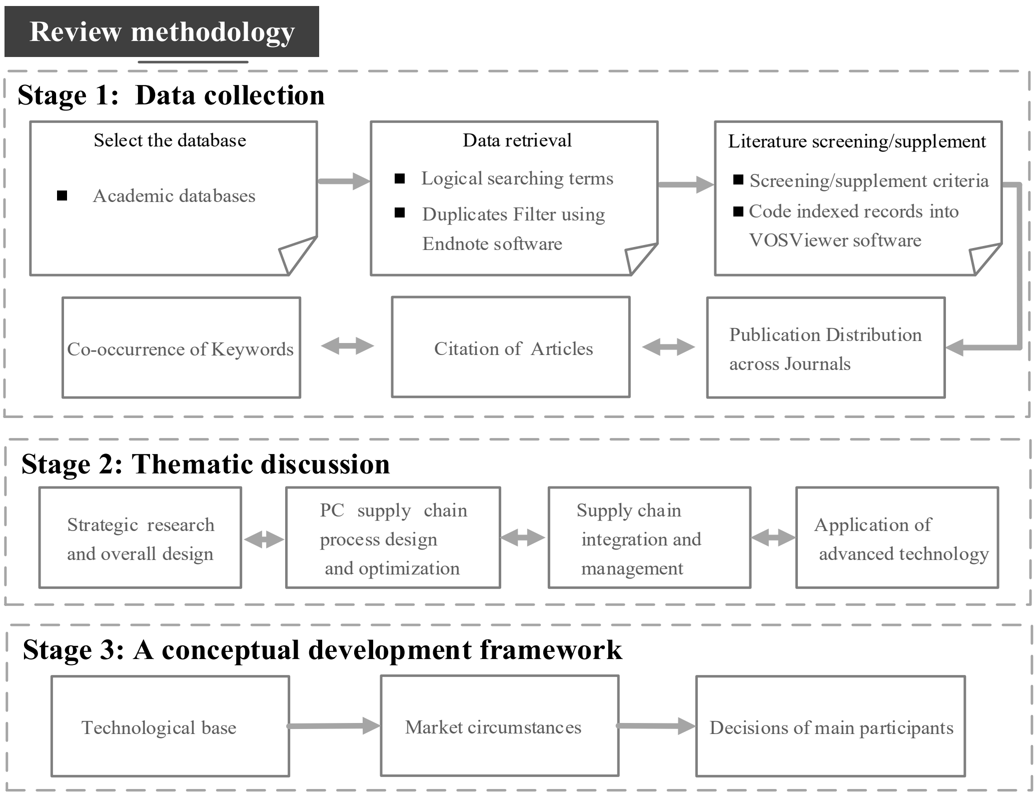

Figure 1. The process of the review method.

The first step is data collection, including the data collection process and descriptive statistics of the literature. Through bibliometric software, the general situation of the research field can be summarized. For example, journal analysis can identify missing areas of research, and keyword analysis can help identify research focus. The bibliometric software used in this paper is VOS Viewer. VOS Viewer is more suitable for visualization of large networks than other text mining tools [36]. The data can be imported directly into it to generate the literature network [37] and create a network map, with the distance between nodes indicating how close they are [38].

The second step is thematic discussion. Based on the clustering results of bibliometric software, the author browsed the whole literature to ensure the accuracy and reliability of the clustering, four topics in the current research field of PCSCM were summarized, including (1) strategic research and overall design, (2) PC supply chain process design and optimization, (3) supply chain integration and management, and (4) the application of advanced technology.

Finally, a conceptual development framework for PCSCM is proposed. Combined with the systematic review, the framework consists of three parts: technology base, market circumstances and decisions of main participants. The coordinated development of technology, market circumstances and decisions of main participants can promote the integration of supply chain to optimize the efficiency and sustainability of PC industry.

4. Data Collection

4.1. Data collection Process

There are three steps in data collection process, which follows Meho (2008) [39], as shown in Figure 2.

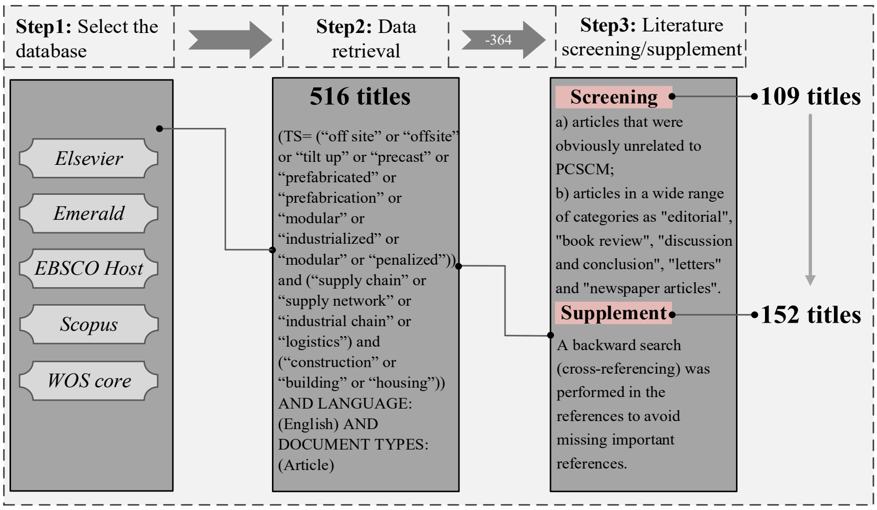

Figure 2. Literature retrieval and screening process.

Step1: Select the database. Scopus was chosen as the primary retrieval database for this review. Scopus is the world's largest database of abstracts and citations of peer-reviewed research literature [39]. And the databases of previous reviews in the theme of PC and SCM have been summarized in Table 2. To ensure the integrity of retrieval results, Elsevier, Web of Science (WoS) core, Emerald, and EBSCO Host are added as additional databases.

Step2: Data retrieval. Keywords of PCSCM were chosen based on the systematic review of these previous papers of PCSCM definitions which is presented in Table 2 [17]. 516 initial records were obtained using the retrieval syntax in Figure 2. Search in the "Title/Abstract/Keywords" field. There was no limit to the publication, and the date range was set to "all years to the present". The earliest record retrieved was published in 2001.

Step3: Literature screening and supplement. Some inclusion/exclusion criteria still need to be set to ensure the accuracy of the retrieval results. First, the initial retrieved records were imported into software EndNote X8 to filter duplicates. Next, the following two types of articles were deleted, a) articles that were clearly unrelated to PCSCM (e.g., finance, medicine, manufacturing); b) articles in a wide range of categories as "editorial", "book review", "discussion and conclusion", "letters" and "newspaper articles". Then, a backward search (cross-referencing) was performed in the references to avoid missing important references. Finally, 152 qualified articles were screened out, as shown in the Appendix A Table A1.

Additionally, the papers on supply chain management/prefabrication/construction in broad sense were not directly adopted because the focus of this work is on PCSCM rather than the broad field it covers. Nevertheless, views from these areas might be used to strengthen the analysis, although the papers might not be included in the literature review portfolio.

Table 2. Databases and keywords of previous reviews.

Theme	Authors	Databases	Keywords
Prefabricated construction	Li et al. (2014) [1]	Scopus	"prefabrication", "prefabricated construction/building", "off-site construction","industrialized building/housing", "modular construction/building"
	Mostafa et al. (2016) [2]	Emerald, Elsevier, Scopus	"industrialized building", "off-site building", "penalized construction", "offsite construction", "prefabricated construction"
	Hosseini et al. (2018) [17]	Scopus	"Off-site construction" OR "Off site construction" OR "Prefabricated construction" OR "Industrialized building" OR "Panelized construction" OR "Modular construction" OR "tilt up construction" OR "Precast" OR "offsite construction" OR "precast construction" OR "tilt-up construction"
Supply chain management	Fahimnia et al. (2015) [40]	Scopus	"Supply Chain Management" OR "Industrial Chain Management"
	Nguyen et al. (2017) [41]	Elsevier, Emerald, Scopus, and EBSCO	"Supply Chain Management" OR "Logistics"

Figure 3 shows the annual number of publications from 2001 to 2018. Through simple statistical analysis, it can be found that the research on PCSCM has been growing rapidly in recent years, with the number of papers in 2018 reaching 37.

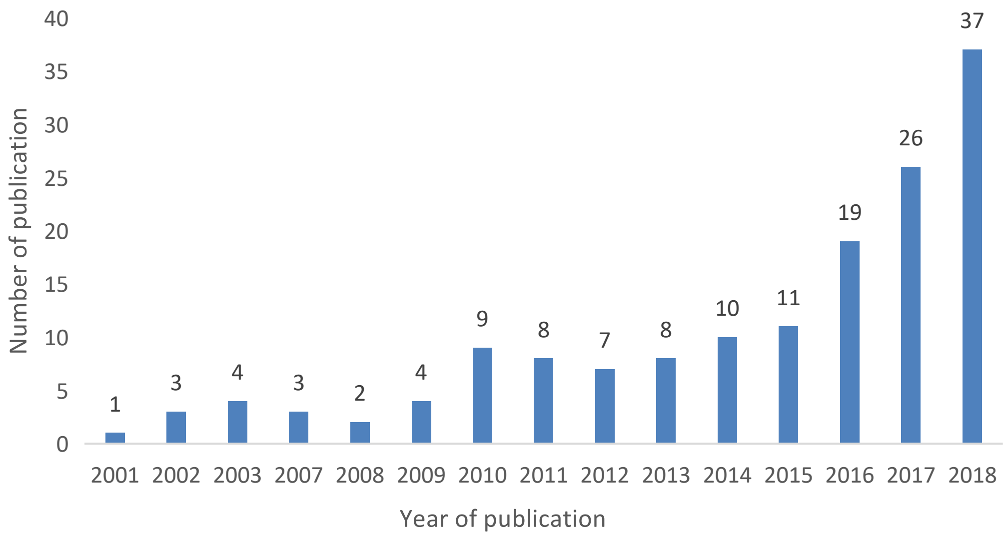

Figure 3. Yearly publications from 2001 to 2018.

4.2. Descriptive Statistics of the Reviewed Literature

4.2.1. The Cross-Journal Publication Distribution Experiment

The results of the cross-journal publication distribution experiment can reflect the contributions of each journal to the PCSCM field to some extent. Under the selection criteria of the minimum publication quantity and citations of 3 and 10 articles respectively, the top 10 of 38 journals included in our literature review portfolio are shown in Figure 4. The node size and font size of the journal name increase with the number of publications published in the journal. The lighter the color, the closer the year of the article published. The thickness of the link between nodes indicates the frequency of references between two journals.

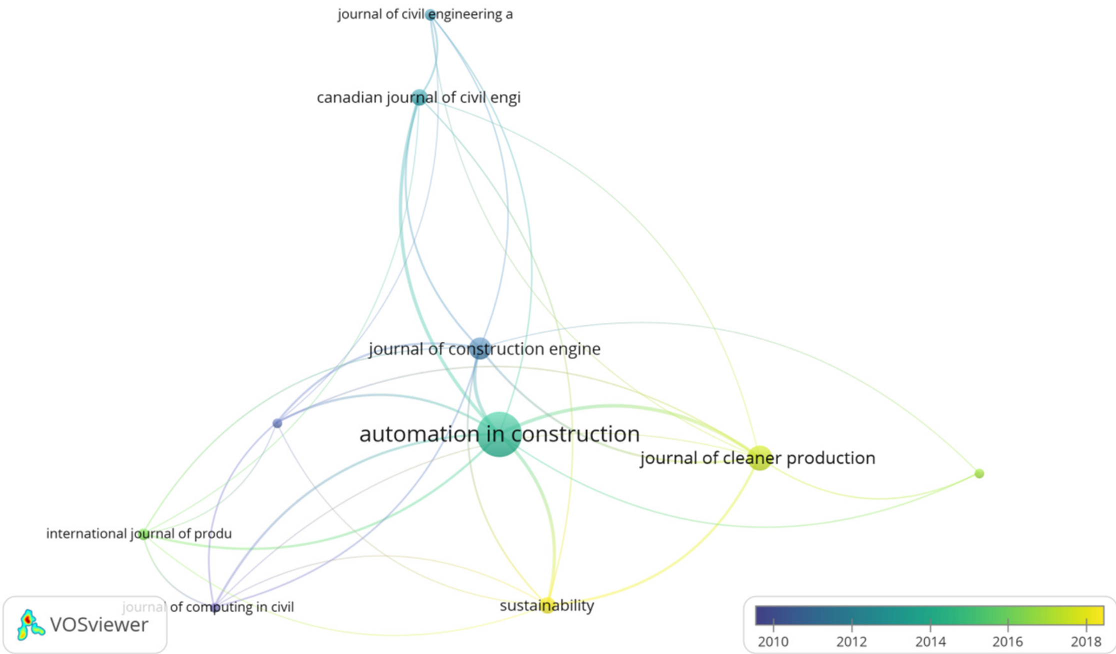

Figure 4. Publication Distribution across Journals in PCSCM.

Table 3 details the total link strength, number of articles, total citations, average publication years, average citations and average normalized citations. The first three of them are usually highly correlated, and are used as quantitative indicators to measure the productivity of journals. Average citations and average normalized citations are taken as qualitative indicators to measure the impact of the journal. In terms of the publications number, Automation in Construction, Journal of Construction Engineering and Management, Journal of Cleaner Production, and Sustainability are the top four Journals. It also can be found that the most influential journal is Automation in Construction in the field due to its high average of normalized citations.

Table 3. Analysis of sources publishing PCSCM research.

Source	Total Link Strength	Number of Articles	Total Citations	Avg. Pub. Year	Avg. Citations	Avg. Norm. Citations
Automat. Constr.	70	26	462	2014	18	1.28
J. Constr. Eng. M. ASCE	37	8	141	2011	18	0.72
Cleaner Prod.	31	10	78	2017	8	2.22
Sustainability	25	6	10	2017	1	0.72
Can. J. Civ. Eng.	24	6	33	2013	7	0.44
Expert Syst. Appl.	19	4	39	2011	20	1.01
J. Comput. Civ. Eng.	16	4	31	2010	16	1.25
Int. J. Prod. Res.	13	3	11	2016	4	0.59
J. Civ. Eng. M.	10	3	24	2012	8	0.51
KSCE J. Civ. Eng.	5	3	21	2018	11	0.99

It can be found that as a cross-disciplinary subject, PCSCM's influential journals mostly belong to management field (e.g., engineering management and environmental management), while civil engineering field pays little attention to this topic [42]. The research on SCM based on the characteristics of civil engineering should be strengthened later.

4.2.2. Citation of Articles

According to the citation statistics of SCOPUS database, the top ten papers are shown in Table 4 with citation number ranges from 36 to 103. Specifically, the top three of citations are [32,43] and [44], which are cited 103, 58, and 54 times respectively.

Table 4. List of the most influential publications in PCSCM.

Author	Title	Year	Citations
Ergen & Akinci [32]	Tracking and locating components in a precast storage yard utilizing radio frequency identification technology and gps	2007	103
Yin et al. [43]	Developing a precast production management system using rfid technology	2009	58
Chen et al. [44]	Decision support for construction method selection in concrete buildings: prefabrication adoption and optimization	2010	54
Bankvall et al. [45]	Interdependence in supply chains and projects in construction	2010	50
Ergen et al. [46]	Life-cycle data management of engineered-to-order components using radio frequency identification	2007	49
Pan et al. [47]	Strategies for Integrating the Use of Off-Site Production Technologies in House Building	2012	44
Jaillon & Poon [48]	Life cycle design and prefabrication in buildings: a review and case studies in hong kong	2014	43
Pheng et al. [49]	Just-in-time management of precast concrete components	2001	42
Chan et al. [50]	Constraint programming approach to-precast production scheduling	2002	40
Leu et al. [51]	GA-based resource-constrained flow-shop scheduling model for mixed precast production	2002	36

Ergen and Akinci (2007) [32] innovatively integrated RFID into PCSCM, effectively avoiding construction delay and labor cost increase caused by repeated processing, parts dislocation and incorrect installation. Yin et al. (2009) [43] built a precast production management system combined Personal Digital Assistant (PDA) and RFID, which solved the difficulties of data storage and record audit, avoided repeated data entry and facilitated immediate feedback. Chen et al. (2010) [44] proposed a transparent construction method selection model (CMSM) to assist scientific prefabrication decisions.

The three papers all focus on the combination of modern information technology (e.g., RFID, PDA) and PCSCM, so as to achieve the purpose of reducing cost, shortening construction period and improving work efficiency. It shows that the application of advanced information technology and supply chain efficiency are the focus of PCSCM.

4.2.3. Keywords Co-Occurrence Experiment

Keywords reflect not only the core themes of the literature, but also the main content of a particular field [18]. So, through the keyword co-occurrence experiment, the focus of current PSCSM field can be found. There are two kinds of keywords in VOS Viewer: (i) the initial keywords provided by the author, and (ii) added keywords based on journal, title, abstract and other data. The frequency of co-occurrence of two keywords is taken as the link strength between them [52]. Among the 536 keywords in all literatures, 61 met the setting condition of the minimum link strength of 3. Then, combine the synonyms, such as "BIM" and "building information modeling", and omit general terms such as "prefabrication", "supply chain" and "management". Finally, PCSCM research topic relational network is generated as shown in Figure 5, which contains 24 nodes and 132 links.

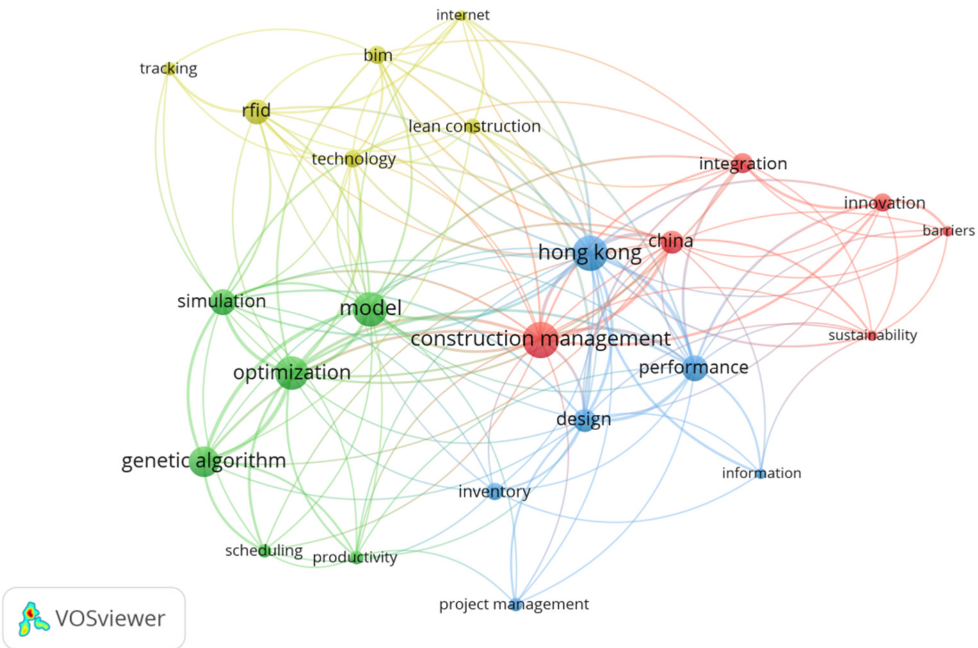

Figure 5. PCSCM research topic relationship network based on keywords co-occurrence experiment.

Based on the frequency and co-occurrence probability of keywords, the 24 keywords shown were further divided into clusters with different node colors by VOS Viewer, which has been practiced in many literatures [18]. For example, as shown in Figure 5, yellow node cluster includes RFID, BIM and technology, etc. Keyword co-occurrence analysis is only to obtain the general topic and classification of PCSCM. Whether the topic matches the literature it includes is further modified after the authors browse the full text, as shown in Table 5. By browsing the full text of literature within each cluster, adjusting the inaccurate and inappropriate classification, extracting the keyword commonality of each classification, and naming the cluster as:

(1) Strategic research and overall design (red nodes): focus on the integrated management and sustainability performance evaluation of the whole process of PC management. Much of the research is based on the China case.
(2) PC supply chain process design and optimization (green nodes): focus on the modeling and simulation [53] of the four main parts of PCSCM: ordering [54], manufacturing [55], transportation and installation [56]. Genetic algorithm is the most commonly used algorithm.
(3) Supply chain integration and management (blue nodes): focus on the internal integration and external integration. The former aims to improve the interests of all stakeholders, while the latter focuses on the cooperation and communication [57]. Much of the research is based on the Hong Kong case.
(4) Application of advanced technology (yellow nodes): focus on adopting advanced technologies, including BIM, RFID, and lean, etc., to solve highly decentralized PCSCM problems [58] and optimize the efficiency of the supply chain [59].

Table 5 further summarizes the quantitative measurement of keywords. Construction management, optimization, and performance have the highest link strength, reflecting the overall focus of the study. The number of keyword occurrence is similar to the ranking of link strength. According to the average publication year, BIM, internet, information, and sustainability seem to be emerging keywords, which shows the importance and necessity of the application of advanced technology and sustainability. In contrast, although there are many researches on the design and optimization of PCSCM route based on genetic algorithm, the popularity of it has decreased significantly. Tracking, BIM, and RFID show prominent performance in the average normalized citations index, which further shows the degree of attention of advanced technology applications in PCSCM. A detailed thematic discussion is given in Section 6.

Table 5. Summaries of most frequently studied keywords in PCSCM.

Category	Keyword	Link Strength	Occurrences	Avg. Pub. Year	Avg. Citations	Avg. Norm. Citations
Strategic management	Construction Management	43	21	2014	19	1.06
	Barriers	9	3	2017	8	0.86
	Integration	19	8	2015	10	0.49
	Sustainability	11	3	2018	1	1.21
	China	28	10	2017	11	1.19
	Innovation	17	7	2015	14	1.02
Route design and optimization in PCSCM	Model	32	19	2016	10	1.39
	Simulation	27	12	2014	9	1.06
	Optimization	43	18	2016	6	0.9
	Genetic algorithm	29	16	2013	11	0.87
	Scheduling	12	4	2010	16	0.7
	Productivity	12	4	2011	15	0.69
Supply chain integration and management	Project Management	7	4	2016	9	0.89
	Design	32	10	2015	9	0.81
	Inventory	10	6	2014	5	0.46
	Information	9	3	2018	2	0.69
	Hong Kong	40	20	2017	10	1.25
	Performance	37	12	2016	7	0.73
Application of advanced technology	Lean construction	14	5	2017	3	0.51
	RFID	20	11	2013	24	1.24
	Technology	19	6	2017	3	1.08
	BIM	18	7	2017	8	1.46
	Internet	12	3	2018	2	0.79
	Tracking	7	4	2013	30	2.26

5. Thematic Discussion

Based on the results of scientometrics analysis, we further divided the four important directions of current research (Table 5) into the management and technical levels shown in Figure 6 for discussion. Obviously, the management level includes (1) strategic research and overall design, and (2) supply chain integration and management, while the technical level includes (3) supply chain process design and optimization, and (4) the application of advanced technology. Then, according to the convention, this study proposed the research gap and the future research direction. Finally, an innovative and reasonable framework was constructed to promote the development of PCSCM.

At the management level, it is necessary to clarify the obstacles and driving factors of all enterprises in the SC, and then optimize their cooperation mode and information exchange mode, so as to promote the implementation of the SC from the perspective of overall benefit maximization. In implementation level, under the guidance of the management philosophy of overall benefit maximization, all enterprises optimize the supply chain process through the application of advanced technologies to achieve economic and sustainable goals. In general, the optimization of management is the basis for the optimization of implementation, and the optimization of implementation is the driving force for the optimization of management. Only if the two develop together can PCSCM be efficient and sustainable

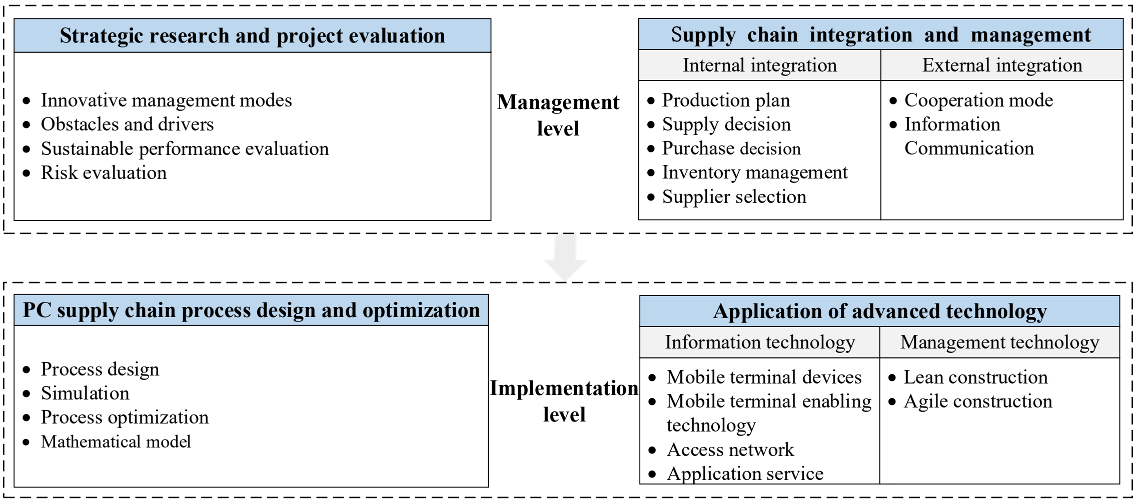

Figure 6. Research topics in PCSCM.

5.1. Strategic Research and Project Evaluation

In general, the development of PC is still a long way from large-scale application [25]. Regional industrial layout and enterprise level strategic research still cannot meet the needs of market development [60]. Although as the main body of the project management the enterprises or projects are aware of the importance of supply chain management, and most of the innovative management modes developed were still centered on the construction and installation management on the site, instead of substantially extending to the whole supply chain [61]. Market awareness and the acceptance of PC is still insufficient [62]. The market almost passively accepts the government's policy regulation and has not been able to actively participate in the strategic planning of PCSCM development [63]. The research level also focuses on three core issues in the process of promoting the development of PCSCM and market cognition: obstacles and drivers, sustainable performance evaluation, and risk evaluation.

5.1.1. Obstacles and Drivers

Compared with conventional techniques, cost is the main obstacle to the adoption of PC, which is reflected in every link of the supply chain, including the cost increase caused by the long decision-making time of the supply chain [24]. In addition, the lack of understanding of PCSCM [64] and complicated implementation processes [65] are also important factors hindering the advancement of PC [66]. Definitely, PCSCM is driven by many obvious factors, such as sustainable competitive advantage [67] and favorable policy environment [68], technological innovation [14], and diversified market demand [69].

5.1.2. Sustainable Performance Evaluation

Sustainable performance evaluation mainly includes environmental performance, economic performance, and social performance [70]. In terms of economic performance, the implementation of effective supply chain management on prefabricated projects can increase enterprise profits by nearly 40% [71]. For environmental performance, PC itself has better life cycle performance in energy performance [72]. Effective integration of PCSCM has more significant social effects, such as reducing labor consumption and energy conservation. In a word, the considerable sustainable performance of PCSCM is the main reason why it is favored by the government and the market.

5.1.3. Risk Evaluation

Risks in the whole PCSCM are diverse, dynamic, uncertain, and interactive [73]. Due to the complexity of the supply process, schedule risk is recognized as the most important and should be strictly controlled [74]). It is also necessary to emphasize the importance of information interoperability between resource planning systems of different supply chain bodies [75]. One of the most common risk factors is late delivery due to inconsistent logistics information caused by human error [76]. Successful supply chain strategic research and project evaluation contribute to stakeholders grasping market opportunities and challenges, reducing total cost, improving construction efficiency, seizing the construction market, and further winning development.

5.2. Supply Chain Integration and Management

Supply chain integration and management includes external integration and internal integration, as shown in Figure 7. External integration of supply chain management ensures real-time information exchange among all participants by looking for effective cross-organization cooperation mode, and realizes the sharing of market demand, inventory status, production plan, demand forecast and delivery plan. The advantages of external integration of supply chains have been widely proven in the manufacturing and logistics industries, which promotes sustainable economic development by strengthening cooperation among enterprises. For PCSCM, no matter in research or practice, enterprises are still trying to improve their own interests through internal integration [77], but ignore the overall interests of the supply chain.

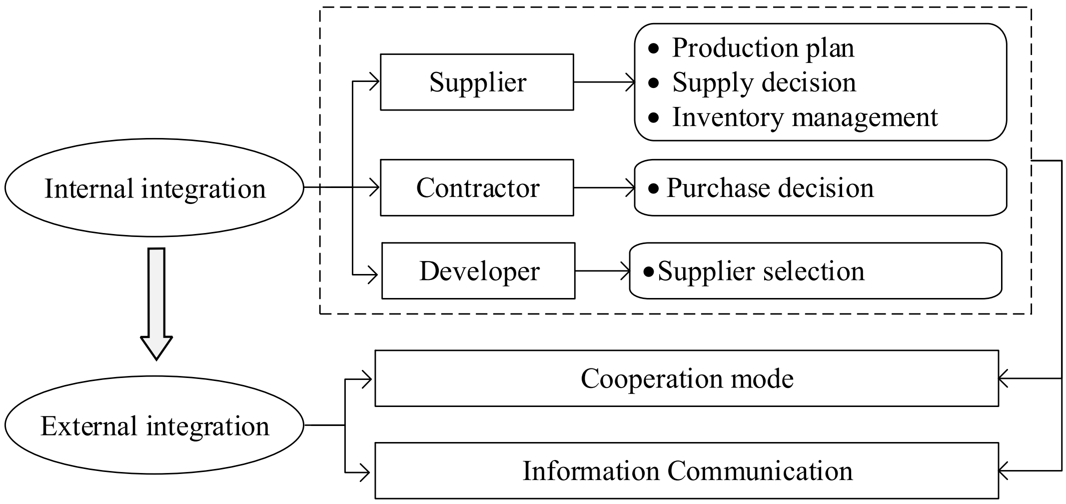

Figure 7. Research framework of supply chain integration.

5.2.1. Internal Integration

Supply chain participants improve construction profit through self-integration within the enterprise [78]. Production plan [79], purchasing decision [80], and supplier selection [81] are the core issues of internal integration. Operations research is the main research method to deal with the complexity of internal integrated management decision-making, accounting for about 70% of the research methods in this part of the literature [82]. Among them, the traditional multi-objective optimization algorithm (e.g., constraint programming) accounts for 15% of the research methods, and the multi-objective genetic algorithm accounts for 45%. It can be seen that multi-objective genetic algorithm is the main research method in this field. It is necessary for the supplier to develop an appropriate inventory management plan of prefabricated components for the delivery requirements of multiple contractors [83]. In contrast, contractor procurement decision-making includes multi-component coordination and supplier relationship management [84]. Supplier selection affects the performance of PCSCM, and its evaluation criteria include procurement process, operational efficiency, relationship coordination, and strategic adjustment [85].

5.2.2. External Integration

External integration focuses on supply chain cooperation mode and information communication. The main purpose of the research on cooperation mode is mainly to design reasonable models of cost sharing [86], risk [87] and benefit distribution [88]. Game theory is an effective theory for dynamic analysis of supply chain participants' cooperation and competition behavior, accounting for 60% of the research methods of cooperation mode module, including evolutionary game [89], comprehensive game, differential game [90] and so on. For example, [91] explored the factors influencing the formation and disintegration of a cooperative network. Information communication mainly uses advanced information technology to realize real-time communication, so as to reduce delay and waste and create the greatest common interests [92]. Supply chain integration ensures that all participants in the supply chain can transmit and obtain information in a timely manner, so as to better help each participant in the prefabricated construction achieve their profit objective, to achieve sustainable economic development.

5.3. Supply Chain Process Design and Optimization

PCSC is very different from traditional SC. PCSC is customized, and the total number of components matches the requirements of construction site, so there is no need to keep safety inventory [93]. The PC supply chain process design consists of four stages: ordering, manufacturing, transportation and assembly, as is shown in Figure 8. Simulation is mostly used in the process design to evaluate its effectiveness. The PC supply chain process optimization with time or cost as its objective is developing towards multi-objective optimization [94].

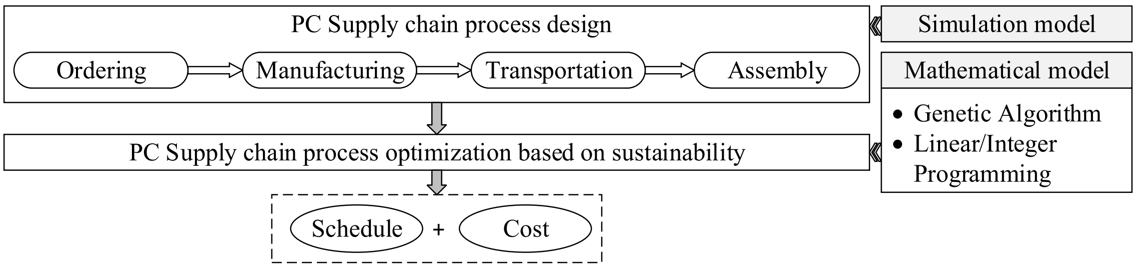

Figure 8. Research framework of process design and optimization.

5.3.1. PC Supply Chain Process Design Based on Simulation.

Dynamic simulation of PCSC process could help participants to predict the profit level under different behavioral decisions, so as to make rational decisions [95]. Wang et al. (2018) [94] proposed a simulation model for disturbance assessment to evaluate the uncertainty of PCSCM, which can prevent various disturbances in time and improve profits. In addition, simulation can effectively improve the professional quality of practitioners and their understanding of PCSC concepts and knowledge [96].

5.3.2. PC Supply Chain Process Optimization Based on Sustainability

The optimization method of PCSC has developed from traditional technology (e.g. linear programming and integer programming) [88] to modern technology (e.g., genetic algorithm, ant colony optimization and particle swarm optimization) [97]. Similarly, the optimization objective is gradually shifted from the traditional single objective, such as progress, to multi-objective optimization [98]. Among optimization goals, construction schedule is considered to be primary. Timely delivery of prefabricated components is the main bottleneck restricting project productivity. Delays may result in prolonged construction cycles and higher labour costs. But early delivery can also lead to additional storage costs and wasted space [99]. Based on the cost target, resource constraints such as molds [100], workers, inventory [101], and workspace [102] were integrated into the model to develop the production scheduling scheme with the lowest production cost. Supply chain process design and optimization is the best way to improve the production efficiency and competitiveness and realize cost control for assembly construction suppliers and contractors. It should be noted that most of the current research belongs to the normative research, which is accounting for 70%, and the application of empirical analysis method and hybrid method needs to be further strengthened.

5.4. Application of Advanced Technology

The application of advanced technology runs through the whole process of PCSC, including information technology and management technology, which is presented in Figure 9. Management technology could reduce waste and improve efficiency to achieve optimal allocation of resources [70]. Information technology enables the real-time tracking and positioning of precast components and real-time communication between participants [82].

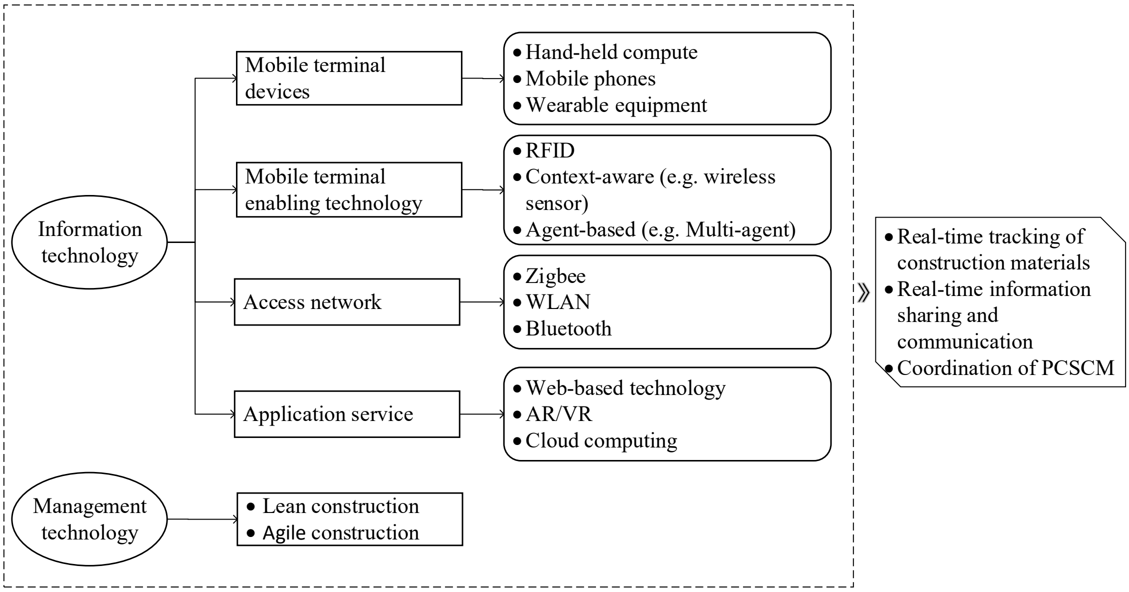

Figure 9. Research framework of advanced technology.

5.4.1. Management Technology

Management technology mainly includes lean construction and agile construction. Wet construction in the traditional construction industry limits the promotion of lean construction [103]. However, lean construction is valued and promoted in PC because of the standardized design, factory-based parts and integrated information. The advantage of lean construction is that its strict production plan and process can effectively reduce waste and constantly improve the PC supply chain [104]. Agile principles are an important complement to lean concepts in PCSCM. The lean principle applies to stable conditions (stable requirements of quantity), while the PC is characterized by uncertainty (e.g. changes in demand) [105]. Therefore, it is necessary to supplement agile principles to reduce these uncertainties [106].

5.4.2. Information Technology

Information technology applied in PCSCM can be divided into the following four categories: mobile terminal devices (PDA, mobile phones, wearable equipment), mobile terminal enabling technology (RFID, GPS), access network (WLAN, Zigbee) and application service (AR/VR, cloud computing) [107]. The purpose of applying information technology is to promote the real-time acquisition and sharing of information among different stakeholders of PCSCM and reduce human error [108]. One research focus is the real-time tracking of prefabricated components or materials in the whole supply chain. For example, BIM and RFID-based prefabricated component management system can actively and accurately facilitate the collection and transmission of information related to material storage and use, so as to timely adjust production objectives and plans [32]. The RANSAC model, an RFID-based optimal management system, can quickly and automatically screen a large amount of RFID data to obtain effective information [109], and provide the data to mobile terminal equipment (e.g., PDA) or mobile terminal enabling technology (e.g., GPS), so as to strengthen quality control and improve supply chain efficiency [43]. Another type of research focuses on rapid communication in supply chains. Such as, the 3D dynamic interaction model of mobile client based on virtual reality can promote the information exchange of the whole supply chain [110]. Cloud computing and BIM provide solutions for data sharing among the architecture, engineering, and construction (AEC) industries, which further reduces supply chain costs [111] and time [112]. Applying advanced technology to collect and process large amounts of data quickly and accurately can effectively reduce manpower and material resources, thus improving the quality, efficiency, and management level of prefabrication construction.

5.5. Research Gap and Future Research Direction

5.5.1. Collaborative PCSCM with Advanced Technology

Many advanced technologies have been applied in PCSCM, but they are still low-level applications. Fast and accurate processing of massive data in PCSCM, especially rich tacit knowledge and knowledge sharing of supply chain, achieving multi-technology integration and collaboration with the whole process of PCSCM, could effectively promote the reduction of cost and schedule of prefabricated construction. Big data and cloud computing, which are increasingly used in manufacturing SCM, may provide more efficient support for the construction industry supply chain management's timely interaction with and tracking of prefabricated components.

5.5.2. Sustainable Cooperative Mode of PCSCM

The cooperation mode of supply chain and the contract system are the core problems of PCSCM. They reflect the complexity of supply chain marketing and construction contracts. Theoretical research and application are limited to the analysis of risk sharing model and other local relations [98]. Distributable benefits in the supply chain are not just profits. A benefit sharing model or contract terms should also adapt to the complex prefabricated construction supply chain environment and cooperation model, rather than adopt a certain paradigm. Therefore, an important research direction is to develop sustainable innovative PCSCM cooperation mode to optimize the costs, risks and benefits of each participant. Ultimately, win–win cooperation will be achieved.

5.5.3. Introducing Third-Party Logistics into PCSC

Third party logistics (TPL) refers to the contractor employ logistics professionals to manage all logistics activities. The employment of TPL helps to centralize the control and management of prefabricated components from multiple suppliers and avoid the inconsistencies caused by the producer's separate responsibility for the transportation of their own products. But this will bring about a redistribution of responsibility and new coordination management problems. Integrating TPL into PCSCM can optimize delivery time and production cost. This creates a logistics management platform that allows suppliers and contractors to share information, thereby avoiding uncertainty and reducing operating and total supply costs. The application of TPL may be a new development direction in the outsourcing of PC, which is conducive to the improvement of efficiency and sustainability from the perspective of PCSCM.

5.5.4. Multi-Level Strategy Research based on Market Characteristics

The development of technology cannot be separated from the market characteristics and industrial level of the region. Most of the current studies take China and Hong Kong as the empirical background. It is obvious that more extensive research in more regions will contribute to the promotion and theoretical development of PCSCM. Supply chain optimization and industrial integration depend on the interaction of governments, contractors, suppliers and carriers. Internal integration and optimization of each independent level is the premise. In addition, compared with supply chain management of manufacturing industry, PCSCM has unique construction technology and market environment. Based on this, the conceptual development framework of PCSCM is presented in Figure 10.

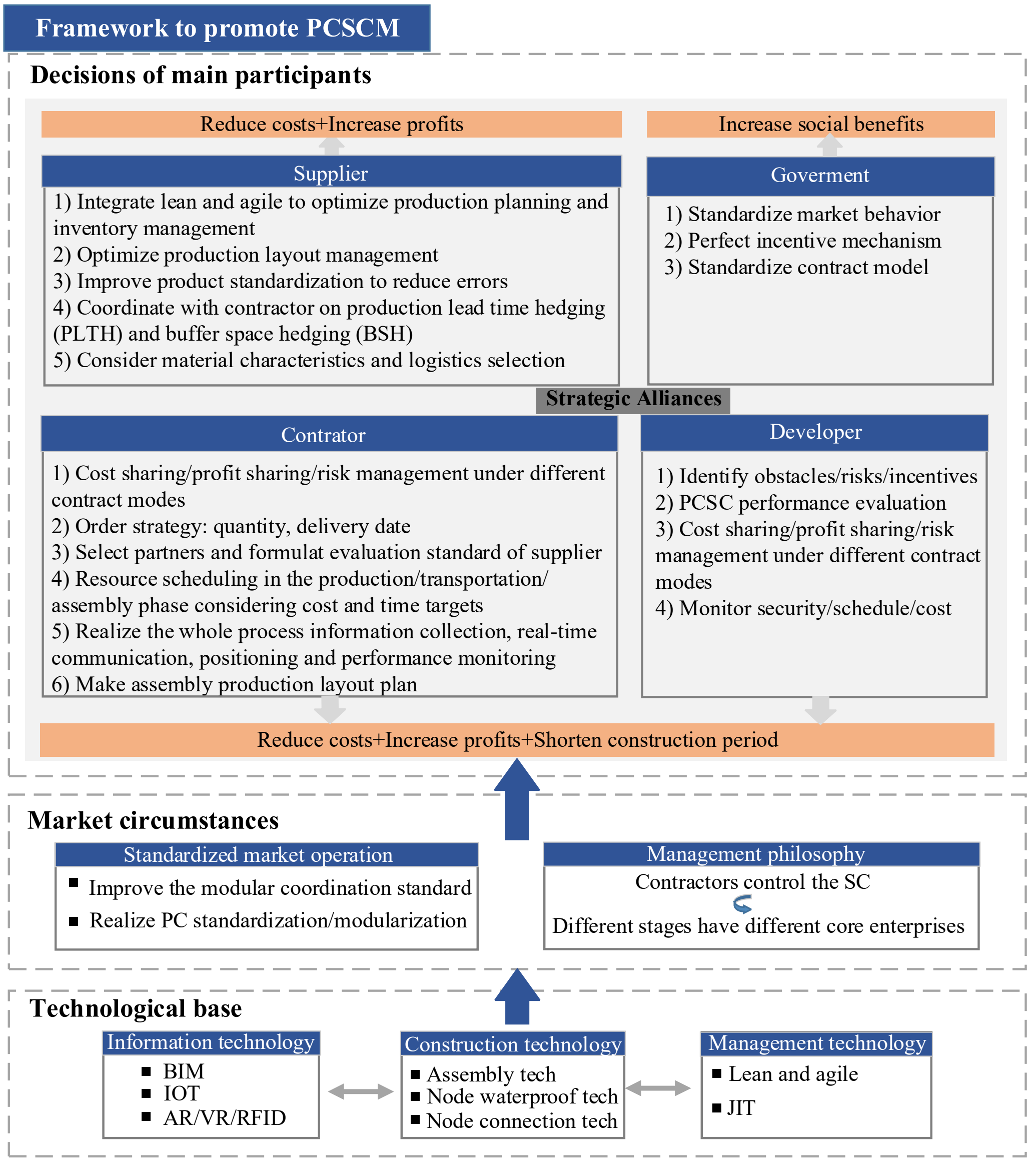

Figure 10. A conceptual development framework for PCSCM

5.6. *A Conceptual Development Framework for PCSCM*

The conceptual development framework to facilitate PCSCM implementation consists of three parts: technology base, market circumstances, and decisions of main participants, as shown in Figure 10. Strengthening the practical application of technology and standardization of market environment is the basis to promote the implementation of PCSCM. The decision optimization of participants based on the integration of industrial chain can further optimize the PCSC efficiency.

Technology base. Technology, including management technology, information technology, and construction technology, is the basis to promote PCSCM. At present, the joint waterproof, joint connection and other construction technologies have developed more perfect. Combining lean and agile management methods to create a flexible supply chain at minimal cost and to adapt to the diversity of contractor needs is the focus of further research. BIM, RFID, and other information technologies have been widely used in PCSCM, but how to process a large amount of data quickly and accurately is one of the current problems.

Market circumstances. Favorable market circumstances can further promote the implementation of PCSCM and achieve sustainable development. The first is the standardized operation of the market, including clarifying the standard system of the key links of PCSC and realizing PC standardization and modularization. It is necessary to establish the codes and standards for the design, production, construction and acceptance of prefabricated buildings. In addition, the implementation of generalization, standardization, and modularization has become a consensus. Standardization is the symbol of industrialization level. Only with high standardization level can mass production be realized, and mass production is also the main means to reduce the cost of prefabricated construction. The second is the change of management philosophy. PCSCM is transformed from being dominated by the contractor to having different core enterprises in different stages. The traditional construction supply chain is a satellite enterprise group with contractors as the core. However, for prefabricated buildings, the schedule and cost are largely limited by the production and transportation stages, thus forming a group of enterprises with relatively balanced rights.

Decisions of main participants. PCSC involves many participants, such as contractors, suppliers, developers, governments, etc. Different participants must have different goals and conflicts of interest. Major participants should make decisions based on the concept of win-win cooperation and sustainable development. After integrating the responsibilities of all parties, two aspects are obtained: optimization of production process design and optimization of contract system. In terms of production process design, suppliers need to integrate lean and agile concepts, optimize production planning, inventory management, and coordinate production lead time hedging (PLTH). The contractor needs to consider factors, such as the delivery time and volume of prefabricated components, to develop a reasonable production layout plan. A whole-process resource scheduling scheme combining cost and time objectives need to be developed. Further, BIM and other information technologies needs to be combined to realize the real-time communication, information collection, performance monitoring and positioning functions. For the optimization of contract system, the optimal cost sharing, profit distribution and risk management measures under different contract modes are the further research direction. In addition, due to the strong positive externalities of PC, the government plays an indispensable role in the early stage. The government needs to formulate incentives such as subsidies and penalties, so as to guide enterprises to enter the PC market reasonably and form a good construction market operation mechanism.

Only through the coordinated development of technology, market circumstances and decision-making level of participants, can the PCSC form an integrated whole, so as to optimize the efficiency and sustainability of the PC industry and improve its level.

6. Conclusions

PC supports urban economy and sustainable development, and it is a new trend for the construction industry to cope with environmental pollution and the severe shortage of social resources. At present, PCSCM has become a critical factor restricting the popularization and development of PC. The present situation, trend and gap of PCSCM research were reviewed in this paper, and further puts forward the research framework to promote the development of PCSCM. Retrieval databases include Elsevier, Emerald, Scopus, WOS, and EBSCO. From 516 records, the author screened out 152 records which were closely related to PCSCM.

First of all, the bibliometric software was used to analyse the cross-journal publication distribution, article citation and keyword co-occurrence of the included literature. The author further browsed the whole paper of all the reviewed literature, optimized the keyword clustering results, and separated the research topics reasonably.

Then, the research topics included strategic research and project evaluation, PC supply chain process design and optimization, supply chain integration and management, and application of advanced technology. A series of themes, including collaborative PCSCM with advanced technology, cooperative mode of PCSCM, introducing third-party logistics into PCSC, and multi-level strategy research based on market characteristics, were proposed to improve the research of PCSCM.

At last, a PCSCM implementation framework was constructed. This framework set out the recommendations to promote the development of PCSC from three levels of technology base, market conditions, and decisions of main participants, respectively, so as to achieve the purpose of reducing the prefabricated construction cost, shortening the schedule, and improving the efficiency and sustainability. The findings contribute to the acquisition of academic knowledge, research frontiers, and emerging trends about PCSCM research, help solve the problems and difficulties faced by PC, and further facilitate PC to develop into an environmentally friendly and economically sustainable construction mode. Future research could complement the literature by adopting the other theoretical lens (e.g., the theory of swift and even flow). The uses of different theoretical lenses would complement and provide a more complete map of PCSCM.

However, there is a problem that the collected literature may not be complete. First, while we believe that the right keywords have been selected to achieve our goals, they may be improved in the future to search articles more comprehensively. Second, the collected literatures do not include non-English books, reports, manuscripts, etc. Existing literature can effectively summarize the research status, so the summary of the research trend and the proposal of the framework are relatively accurate.

Author Contributions: The review was performed and written by Y.L.; J.D. and L.S. contributed by guiding the review work, discussing ideas, and supervising the writing of this paper. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding

Appendix A

Table A1. List of papers included in the review along with their research topic

No.	Author (year)	Journal	Volume (issue), Page	Research Topic
1	Chang et al. (2018)	Resources Conservation and Recycling	139, 259–261	Strategic research and overall design
2	Liu et al. (2018)	Sustainability	10(9), 3046	Strategic research and overall design
3	Finnie et al. (2018)	Proceedings of the Institution of Civil Engineers - Management Procurement and Law	171(4) 176–185	Strategic research and overall design
4	Dallasega et al. (2018)	Buildings	8(3), 38	Strategic research and overall design
5	Hosseini et al. (2018)	Automation in Construction	87, 235–247	Strategic research and overall design
6	Li et al. (2018)	Journal of Management in Engineering	34(2), 4017053	Strategic research and overall design
7	Sahin et al. (2018)	International Journal of Construction Management	18(1), 34–52	Strategic research and overall design
8	Arashpour et al. (2018)	Automation in Construction	84, 146–153	Strategic research and overall design
9	Viana et al. (2017)	Energies	10(10), 1622	Strategic research and overall design
10	Li et al. (2017)	Journal of Cleaner Production	153, 692–706	Strategic research and overall design

Table A1. *Cont.*

No.	Author (year)	Journal	Volume (issue), Page	Research Topic
11	London and Pablo (2017)	Construction Management and Economics	35(8, 553–577	Strategic research and overall design
12	Ismail (2017)	Industrial Management & Data Systems	117(7), 1485–1502	Strategic research and overall design
13	Goh and Loosemore (2016)	Construction Management and Economics	35(5), 288–304	Strategic research and overall design
14	Schoenwitz et al. (2017)	International Journal of Production Economics	183, 79–90	Strategic research and overall design
15	Ramaji and Memari (2017)	Journal of Construction Engineering and Management	142(10), 4016047	Strategic research and overall design
16	Mao et al. (2015)	Journal of Management in Engineering	31(3), 04014043	Strategic research and overall design
17	]Jaillon and Poon (2014)	Automation in Construction	39, 195–202	Strategic research and overall design
18	Wu and Feng (2013)	Architectural Science Review	57(2), 105–113	Strategic research and overall design
19	Zhang et al. (2014)	Habitat International	41, 176–184	Strategic research and overall design
20	Zhang et al. (2013)	Journal of Production Research	51(23-24), 6923–6949	Strategic research and overall design
21	Azman et al. (2014)	Journal of Civil Engineering and Management	19(Supplement_1), S131-S140	Strategic research and overall design
22	Da Rocha (2014)	Computers & Operations Research	9, 214–219	Strategic research and overall design
23	Chen et al. (2010)	Automation in Construction	19(6), 665–675	Strategic research and overall design
24	Hofman et al. (2009)	Building Research & Information	37(1), 31–42	Strategic research and overall design
25	Shi et al. (2018)	Sustainability, 10(4)	1260	Strategic research and overall design
26	Teng et al. (2017)	Journal of Cleaner Production	152, 387–398	Strategic research and overall design
27	Tam et al. (2015)	Journal of Cleaner Production	109, 216–231	Strategic research and overall design
28	Nguyen et al. (2018)	Computers & Operations Research	98, 254–264	Strategic research and overall design
29	Bankvall et al. (2010)	Supply Chain Management: An International Journal	15(5), 385–393	Strategic research and overall design
30	Vrijhoef et al. (2000)	European Journal of Purchasing and Supply Management	6(3), 169–178	Strategic research and overall design
31	Zhao (2017)	Automation in Construction	80, 37–47	Strategic research and overall design
32	Li et al. (2014)	Habitat International	43, 240–249	Strategic research and overall design
33	Mostafa et al. (2016)	Construction Innovation	16(4), 483–525	Strategic research and overall design
34	Boafo et al. (2016)	Sustainability	8(6), 558	Strategic research and overall design
35	Han and Wang (2016)	Journal of Civil Engineering and Management	24(5), 364-377	Strategic research and overall design
36	Höök and Stehn (2008)	Construction Management and Economics	26(10), 1091–1100	Strategic research and overall design
37	Kamali and Hewage (2016)	Renewable and Sustainable Energy Reviews	62, 1171–1183	Strategic research and overall design
38	Jin et al. (2018)	Journal of Cleaner Production	202, 1202–1219	Strategic research and overall design
39	Jaillon and Poon (2008)	Construction Management and Economics	26(9), 953–966	Strategic research and overall design
40	Jiang et al. (2018)	Sustainability	11(20), 5658	Strategic research and overall design

Table A1. *Cont.*

No.	Author (year)	Journal	Volume (issue), Page	Research Topic
41	Wang et al. (2018)	Sustainability	11(12), 3450	Strategic research and overall design
42	Jiang et al. (2018)	Sustainability	11(1), 42	Strategic research and overall design
43	Mao et al. (2017)	KSCE Journal of Civil Engineering	22(8), 2678–2690	Strategic research and overall design
44	Jiang et al. (2018)	Sustainability	10(7), 2516	Strategic research and overall design
45	Hong et al. (2018)	Journal of Cleaner Production	172, 649-660	Strategic research and overall design
46	Sacks et al. (2004)	Journal of Construction Engineering and Management	130(2), 206–215	Strategic research and overall design
47	Polat (2008)	Journal of Construction Engineering and Management	134(3), 169–178	Strategic research and overall design
48	Voordijk et al. (2006)	International Journal of Operations and Production Management	26(6), 600–618	Strategic research and overall design
49	Sertyesilisik (2014)	Optimization and Control Methods in Industrial Engineering and Construction	179–196	Strategic research and overall design
50	Zeng et al. (2018)	Sustainability	10(10), 3581	Strategic research and overall design
51	Akmam Syed Zakaria et al. (2018)	Architectural Engineering and Design Management	14(1–2), 27–45	Strategic research and overall design
52	Le et al. (2018)	International Journal of Construction Management	1–20	Strategic research and overall design
53	Aloini et al. (2012)	Business Process Management Journal	18(5), 735–761	Strategic research and overall design
54	Jaillon and Poon (2008)	Construction Management and Economics	26(9), 953–966	Strategic research and overall design
55	Yashiro (2014)	Construction Management and Economics	32(1–2), 16–39	Strategic research and overall design
56	Yang et al. (2018)	Mathematical Problems in Engineering	2018, 1–16	Supply chain integration and management
57	Zhai et al. (2018)	International Journal of Production Economics	200, 192–206	Supply chain integration and management
58	Wang et al. (2018)	Journal of Cleaner Production	177, 232–244	Supply chain integration and management
59	Xue et al. (2018)	Journal of Cleaner Production	184, 490–502	Supply chain integration and management
60	Wang et al. (2018)	Mathematical Problems in Engineering	2018, 1–5	Supply chain integration and management
61	Zhai et al. (2017)	International Journal of Production Research	55(14), 3984–4002	Supply chain integration and management
62	Han et al. (2017)	Sustainability	9(11), 2069	Supply chain integration and management
63	Chen et al. (2017)	Canadian Journal of Civil Engineering	44(6), 393–406	Supply chain integration and management
64	Feng et al. (2017)	Mathematical Problems in Engineering	2017, 1–6	Supply chain integration and management
65	Kim et al. (2016)	Canadian Journal of Civil Engineering	43(4), 287–293	Supply chain integration and management

Table A1. *Cont.*

No.	Author (year)	Journal	Volume (issue), Page	Research Topic
66	Demiralp et al. (2012)	Automation in Construction	24, 120–129	Supply chain integration and management
67	Hong et al. (2018)	Journal of Cleaner Production	172, 649–660	Supply chain integration and management
68	Albuquerque et al. (2012)	Automation in Construction	22, 348–356	Supply chain integration and management
69	Wang and Hu et al. (2018)	International Journal of Production Research	56(16), 5386–5401	Supply chain integration and management
70	Xue et al. (2018)	Sustainability	10(2), 159	Supply chain integration and management
71	Khalili and Chua (2014)	Journal of Construction Engineering and Management	140(2), 04013052	Supply chain integration and management
72	Sutrisna and Goulding (2018)	Construction and Architectural Management	26(2), 267–284	Supply chain integration and management
73	Goulding et al. (2014)	Architectural Engineering and Design Management	11(3), 163–184	Supply chain integration and management
74	Eshtehardian et al. (2013)	KSCE Journal of Civil Engineering	17(2), 262–270	Supply chain integration and management
75	Wong et al. (2010)	Journal of Construction Engineering and Management	136(10),1116–1128	Supply chain integration and management
76	Purvis et al. (2014)	International Journal of Production Economics	151, 100–111	Supply chain integration and management
77	Horta et al. (2013)	Journal of Construction Engineering and Management	139(8), 910–917	Supply chain integration and management
78	Pero et al. (2015)	International Journal of Production Economics	170, 602–615	Supply chain integration and management
79	Tennant and Fernie (2013)	Construction and Architectural Management	20(1), 83–98	Supply chain integration and management
80	Briscoe and Dainty (2005)	Supply Chain Management: An International Journal	10(4), 319–326	Supply chain integration and management
81	Dawood, N., & Marasini, R. (2003).	Automation in Construction	12(2), 113–122	Supply chain integration and management
82	Dainty (2001)	Supply Chain Management: An International Journal	6(4), 163–173	Supply chain integration and management
83	Cagliano et al. (2006)	International Journal of Operations & Production Management	26(3), 282–299	Supply chain integration and management
84	Power (2005)	Supply Chain Management: An International Journal	10(4), 252–263	Supply chain integration and management
85	Doran and Giannakis (2011)	Supply Chain Management: An International Journal	16(4), 260–270	Supply chain integration and management

Table A1. *Cont.*

No.	Author (year)	Journal	Volume (issue), Page	Research Topic
86	Huuhka et al. (2015)	Resources Conservation and Recycling	101, 105–121	Supply chain integration and management
87	Lee et al. (2014)	KSCE Journal of Civil Engineering	18(5), 1528–1538	Supply chain integration and management
88	Ko et al. (2015)	Making formwork construction lean. Journal of Civil Engineering and Management	21(4), 444–458	Supply chain integration and management
89	Li et al. (2016)	Schedule risks in prefabrication housing production in Hong Kong: a social network analysis. Journal of Cleaner Production	134, 482–494	Supply chain process design and optimization
90	Li et al. (2010)	Expert Systems with Applications	37(12), 8406–8416	Supply chain process design and optimization
91	Ma et al. (2018)	Optimized rescheduling of multiple production lines for flowshop production of reinforced precast concrete components. Automation in Construction	95, 86–97	Supply chain process design and optimization
92	Hsu et al. (2018)	Automation in Construction	94, 47–61	Supply chain process design and optimization
93	Kong et al. (2018)	Journal of Cleaner Production	193, 684–701	Supply chain process design and optimization
94	Arashpour et al. (2015)	Automation in Construction	50, 72–80	Supply chain process design and optimization
95	Chang and Hu (2002)	Journal of Construction Engineering and Management	128(6), 513–521	Supply chain process design and optimization
96	Wang et al. (2018)	Automation in Construction	86, 69–80	Supply chain process design and optimization
97	Kong et al. (2017)	Automation in Construction	81, 34–43	Supply chain process design and optimization
98	Wang et al. (2017)	Journal of Computing in Civil Engineering	31(4), 4017013	Supply chain process design and optimization
99	Yang et al. (2016)	Automation in Construction	72, 321–329	Supply chain process design and optimization
100	Anvari et al. (2016)	Automation in Construction	71, 226–241	Supply chain process design and optimization
101	Arashpour et al. (2016)	Automation in Construction	71, 262–270	Supply chain process design and optimization
102	Ahmadian et al. (2016)	Journal of Construction Engineering and Management	142(1), 4015050	Supply chain process design and optimization
103	Ko (2013)	Journal of Civil Engineering and Management,	19(3), 335–347	Supply chain process design and optimization
104	Hong et al. (2014)	Automation in Construction	41, 50–59	Supply chain process design and optimization
105	Ko and Wang (2011)	Expert Systems with Applications,	38(7), 8293–8302	Supply chain process design and optimization

Table A1. *Cont.*

No.	Author (year)	Journal	Volume (issue), Page	Research Topic
106	Pan et al. (2012)	Journal of Construction Engineering and Management	138(11), 1331–1340	Supply chain process design and optimization
107	Ko (2011)	Canadian Journal of Civil Engineering	38(2), 191–199	Supply chain process design and optimization
108	Ko (2010)	Journal of Civil Engineering and Management	16(3), 418-427	Supply chain process design and optimization
109	Im et al. (2009)	Canadian Journal of Civil Engineering	36(9), 1444–1458	Supply chain process design and optimization
110	Ko and Wang (2010)	Automation in Construction	19(7), 907–916	Supply chain process design and optimization
111	Chan and Hu (2002)	Journal of Construction Engineering and Management	128(6), 513–521	Supply chain process design and optimization
112	Chan and Hu (2002)	Journal of Computing in Civil Engineering	16(3), 165–174	Supply chain process design and optimization
113	Pheng and Chuan (2001)	Journal of Construction Engineering and Management	127(6), 494–501	Supply chain process design and optimization
114	Wang et al. (2018)	Journal of Construction Engineering and Management	144(11), 4018098	Supply chain process design and optimization
115	Leu et al. (2002)	Automation in Construction	11(4), 439–452	Supply chain process design and optimization
116	Moon et al. (2018)	KSCE Journal of Civil Engineering	22(10), 3697–3706	Supply chain process design and optimization
117	Lee et al. (2013)	KSCE Journal of Civil Engineering	17(4), 806–814	Supply chain process design and optimization
118	Ren et al. (2012)	Journal of Civil Engineering and Management	18(5), 642–654	Supply chain process design and optimization
119	Pan et al. (2012)	Construction Management and Economics	29(11), 1081–1099	Supply chain process design and optimization
120	Wan and Sidwell (2011)	Construction and Architectural Management	16(3), 208–223	Supply chain process design and optimization
121	Fang and Ng (2100)	Construction Innovation	11(3), 259–281	Supply chain process design and optimization
122	Wang et al. (2018)	Journal of Civil Engineering and Management,	24(2), 106–115	Supply chain process design and optimization
123	Luu et al. (2009)	International Journal of Project Management	27(1), 39–50	Supply chain process design and optimization
124	Cavaco et al. (2018)	Engineering Structures	156, 210–223	Supply chain process design and optimization
125	Ji et al. (2018)	Journal of Cleaner Production	173, 124–134	Supply chain process design and optimization

Table A1. *Cont.*

No.	Author (year)	Journal	Volume (issue), Page	Research Topic
126	Kim et al. (2016)	Journal of Civil Engineering and Management	22(5), 634–644	Supply chain process design and optimization
127	Vaghei et al. (2017)	Earthquake Engineering and Engineering Vibration	16(1), 97–117	Supply chain process design and optimization
128	Xu et al. (2018)	Automation in Construction	93, 123–134	Application of advanced technology
129	He et al. (2018)	Sustainability	10(8), 2613	Application of advanced technology
130	Li et al. (2018)	Automation in Construction	89, 146–161	Application of advanced technology
131	Altaf et al. (2018)	Automation in Construction	85, 369–383	Application of advanced technology
132	Chen et al. (2017)	International Journal of Computer Integrated Manufacturing	31(4), 349–361	Application of advanced technology
133	Li et al. (2017)	Journal of Cleaner Production	165, 1048–1062	Application of advanced technology
134	Wang et al. (2017)	Computer-Aided Civil and Infrastructure Engineering	32(6), 499–514	Application of advanced technology
135	Zhong et al. (2017)	Automation in Construction	76, 59–70	Application of advanced technology
136	Arashpour et al. (2015)	Automation in Construction	53, 13–21	Application of advanced technology
137	Ergen and Wakefield et al. (2008)	Journal of Construction Engineering and Management	134(2), 112–121	Application of advanced technology
138	Nasir et al. (20107)	Canadian Journal of Civil Engineering	37(4), 588–599	Application of advanced technology
139	Čuš-Babič et al. (2014)	Computers in Industry	65(2), 345–353	Application of advanced technology
140	Yin et al. (2009)	Automation in Construction	18(5), 677–691	Application of advanced technology
141	Ergen et al. (2007)	Automation in Construction	16(13), 354–367	Application of advanced technology
142	Shin et al. (2010)	Automation in Construction	20(5), 706–715	Application of advanced technology
143	Ergen et al. (2007)	Advanced Engineering Informatics	21(4), 356–366	Application of advanced technology
144	Xu et al. (2018)	Enterprise Information Systems	1–20	Application of advanced technology
145	Shi et al. (2016)	Automation in Construction	72, 143–154	Application of advanced technology

Table A1. *Cont.*

No.	Author (year)	Journal	Volume (issue), Page	Research Topic
146	Bilal et al. (2015)	International Journal of Sustainable Building Technology and Urban Development,	6(4), 211–228	Application of advanced technology
147	Irizarry et al. (2013)	Automation in Construction	31, 241–254	Application of advanced technology
148	Ahmadian et al. (2017)	EngineeringConstruction and Architectural Management	24(4), 668–695	Application of advanced technology
149	Tserng et al. (2005)	Computer-Aided Civil and Infrastructure Engineering	20(4), 242–264	Application of advanced technology
150	Zhong et al. (2015)	Ifac-Papersonline	48(3), 1079–1086	Application of advanced technology
151	Wang et al. (2007)	Advanced Engineering Informatics	21(4), 377–390	Application of advanced technology
152	Zare Mehrjerdi (2009)	Assembly Automation	29(2), 174–183	Application of advanced technology

References

1. Li, Z.; Shen, G.Q.; Xue, X. Critical review of the research on the management of prefabricated construction. *Habitat Int.* **2014**, *43*, 240–249. [CrossRef]
2. Mostafa, S.; Chileshe, N.; Abdelhamid, T. Lean and agile integration within offsite construction using discrete event simulation: A systematic literature review. *Constr. Innov.* **2016**, *16*, 483–525. [CrossRef]
3. Boafo, F.; Kim, J.; Kim, J. Performance of modular prefabricated architecture: Case study-based review and future pathways. *Sustainability* **2016**, *8*, 558. [CrossRef]
4. Han, Y.; Wang, L. Identifying barriers to off-site construction using grey DEMATEL approach: Case of China. *J. Civ. Eng. Manag.* **2018**, *24*, 364–377. [CrossRef]
5. Khalili, A.; Chua, D.K. Integrated Prefabrication Configuration and Component Grouping for Resource Optimization of Precast Production. *J. Constr. Eng. Manag.* **2014**, *140*, 04013052. [CrossRef]
6. Shin, T.; Chin, S.; Yoon, S.; Kwon, S. A service-oriented integrated information framework for RFID/WSN-based intelligent construction supply chain management. *Autom. Constr.* **2011**, *20*, 706–715. [CrossRef]
7. Zhang, X.; Skitmore, M.; Peng, Y. Exploring the challenges to industrialized residential building in China. *Habitat Int.* **2014**, *41*, 176–184. [CrossRef]
8. Zhai, Y.; Zhong, R.Y.; Huang, G.Q. Buffer space hedging and coordination in prefabricated construction supply chain management. *Int. J. Prod. Econ.* **2018**, *200*, 192–206. [CrossRef]
9. Wang, Z.; Hu, H.; Gong, J. Modeling worker competence to advance precast production scheduling optimization. *J. Constr. Eng. Manag.* **2018**, *144*, 4018098. [CrossRef]
10. Sutrisna, M.; Goulding, J. Managing information flow and design processes to reduce design risks in offsite construction projects. *Eng. Constr. Archit. Manag.* **2019**, *26*, 267–284. [CrossRef]
11. Goulding, J.S.; Pour Rahimian, F.; Arif, M.; Sharp, M.D. New offsite production and business models in construction: Priorities for the future research agenda. *Archit. Eng. Des. Manag.* **2014**, *11*, 163–184. [CrossRef]
12. Polat, G. Precast concrete systems in developing vs. industrialized countries. *J. Civ. Eng. Manag.* **2010**, *16*, 85–94. [CrossRef]
13. Han, Y.; Skibniewski, M.; Wang, L. A market equilibrium supply chain model for supporting self-manufacturing or outsourcing decisions in prefabricated construction. *Sustainability* **2017**, *9*, 2069. [CrossRef]
14. Chang, Y.; Li, X.; Masanet, E.; Zhang, L.; Huang, Z.; Ries, R. Unlocking the green opportunity for prefabricated buildings and construction in China. *Resour. Conserv. Recycl.* **2018**, *139*, 259–261. [CrossRef]

15. Höök, M.; Stehn, L. Applicability of lean principles and practices in industrialized housing production. *Constr. Manag. Econ.* **2008**, *26*, 1091–1100. [CrossRef]
16. Kamali, M.; Hewage, K. Life cycle performance of modular buildings: A critical review. *Renew. Sustain. Energy Rev.* **2016**, *62*, 1171–1183. [CrossRef]
17. Hosseini, M.R.; Martek, I.; Zavadskas, E.K.; Aibinu, A.A.; Arashpour, M.; Chileshe, N. Critical evaluation of off-site construction research: A scientometric analysis. *Autom. Constr.* **2018**, *87*, 235–247. [CrossRef]
18. Jin, R.; Gao, S.; Cheshmehzangi, A.; Aboagye-Nimo, E. A holistic review of off-site construction literature published between 2008 and 2018. *J. Clean. Prod.* **2018**, *202*, 1202–1219. [CrossRef]
19. Cavaco, E.; Pacheco, I.; Camara, J. Detailing of concrete-to-concrete interfaces for improved ductility. *Eng. Struct.* **2018**, *156*, 210–223. [CrossRef]
20. Ji, Y.; Li, K.; Liu, G.; Shrestha, A.; Jing, J. Comparing greenhouse gas emissions of precast in-situ and conventional construction methods. *J. Clean. Prod.* **2018**, *173*, 124–134. [CrossRef]
21. Huuhka, S.; Kaasalainen, T.; Hakanen, J.H.; Lahdensivu, J. Reusing concrete panels from buildings for building: Potential in finnish 1970s mass housing. *Resour. Conserv. Recycl.* **2015**, *101*, 105–121. [CrossRef]
22. Kim, S.; Lee, S.; Chun, H.; Hong, K. Design of PC Beam-column Joint Applied X-Braced Bars in the Segmented Structural System. *J. Civ. Eng. Manag.* **2016**, *22*, 634–644. [CrossRef]
23. Vaghei, R.; Hejazi, F.; Taheri, H.; Jaafar, M.S.; Aziz, F.N.A.A. Development of a new connection for precast concrete walls subjected to cyclic loading. *Earthq. Eng. Eng. Vib.* **2017**, *16*, 97–117. [CrossRef]
24. Mao, C.; Shen, Q.; Pan, W.; Ye, K. Major Barriers to Off-Site Construction: The Developer's Perspective in China. *J. Manag. Eng.* **2015**, *31*, 04014043. [CrossRef]
25. Jaillon, L.; Poon, C.S. Sustainable construction aspects of using prefabrication in dense urban environment: A Hong Kong case study. *Constr. Manag. Econ.* **2008**, *26*, 953–966. [CrossRef]
26. Feng, T.; Tai, S.; Sun, C.; Man, Q. Study on Cooperative Mechanism of Prefabricated Producers Based on Evolutionary Game Theory. *Math. Probl. Eng.* **2017**, *2017*, 1676045. [CrossRef]
27. Yang, H.; Chung, J.K.H.; Chen, Y.; Pan, Y.; Mei, Z.; Sun, X. Ordering Strategy Analysis of Prefabricated Component Manufacturer in Construction Supply Chain. *Math. Probl. Eng.* **2018**, *2018*, 4062871. [CrossRef]
28. Ismail, Z.-A. Improving conventional method on precast concrete building maintenance. *Ind. Manag. Data Syst.* **2017**, *117*, 1485–1502. [CrossRef]
29. Schoenwitz, M.; Potter, A.; Gosling, J.; Naim, M. Product, process and customer preference alignment in prefabricated house building. *Int. J. Prod. Econ.* **2017**, *183*, 79–90. [CrossRef]
30. Jiang, Y.; Zhao, D.; Wang, D.; Xing, Y. Sustainable performance of buildings through modular prefabrication in the construction phase: A comparative study. *Sustainability* **2019**, *11*, 5658. [CrossRef]
31. Teng, Y.; Mao, C.; Liu, G.; Wang, X. Analysis of stakeholder relationships in the industry chain of industrialized building in china. *J. Clean. Prod.* **2017**, *152*, 387–398. [CrossRef]
32. Ergen, E.; Akinci, B.; Sacks, R. Tracking and locating components in a precast storage yard utilizing radio frequency identification technology and GPS. *Autom. Constr.* **2007**, *16*, 354–367. [CrossRef]
33. Van den Berg, T.I.J.; Elders, L.A.M.; de Zwart, B.C.H.; Burdorf, A. The effects of work-related and individual factors on the Work Ability Index: A systematic review. *Occup. Environ. Med.* **2008**, *66*, 211–220. [CrossRef] [PubMed]
34. Mingers, J.; Leydesdorff, L. A review of theory and practice in scientometrics. *Eur. J. Oper. Res.* **2015**, *246*, 1–19. [CrossRef]
35. Van Eck, N.J.; Waltman, L. Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics* **2009**, *84*, 523–538. [CrossRef]
36. Van Eck, N.J.; Waltman, L.; Dekker, R.; van den Berg, J. A comparison of two techniques for bibliometric mapping: Multidimensional scaling and VOS. *J. Am. Soc. Inf. Sci. Technol.* **2010**, *61*, 2405–2416. [CrossRef]
37. Zhao, X. A scientometric review of global BIM research: Analysis and visualization. *Autom. Constr.* **2017**, *80*, 37–47. [CrossRef]
38. Meho, L.I.; Rogers, Y. Citation counting, citation ranking, & h-index of human-computer interaction researchers: A comparison of scopus and web of science. *J. Am. Soc. Inf. Sci. Technol.* **2008**, *59*, 1711–1726.
39. Fahimnia, B.; Sarkis, J.; Davarzani, H. Green supply chain management: A review and bibliometric analysis. *Int. J. Prod. Econ.* **2015**, *162*, 101–114. [CrossRef]
40. Nguyen, T.; Zhou, L.; Spiegler, V.; Ieromonachou, P.; Lin, Y. Big data analytics in supply chain management: A state-of-the-art literature review. *Comput. Oper. Res.* **2018**, *98*, 254–264. [CrossRef]

41. Li, C.Z.; Hong, J.; Fan, C.; Xu, X.; Shen, G.Q. Schedule delay analysis of prefabricated housing production: A hybrid dynamic approach. *J. Clean. Prod.* **2018**, *195*, 1533–1545. [CrossRef]
42. Yin, S.Y.L.; Tserng, H.P.; Wang, J.C.; Tsai, S.C. Developing a precast production management system using RFID technology. *Autom. Constr.* **2009**, *18*, 677–691. [CrossRef]
43. Chen, Y.; Okudan, G.E.; Riley, D.R. Decision support for construction method selection in concrete buildings: Prefabrication adoption and optimization. *Autom. Constr.* **2010**, *19*, 665–675. [CrossRef]
44. Bankvall, L.; Bygballe, L.E.; Dubois, A.; Jahre, M. Interdependence in supply chains and projects in construction. *Supply Chain Manag. Int. J.* **2010**, *15*, 385–393. [CrossRef]
45. Ergen, E.; Akinci, B.; Sacks, R. Life-cycle data management of engineered-to-order components using radio frequency identification. *Adv. Eng. Inform.* **2007**, *21*, 356–366. [CrossRef]
46. Pan, W.; Gibb, A.G.F.; Dainty, A.R.J. Strategies for Integrating the Use of Off-Site Production Technologies in House Building. *J. Constr. Eng. Manag.* **2012**, *138*, 1331–1340. [CrossRef]
47. Jaillon, L.; Poon, C.S. Life cycle design and prefabrication in buildings: A review and case studies in Hong Kong. *Autom. Constr.* **2014**, *39*, 195–202. [CrossRef]
48. Pheng, L.S.; Chuan, C.J. Just-in-Time Management of Precast Concrete Components. *J. Constr. Eng. Manag.* **2001**, *127*, 494–501. [CrossRef]
49. Chan, W.T.; Hu, H. Constraint Programming Approach to Precast Production Scheduling. *J. Constr. Eng. Manag.* **2002**, *128*, 513–521. [CrossRef]
50. Leu, S.-S.; Hwang, S.-T. GA-based resource-constrained flow-shop scheduling model for mixed precast production. *Autom. Constr.* **2002**, *11*, 439–452. [CrossRef]
51. Šubelj, L.; van Eck, N.J.; Waltman, L. Clustering scientific publications based on citation relations: A systematic comparison of different methods. *PLoS ONE* **2016**, *11*, e0154404. [CrossRef] [PubMed]
52. Wang, Z.; Shen, H.; Zuo, J. Risks in prefabricated buildings in china: Importance-performance analysis approach. *Sustainability* **2019**, *11*, 3450. [CrossRef]
53. Dallasega, P.; Rauch, E.; Frosolini, M. A lean approach for real-time planning and monitoring in engineer-to-order construction projects. *Buildings* **2018**, *8*, 38. [CrossRef]
54. Ma, Z.; Yang, Z.; Liu, S.; Wu, S. Optimized rescheduling of multiple production lines for flowshop production of reinforced precast concrete components. *Autom. Constr.* **2018**, *95*, 86–97. [CrossRef]
55. Kong, L.; Li, H.; Luo, H.; Luo, X.; Ding, L.; Skitmore, M. Optimal single-machine batch scheduling for the manufacture, transportation and JIT assembly of precast construction with changeover costs within due dates. *Autom. Constr.* **2017**, *81*, 34–43. [CrossRef]
56. Liu, K.; Su, Y.; Zhang, S. Evaluating supplier management maturity in prefabricated construction project-survey analysis in china. *Sustainability* **2018**, *10*, 3046. [CrossRef]
57. Li, C.Z.; Shen, G.Q.; Xu, X.; Xue, F.; Sommer, L.; Luo, L. Schedule risk modeling in prefabrication housing production. *J. Clean. Prod.* **2017**, *153*, 692–706. [CrossRef]
58. Azman, M.N.A.; Ahamad, M.S.S.; Majid, T.A.; Yahaya, A.S.; Hanafi, M.H. Statistical evaluation of pre-selection criteria for industrialized building system (IBS). *J. Civ. Eng. Manag.* **2014**, *19* (Suppl. 1), S131–S140. [CrossRef]
59. Moon, S.; Zekavat, P.R.; Bernold, L.E.; Leviakangas, P. Dynamic Control of Resource Logistics Quality to Eliminate Process Waste in Rebar Placement Work. *KSCE J. Civ. Eng.* **2018**, *22*, 3697–3706. [CrossRef]
60. Kim, S.-Y.; Nguyen, V.T. An AHP Framework for Evaluating Construction Supply Chain Relationships. *KSCE J. Civ. Eng.* **2017**, *22*, 1544–1556. [CrossRef]
61. Lee, H.; Boile, M.; Theofanis, S.; Choo, S. Game theoretical models of the cooperative carrier behavior. *KSCE J. Civ. Eng.* **2014**, *18*, 1528–1538. [CrossRef]
62. Lee, H.; Zhang, T.; Boile, M.; Theofanis, S.; Choo, S. Designing an integrated logistics network in a supply chain system. *KSCE J. Civ. Eng.* **2013**, *17*, 806–814. [CrossRef]
63. Mao, C.; Liu, G.; Shen, L.; Wang, X.; Wang, J. Structural Equation Modeling to Analyze the Critical Driving Factors and Paths for Off-site Construction in China. *KSCE J. Civ. Eng.* **2017**, *22*, 2678–2690. [CrossRef]
64. Almusallam, T.H.; Elsanadedy, H.M.; Al-Salloum, Y.A.; Siddiqui, N.A.; Iqbal, R.A. Experimental Investigation on Vulnerability of Precast RC Beam-column Joints to Progressive Collapse. *KSCE J. Civ. Eng.* **2018**, *22*, 3995–4010. [CrossRef]
65. Blismas, N.; Wakefield, R. Drivers, constraints and the future of offsite manufacture in australia. *Constr. Innov.* **2009**, *9*, 72–83. [CrossRef]

66. Eshtehardian, E.; Ghodousi, P.; Bejanpour, A. Using ANP and AHP for the supplier selection in the construction and civil engineering companies; Case study of Iranian company. *KSCE J. Civ. Eng.* **2013**, *17*, 262–270. [CrossRef]
67. Tam, V.W.Y.; Fung, I.W.H.; Sing, M.C.P.; Ogunlana, S.O. Best practice of prefabrication implementation in the hong kong public and private sectors. *J. Clean. Prod.* **2015**, *109*, 216–231. [CrossRef]
68. Hong, J.; Shen, G.Q.; Li, Z.; Zhang, W.; Zhang, B. Barriers to promoting prefabricated construction in china: A cost–benefit analysis. *J. Clean. Prod.* **2018**, *172*, 649–660. [CrossRef]
69. Arashpour, M.; Wakefield, R.; Blismas, N.; Maqsood, T. Autonomous production tracking for augmenting output in off-site construction. *Autom. Constr.* **2015**, *53*, 13–21. [CrossRef]
70. Wong, C.K.; Fung, I.W.H.; Tam, C.M. Comparison of Using Mixed-Integer Programming and Genetic Algorithms for Construction Site Facility Layout Planning. *J. Constr. Eng. Manag.* **2010**, *136*, 1116–1128. [CrossRef]
71. Albuquerque, A.T.; El Debs, M.K.; Melo, A.M.C. A cost optimization-based design of precast concrete floors using genetic algorithms. *Autom. Constr.* **2012**, *22*, 348–356. [CrossRef]
72. Sacks, R.; Eastman, C.M.; Lee, G. Process Model Perspectives on Management and Engineering Procedures in the Precast/Prestressed Concrete Industry. *J. Constr. Eng. Manag.* **2004**, *130*, 206–215. [CrossRef]
73. Polat, G. Factors Affecting the Use of Precast Concrete Systems in the United States. *J. Constr. Eng. Manag.* **2008**, *134*, 169–178. [CrossRef]
74. Luu, V.T.; Kim, S.; Tuan, N.V.; Ogunlana, S.O. Quantifying schedule risk in construction projects using bayesian belief networks. *Int. J. Proj. Manag.* **2009**, *27*, 39–50. [CrossRef]
75. Li, C.Z.; Zhong, R.Y.; Xue, F.; Xu, G.; Chen, K.; Huang, G.G.; Shen, G.Q. Integrating RFID and BIM technologies for mitigating risks and improving schedule performance of prefabricated house construction. *J. Clean. Prod.* **2017**, *165*, 1048–1062. [CrossRef]
76. Yang, Z.; Ma, Z.; Wu, S. Optimized flowshop scheduling of multiple production lines for precast production. *Autom. Constr.* **2016**, *72*, 321–329. [CrossRef]
77. Zhong, R.Y.; Peng, Y.; Xue, F.; Fang, J.; Zou, W.; Luo, H.; Huang, G.Q. Prefabricated construction enabled by the Internet-of-Things. *Autom. Constr.* **2017**, *76*, 59–70. [CrossRef]
78. Xue, H.; Zhang, S.; Su, Y.; Wu, Z.; Yang, R.J. Effect of stakeholder collaborative management on off-site construction cost performance. *J. Clean. Prod.* **2018**, *184*, 490–502. [CrossRef]
79. Wang, S.; Mursalin, Y.; Lin, G.; Lin, C. Supply chain cost prediction for prefabricated building construction under uncertainty. *Math. Probl. Eng.* **2018**, *2018*, 4580651. [CrossRef]
80. Zhai, Y.; Zhong, R.Y.; Li, Z.; Huang, G. Production lead-time hedging and coordination in prefabricated construction supply chain management. *Int. J. Prod. Res.* **2017**, *55*, 3984–4002. [CrossRef]
81. Gosling, J.; Naim, M.; Towill, D. Identifying and categorizing the sources of uncertainty in construction supply chains. *J. Constr. Eng. Manag.* **2013**, *139*, 102–110. [CrossRef]
82. Ko, C.-H.; Kuo, J.-D. Making Formwork Construction Lean. *J. Civ. Eng. Manag.* **2015**, *21*, 444–458. [CrossRef]
83. Voordijk, H.; Meijboom, B.; de Haan, J. Modularity in supply chains: A multiple case study in the construction industry. *Int. J. Oper. Prod. Manag.* **2006**, *26*, 600–618. [CrossRef]
84. Chen, J.-H.; Yan, S.; Tai, H.-W.; Chang, C.-Y. Optimizing profit and logistics for precast concrete production. *Can. J. Civ. Eng.* **2017**, *44*, 393–406. [CrossRef]
85. Xu, G.; Li, M.; Luo, L.; Chen, C.-H.; Huang, G.Q. Cloud-based fleet management for prefabrication transportation. *Enterp. Inf. Syst.* **2018**, *13*, 87–106. [CrossRef]
86. Goh, E.; Loosemore, M. The impacts of industrialization on construction subcontractors: A resource based view. *Constr. Manag. Econ.* **2016**, *35*, 288–304. [CrossRef]
87. Zarbakhshnia, N.; Soleimani, H.; Ghaderi, H. Sustainable third-party reverse logistics provider evaluation and selection using fuzzy SWARA and developed fuzzy COPRAS in the presence of risk criteria. *Applied Soft Comput.* **2018**, *65*, 307–319. [CrossRef]
88. Kim, Y.; Chang, S.; Han, S.; Yi, J. Supply chain cost model for prefabricated building material based on time-driven activity-based costing. *Can. J. Civ. Eng.* **2016**, *43*, 287–293. [CrossRef]
89. Demiralp, G.; Guven, G.; Ergen, E. Analyzing the benefits of RFID technology for cost sharing in construction supply chains: A case study on prefabricated precast components. *Autom. Constr.* **2012**, *24*, 120–129. [CrossRef]
90. London, K.; Pablo, Z. An actor–network theory approach to developing an expanded conceptualization of collaboration in industrialized building housing construction. *Constr. Manag. Econ.* **2017**, *35*, 553–577. [CrossRef]

91. Hsu, P.; Angeloudis, P.; Aurisicchio, M. Optimal logistics planning for modular construction using two-stage stochastic programming. *Autom. Constr.* **2018**, *94*, 47–61. [CrossRef]
92. Arashpour, M.; Wakefield, R.; Blismas, N.; Minas, J. Optimization of process integration and multi-skilled resource utilization in off-site construction. *Autom. Constr.* **2015**, *50*, 72–80. [CrossRef]
93. Wang, Z.; Hu, H.; Gong, J. Simulation based multiple disturbances evaluation in the precast supply chain for improved disturbance prevention. *J. Clean. Prod.* **2018**, *177*, 232–244. [CrossRef]
94. Wang, Z.; Hu, H. Improved precast Production–Scheduling model considering the whole supply chain. *J. Comput. Civ. Eng.* **2017**, *31*, 4017013. [CrossRef]
95. Arashpour, M.; Bai, Y.; Aranda-mena, G.; Bab-Hadiashar, A.; Hosseini, R.; Kalutara, P. Optimizing decisions in advanced manufacturing of prefabricated products: Theorizing supply chain configurations in off-site construction. *Autom. Constr.* **2017**, *84*, 146–153. [CrossRef]
96. Anvari, B.; Angeloudis, P.; Ochieng, W.Y. A multi-objective GA-based optimisation for holistic manufacturing, transportation and assembly of precast construction. *Autom. Constr.* **2016**, *71*, 226–241. [CrossRef]
97. Arashpour, M.; Wakefield, R.; Abbasi, B.; Lee, E.W.M.; Minas, J. Off-site construction optimization: Sequencing multiple job classes with time constraints. *Autom. Constr.* **2016**, *71*, 262–270. [CrossRef]
98. Chan, W.T.; Hu, H. Production scheduling for precast plants using a flow shop sequencing model. *J. Comput. Civ. Eng.* **2002**, *16*, 165–174. [CrossRef]
99. Li, C.Z.; Xue, F.; Li, X.; Hong, J.; Shen, G.Q. An Internet of Things-enabled BIM platform for on-site assembly services in prefabricated construction. *Autom. Constr.* **2018**, *89*, 146–161. [CrossRef]
100. Wang, Z.; Hu, H.; Zhou, W. RFID enabled Knowledge-Based precast construction supply chain. *Comput. Aided Civ. Infrastruct. Eng.* **2017**, *32*, 499–514. [CrossRef]
101. Hong, W.; Lee, S.; Lee, G.; Kim, S. Algorithms for in-situ production layout of composite precast concrete members. *Autom. Constr.* **2014**, *41*, 50–59. [CrossRef]
102. Purvis, L.; Gosling, J.; Naim, M.M. The development of a lean, agile and leagile supply network taxonomy based on differing types of flexibility. *Int. J. Prod. Econ.* **2014**, *151*, 100–111. [CrossRef]
103. Ahmadian, F.F.A.; Akbarnezhad, A.; Rashidi, T.H.; Waller, S.T. Accounting for transport times in planning off-site shipment of construction materials. *J. Constr. Eng. Manag.* **2016**, *142*, 4015050. [CrossRef]
104. Wang, Z.; Hu, H.; Gong, J. Framework for modeling operational uncertainty to optimize offsite production scheduling of precast components. *Autom. Constr.* **2018**, *86*, 69–80. [CrossRef]
105. Sertyesilisik, B. Lean and Agile Construction Project Management: As a Way of Reducing Environmental Footprint of the Construction Industry. In *Optimization and Control Methods in Industrial Engineering and Construction*; Springer: Dordrecht, The Netherlands, 2014; pp. 179–196.
106. Shi, Q.; Ding, X.; Zuo, J.; Zillante, G. Mobile Internet based construction supply chain management: A critical review. *Autom. Constr.* **2016**, *72*, 143–154. [CrossRef]
107. Chen, K.; Xu, G.; Xue, F.; Zhong, R.Y.; Liu, D.; Lu, W. A Physical Internet-enabled Building Information Modelling System for prefabricated construction. *Int. J. Comput. Integr. Manuf.* **2017**, *31*, 349–361. [CrossRef]
108. Altaf, M.S.; Bouferguene, A.; Liu, H.; Al-Hussein, M.; Yu, H. Integrated production planning and control system for a panelized home prefabrication facility using simulation and RFID. *Autom. Constr.* **2018**, *85*, 369–383. [CrossRef]
109. Li, C.Z.; Hong, J.; Xue, F.; Shen, G.Q.; Xu, X.; Mok, M.K. Schedule risks in prefabrication housing production in Hong Kong: A social network analysis. *J. Clean. Prod.* **2016**, *134*, 482–494. [CrossRef]
110. Li, S.H.A.; Tserng, H.P.; Yin, S.Y.L.; Hsu, C. A production modeling with genetic algorithms for a stationary pre-cast supply chain. *Expert Syst. Appl.* **2010**, *37*, 8406–8416. [CrossRef]
111. Wang, Y.; Yuan, Z.; Sun, C. Research on assembly sequence planning and optimization of precast concrete buildings. *J. Civ. Eng. Manag.* **2018**, *24*, 106–115. [CrossRef]
112. Bilal, M.; Oyedele, L.O.; Qadir, J.; Munir, K.; Akinade, O.O.; Ajayi, S.O.; Owolabi, H.A. Analysis of critical features and evaluation of BIM software: Towards a plug-in for construction waste minimization using big data. *Int. J. Sustain. Build. Technol. Urban Dev.* **2015**, *6*, 211–228. [CrossRef]