buildings

MDPI

Review

Conceptualising Project Uncertainty in the Context of Building Refurbishment Safety: A Systematic Review

Udara Ranasinghe [1,*], Marcus Jefferies [1], Peter Davis [1] and Manikam Pillay [2]

[1] School of Architecture and Built Environment, The University of Newcastle, Callaghan, NSW 2308, Australia; marcus.jefferies@newcastle.edu.au (M.J.); peter.davis@newcastle.edu.au (P.D.)
[2] School of Health Sciences, The University of Newcastle, Callaghan, NSW 2308, Australia; manikam.pillay@newcastle.edu.au
* Correspondence: Udara.RanasingheRanawalage@uon.edu.au

Abstract: Project uncertainty is an inherent attribute in safety-critical projects, such as building refurbishment. While it has been suggested that project safety performance is often challenged due to project uncertainty, uncertainties are yet to be conceptualised in building refurbishment projects. The purpose of this research is to propose an industry-specific factor model of project uncertainty that can be used to diagnose and assess uncertainty in construction refurbishment research and practice. An extensive review of existing literature, following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines, where 53 articles were selected to identify the determinants of project uncertainty and strategies for managing uncertainty. In total, 23 project uncertainty factors were identified and clustered under the taxonomy of uncertain information, uncertain complexity, uncertain temporal clarity, and uncertain understanding. Thus, 12 management strategies for coping with uncertainty in building refurbishment projects were determined. Learning and a flexible working environment were the most frequently raised strategies among all the reviewed articles. The factor model proposed enables project managers and academics to better understand, assess and manage project uncertainty and deliver safer building refurbishment projects. As such, it also provides a sufficient platform and initiates debate towards the development of uncertainty management strategies to better prepare for surprises as projects progress.

Keywords: building refurbishment projects; project uncertainty; uncertainty management

Citation: Ranasinghe, U.; Jefferies, M.; Davis, P.; Pillay, M. Conceptualising Project Uncertainty in the Context of Building Refurbishment Safety: A Systematic Review. *Buildings* **2021**, *11*, 89. https://doi.org/10.3390/buildings11030089

Academic Editor: Cinzia Buratti

Received: 26 January 2021
Accepted: 23 February 2021
Published: 1 March 2021

1. Introduction

Building refurbishment projects are central to the contemporary construction industry, as they are often more financially viable than demolition and rebuilding ageing structures [1]. Notwithstanding the substantial benefits offered to the environment, economy and society, refurbishment projects, in general, are widely recognised as being high risk, complex and uncertain [2,3]. There are a number of reasons for this, including a lack of information about the existing structure and occupation throughout execution [2]. It has been further stressed that project performance measures such as cost, time, safety often challenged due to an increasing level of uncertainty in construction refurbishment projects [2,4].

The uncertain and complex nature of refurbishment projects has often been associated more specifically with time and cost overruns [4,5]. However, building refurbishment projects can also be described as 'safety-critical projects', where the project crew confronts many unplanned and unknown situations during the project execution that increase the chance of safety failure [6]. In the context of construction, safety is defined as the protection of workers from a physical injury [7] (p. 3). Safety is of paramount importance in any type of construction project and is often conceptualised in the same way as other project objectives such as time, cost and quality. Irrespective of the myriad safety strategies and controls utilised to deliver a safe refurbishment project, the actions and project safety outcomes are often challenging due to project uncertainty [2]. Therefore, the main aim of this research is to conceptualise project uncertainty in construction refurbishment projects as it is imperative to deliver a safe project. There is little agreement on the terms used to define the refurbishment of buildings. Refurbishment projects are spread in different scales from redecoration to total reconstruction of structural members in a building [8]. Based on the definitions of Ali and Noordin [9] and Egbu [10] of a refurbishment project, this study defined building refurbishment as a major change carried out to an existing building which includes large alterations and additions, major renovation, upgrading, conversion, extension or modernisation and excludes routine/minor repair and maintenance and cosmetic work.

The term uncertainty is a wide concept and appears in the non-deterministic stream of project management, which has grown significantly post the year 2000 [11]. Recently, in the project management discipline, an abundance of researches have been undertaken to clarify project uncertainty [12–16] and describe how to manage it [12,14,16–18]. Building refurbishment projects are carried out on ageing and undefined structures, where the effect of uncertainties are non-trivial throughout the project life cycle [19]. Therefore, extant research has contributed to understanding project uncertainty, particularly in building refurbishment projects [20–22]. Hence, this paper offers a systematic review of project uncertainty underpinning industry-specific contextual information highlighted in project management and construction refurbishment literature and subsequently present an uncertainty factor model and management strategies to contribute to construction refurbishment safety.

Identifying project uncertainty at an early phase would give project managers a broader understanding of factors that deliver a refurbishment project safer [23]. It is imperative to have an industry-specific project uncertainty factor model. However, in building refurbishment literature, there is a lack of consistency and no solid factor model to understand or detailed classification as to what factors would cause uncertainty or how this project uncertainty should be managed, specifically uncertainty that challenges project safety. Therefore, in order to achieve the aim of this paper, the objectives are twofold: (1) develop a project uncertainty factor structure, and (2) identify strategies for managing uncertainty.

The first section of the paper presents a general introduction to uncertainty and then, more specifically, in the context of construction refurbishment projects. The second section describes the design of the exploratory study. Following this, a factor model and proposed strategies for uncertainty management are synthesised from the literature. Finally, conclusions, including research limitations, are described, and opportunities for future research are explored.

1.1. Uncertainty

Discussion on uncertainty initially began in the field of economics and psychology [12]. Other scientific fields, such as project management, are built upon the understanding of uncertainty based on constructs grounded in economics and psychology [12]. Uncertainty can manifest as an opportunity or trepidation depending on the situation and the view of a person who faces the situation [24]. Looking at it from a different perspective, uncertainty varies concomitantly with different states of mind [25]. The literature reveals that there is a lack of consensus regarding a definition of "uncertainty" [11]. However, this lack of agreement has become a fundamental issue that continues to broaden arguments in the literature associated with the concept of uncertainty. Consider two examples; uncertainty refers to 'a subject's conscious lack of knowledge about an object, which is not yet clearly defined (or known), in a context requiring a decision' [26] (p. 663); or, uncertainty refers to a; 'the absence of information required for the decision that needs to be taken at a point in time' [27] (p. 347). These definitions suggest that uncertainty is a situation where a person does not have full knowledge or has difficultly understanding a particular situation [16,28].

Uncertainty in the context of a project is closely associated with the concept of risk. There are considerable arguments in relation to the difference between uncertainty and risk in the literature. Whilst risk and uncertainty have been used interchangeably by some researchers; there is also an argument that there is no difference [29]. In the disciplines of Economics, Psychology, and Philosophy, risk is distinguished from uncertainty. Both risk and uncertainty present the degree of knowledge about future events [30], but unlike uncertainty, risk provides an enabler to predict the probabilities for different outcomes [31]. However, risk and uncertainty are not distinguished straightforwardly in the context of project management [12]. For instance, the Project Management Institute (PMI) defined project risk as 'an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives' [32] (p. 391). Perminova [12] has classified uncertainty into two groups, risk and opportunity. Risk appears as a negative consequence, while opportunity is a positive impact, both effect project objectives [12]. Even though most empirical studies defined uncertainty as both threat and opportunity, in a project context, threats can be most problematic for project performance. Therefore, this study identifies uncertainty as a threat to project performance in building refurbishment projects.

1.2. Construction Project Uncertainty

The construction industry is classified as a project-based activity [33]. In the context of a construction project, which is largely understood to be a unique endeavour, there are ill-defined challenges caused by 'unknown-unknowns' [18]. Baccarini [34] has elaborated the different scope of uncertainties as unknowns-unknowns (unfathomable uncertainty), known-unknowns (risks) and known-knowns (total certainty). These unknowns create uncertainty in projects. In construction project management, there is a fundamental assumption that considers the construction process as a linear, simple and sequential process [35]. However, Wood and Ashton [36] argued that a closer examination of the construction process reveals it as a dynamic and complicated process that interacts with a number of inherent uncertainties. In general, many construction projects lack important information at the beginning of the project life cycle, and this increases project uncertainty [27]. In comparison to a new build, building refurbishment projects are more difficult to control [37]. Uncertainties are not only present at the early phase of the project but also can emerge at any stage throughout the life cycle of refurbishment projects [22,38]. These unknowns create uncertainty and consequently cause cost overruns, time delays and, importantly, impact safety. In high safety risk projects, uncertainty has a connection to accidents and safety incidents due to unanticipated outcomes generated by the aforementioned unknowns [18]. Researchers have unveiled uncertainty factors at different stages (pre-project phase, design phase and construction phase) of projects [5,9,23,39]. Poor identification and assessment of project uncertainties at an early phase (design and planning) could create vulnerabilities at the construction phase [40]. For example, a lack of information during the design process could force designers to use their "gut feeling" in making design decisions, and ultimately, this creates safety problems at the construction phase of the building refurbishment process [40]. Therefore, it is vital to understand the determinants or sources of uncertainty at the planning phase (pre-project phase) of refurbishment projects. However, there is a lack of consistency in identifying the determinants of project uncertainty, specifically uncertainty that challenges project safety. Therefore, further research is important to develop a useful solid factor structure of project uncertainty in building refurbishment projects.

2. Methods

The aim of this paper was to conceptualise project uncertainty by identifying uncertainty factors in construction refurbishment projects and uncertainty management strategies. First, a systematic literature review method was followed to identify the determinants of project uncertainty and to develop the factor model. A systematic review of the literature provides better identification of determinants, management strategies, gaps and trends in the context of studies and provides future direction for potential enhancement in the construction industry. The methodological process followed in this research is illustrated in Figure 1.

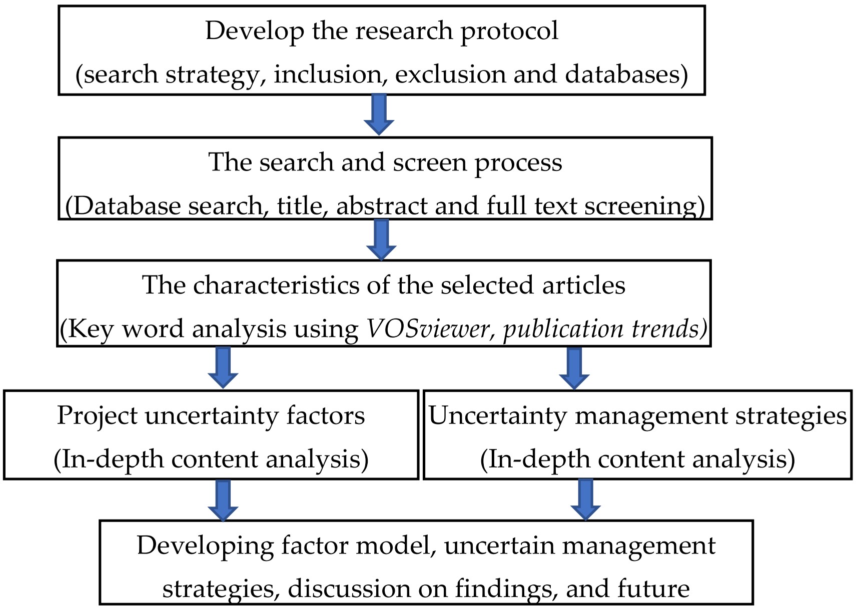

Figure 1. The steps of the research.

Developing a protocol is an important step in the process of reviewing quality literature [41]. This review adopts the guideline of Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) [42]. The review protocol consisted of two main inclusion criteria: (1) studies that revealed determinants of project uncertainty, uncertainty management and studies that were conducted in the context of projects or particular to building refurbishment (2) well-esteemed peer-review journals and conference papers and Phd thesis published in English. Structured searches were carried out using four databases including, Web of Science, Google Scholar, Science Direct and Scopus from commencement to April 2020. There is a dearth of literature relating to project uncertainty in building refurbishment projects. Therefore, in order to capture the most relevant determinants of uncertainty, both the literature on project management and building refurbishment was viewed. Therefore, the keywords used in the searches were: 'Uncertainty', 'Project management', 'Building refurbishment', and 'safety'. Additionally, further articles were added through cross-referencing initially selected articles. The article selection process comprised three steps: (1) Title screening (641 studies were selected), (2) abstract screening (385 studies were selected), and (3) full-text screening. Finally, 53 articles were utilised to conceptualise the theoretical understanding of project uncertainty. Figure 2 illustrates the article selection process according to the PRISMA flowchart.

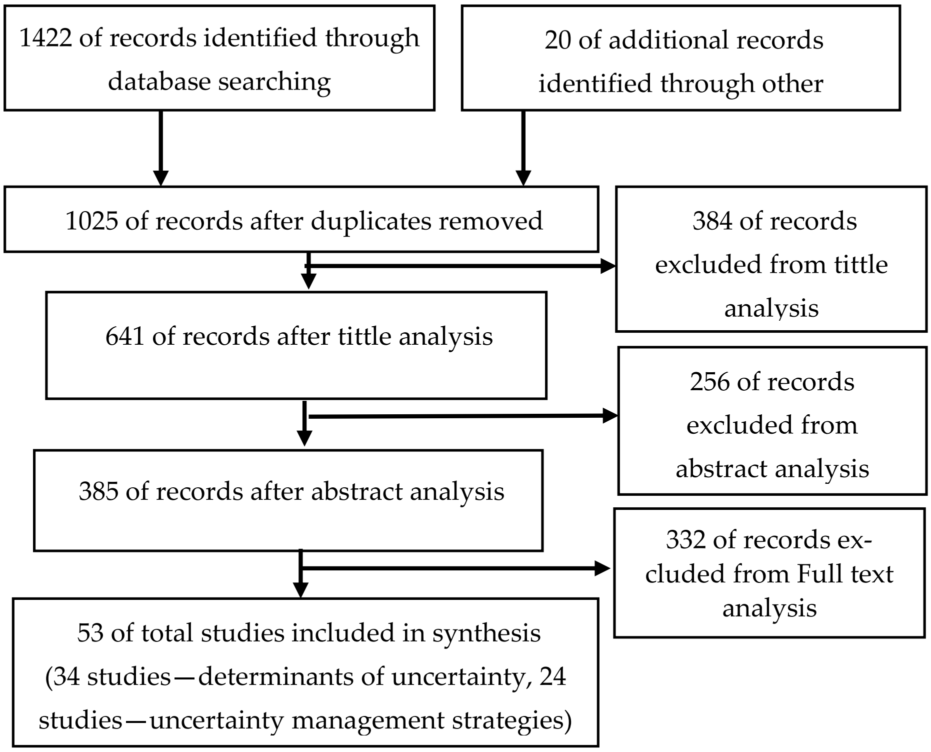

Figure 2. Stages of the material selection process (Adapted from [43]).

The descriptive analysis of selected articles emphasised the characteristics of studies included in the systematic literature review; a spreadsheet was used to facilitate the data analysis, including summarising data: title, year of publication and contents of study: project uncertainty factors and management strategies. The "science mapping" technique was used to develop the methodological patterns of key terms in the sourced literature. Hence, the co-occurrence of author keywords was used to provide further information on the research topic, i.e., identify the relationships, different categories, clusters, and inter-readiness among sub-topics related to the main topic [44]. A science mapping tool, VoSviewer software—Leiden University's Centre for Science and Technology Studies (CWTS), Netherlands [45], was used to map the co-occurrence of author keywords. This process followed two steps (1) developing networks through the co-occurrence of author keywords and (2) generating maps that helped to interpret the relationships, patterns, trends, and outliers.

Apart from the aforementioned, the main data obtained from literature were analysed using direct content analysis to develop patterns and themes [46]. This method was appropriate in the case of incomplete prior research work on phenomena and where the researcher begins by using already developed categorisation or variables from prior research [46]. This research was designed to explore project uncertainty in a new context, building refurbishment project. The previously developed categorisation of project uncertainty by Cleden [15] was applied to this study. Hence, sub-themes were developed based on the interrelationships between main themes identified from the literature. By nature, this study is an exploratory study that is to posit a preliminary model for further investigation [47].

3. Findings and Discussion

3.1. Characteristics of the Selected Articles Included in the Analysis

3.1.1. Publishing Framework

Figure 3 illustrates the years of publication of reviewed papers, spanning between 2000 to 2019. At first glance, it is apparent that project uncertainty and their deliberations started after the year 2002. An increase in the number of papers from 2009 is arguably due to the increase in the dynamic and uncertain nature of social-technical systems such as construction.

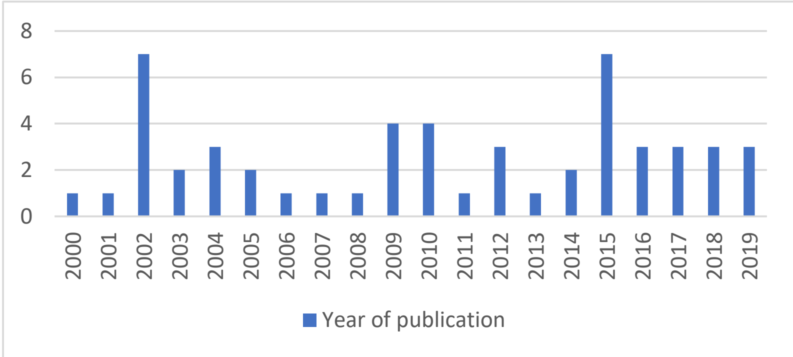

Figure 3. Number of papers published on uncertainty in refurbishment and project management over the reporting period.

3.1.2. Co-Occurrence of Author Keywords

The scientometric analysis of author keywords is accompanied by VOSViewer, which indicates the frequency of occurrence of key themes and their inter-relatedness. Several steps were followed in including and excluding keywords, (1). The threshold value was set as to a minimum of two occurrences. (2). The general themes, such as "buildings", "construction", and "human factor" were removed. (3). Keywords with the same meaning were merged, for example, "safety-critical", "safety", "uncertainty management", and "managing uncertainty". Finally, 10 main author keywords were shortlisted as envisaged in Figure 4.

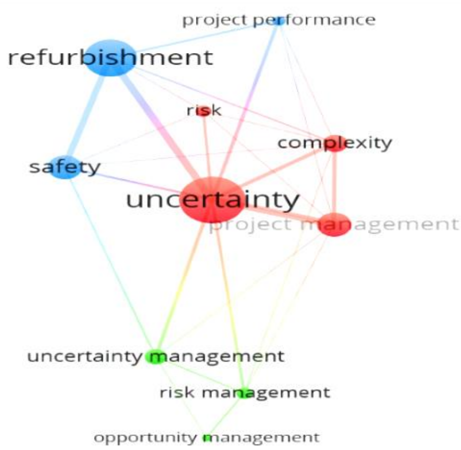

Figure 4. Mapping the co-occurrence of author keywords.

It was observed that 'uncertainty' is strongly linked to refurbishment, safety, project management, complexity and project performance. As can be seen in Figure 3, uncertainty is the most frequently used term to describe the dynamic nature of refurbishment projects. In the network map, items with the same colour represent an identical cluster. Accordingly, there were three clusters representing the main topic of project uncertainty from the 53 papers. The green colour cluster represents 'uncertainty management' which also had links to two other main factors of uncertainty, risk and opportunity, which were described as negative and positive outcomes of uncertainty, respectively. Furthermore, observation of the network map revealed an important research gap, a lack of focus on uncertainty management, particularly on refurbishment projects. There was no link between the two nodes of refurbishment and uncertainty management.

3.2. Developing Project Uncertainty Factor Model

The papers reviewed extracted 23 factors of project uncertainty pertaining to construction projects focused on the nature of building refurbishment projects, and particularly, factors that lead to safety failures. An integration process of all factors into a single factor model removed the unrelated contextual factors and reconceptualised the balance in a comprehensive way. However, it was difficult to draw boundaries as there were many perceptions, abstract conceptualisations and broad definitions [48]. Therefore, as previously mentioned in the research method, this study used already developed classifications of project uncertainty from prior research.

In the literature pertaining to uncertainty, several researchers have articulated different classifications of uncertainty based on different phenomena. Uncertainty arising from internal and external sources on a project is one such classification of uncertainty [49]. Walker and Harremoës [50] have listed the location of uncertainty, level of uncertainty and nature of uncertainty as three further classifications. Zhu and Mostafavi [51] have classified the effect of uncertainty on construction projects into three different uncertain-induced perturbation as agent-related, information-related, and resource-related. With respect to missing knowledge, Cleden [15] identified four categories of uncertainty. Namely, uncertain information, uncertain understanding, uncertain temporal, and uncertain complexity. Similarly, Saunders and Gale [16] classified uncertainty into environmental, individual, complexity, information, temporal and capability in the context of civil-nuclear and aerospace companies. Complexity, information, knowledge/experience, individual manifestation, supplier organisation and project organisation were in a list provided by Perminova [12]. Not all project uncertainty affects project success [14]. Therefore, determining contextual uncertainty is important as it may affect the specific project objectives.

In reviewing the literature pertaining to project management, as opposed to the more specific focus on building refurbishment, it was concluded that not only project information but also inherent project complexity due to inherent aspects of existing buildings determine project uncertainty. As mentioned in the above classifications, individuals and the project team play an important role. Therefore, this study used the classification of Cleden [15] regarding project uncertainty (information, understanding, temporal, and complexity) which covers broad aspects of determinants of project uncertainty from different perspectives. Based on the aforementioned categorisation, we grouped the 23 project uncertainty factors to develop the factor model as exemplified in Table 1.

Table 1. Uncertainty factor model.

Classifications	Factors/Determinants	Studies
Uncertain information	• Imprecise: multiple and conflicting interpretations of the same information	[23,26,40]
	• Information is totally unavailable	[22,23,26,37,39,40,52,53]
	• Volatility: information can change rapidly at execution	[26]
	• Ambiguity with regard to available information (multiple documents/sources)	[54]
	• Insufficient communication of information across interfaces	[22,36,55]
Uncertain complexity	• Space limitations in building or on site	[9,23,53,56]
	• Difficult in access to building or site	[5,9,39,40,52,53]
	• Structural issues with an existing building	[23,52,53]
	• Many trades or parties working in close proximity (building users/public)	[16,23,38,53,56,57]
	• Technological complications	[33,49,56,58]
	• Design complications/errors	[23,37,40,53]
	• Interdependency between project elements	[54,59]

Table 1. *Cont.*

Classifications	Factors/Determinants	Studies
Uncertain temporal	• Speed of changes in project methods, tasks, team, structure, and deliverables as project progress	[33,54,59]
	• Speed of changes in project goals	[33,54,59,60]
	• Time scale	[11,16,60]
	• Speed of change in the external environment as a project progresses (building occupants/uses, technological advancement, legislative changes, and weather conditions)	[33,49,53]
	• Speed of change in project environment (unforeseen site conditions related to existing/neighbouring structures) as a project progresses	[6,21,22,60]
Uncertain understanding	• Lack of uniformity and novelty in work task	[54,61]
	• Lack of a clear specification of project scope and objectives	[37,54,61–63]
	• Difficult to anticipate events and modify decisions at the right time	[16,22,26,53,54,59,61,64–66]
	• Work activities with no well-defined procedure	[33,54]
	• Lack of experience of this particular activity/experience of the project team	[25,26,48,53,60,65,67]
	• Clarity of construction methods employed	[20,66,68]

Table 1 is clarified in the following. However, some factors, despite being presented in the literature, were not included in Table 1. This was a consequence of the study's focus. Other factors were merged as they were interpreted as the same element in different forms. For example, lack of a clear specification of what is required [54] encompassed 'Unclear scope and objectives'. Amount of changes in refurbishment design [40] and design errors that will most likely necessitate redesign [37] were covered in 'Design complications'. Generic elements such as perceived project complexity [16] were not explicitly mentioned in the list but implicit within generic determinants of complexity.

Uncertain information:

Table 1 shows that the theme 'uncertain information' appears explicitly with a dimension in the majority of studies. Unavailability, inconsistency or lack of accurate information often affects decision making, planning assumptions, estimation and accurate specification of scope in the project [15]. Collecting various artefacts (information) required for a project is a complex activity involved in building refurbishment projects [69]. Information should derive from various sources, such as information pertaining to the existing structure [68], adjacent structures [66], pre-construction conditions (strength of walls, the material used, and services installation) [70]. Due to uncertain information, project teams often tend to make a decision regardless of the consequences of the action that ultimately affect in achieving project objectives [26].

Uncertain complexity:

When considering intrinsic precedence, regardless of the academic debate between the term complexity and uncertainty, many researchers classified complexity as a major source of uncertainty [71]. Gidado [72] indicated that uncertain complexity arises from operational activities, resources employed and the environment. Daniel and Daniel [73] viewed complexity as the structure and dynamics of the project as a system. In building refurbishment, complexity was heightened by the operational working environment that includes occupants or building users [68]. Further, the working site of a refurbishment project may be an enclosed building which is difficult to control [74]. Ad hoc site problems in building refurbishment projects were heightened by limited space and difficult access [21,39].

Uncertain Temporal:

Project uncertainty changes as the project progress through its project life cycle. This is mainly due to the level of change in project information, direction and randomness of timing [16]. This was described as when a situation develops faster than or slower than expected [15]. Uncertainty is not only a source from the external environment but also a cognitive reaction of individuals [12]. Viewed from a temporal perspective, it is difficult to determine the right time to act and how much time is needed to resolve the problem before it transitions to a crisis [15]. It also emphasises the trade-off decision on whether to act or not [15] in terms of safety or quality [75]. In many scenarios, temporal uncertainty arises due to project turbulence [24]. This may manifest in repeated changes in project scope, requirements, permitted methods and objectives [24]. Consistent with theory, project uncertainty gradually reduces as a project progresses [27]. However, uncertainty can arise at any point in time in a refurbishment project due to the intrinsic characteristics of the project. The project's external environment, as well as the project environment (unforeseen site conditions related to existing/ neighbouring structures) are subject to change as a project progresses, and can affect pre-planned construction methods.

Uncertain understanding:

The gaps in knowledge pertaining to contextual information, the degree of understanding of the process and underestimation of specific past events may create a background for uncertainty [76]. From a knowledge perspective, all the individuals in the project are responsible for providing critical knowledge about the situation as a team [77]. Understanding each project activity, their interrelation with other project activities, their influence on the project outcome plays a key role in the success of the project [15]. Uncertainty in terms of the technical method to be used, lack of specification for project operations, unfamiliarity with project environment and resources also emphasises the uncertain understanding of the project [72]. Understanding how information interrelates is important to avoid uncertainty [15]. A Refurbishment project is a unique endeavour that involves considerable novel activities, and a project team requires experience in performing tasks and making decisions with respect to changes in the project. Workers need to devote extra effort to making decisions beyond the procedures to ensure safety during the refurbishment project [6]. However, the ability of rational acts are constrained as a result of poor information, time constraints to make rational decisions and limited cognitive capacity [16].

Even though the literature largely highlights the environmental uncertainty of a project, it is placed under the category of complexity rather than setting it as the fifth category of uncertainty. In addition, Bosch-Rekveldt and Jongkind [78] categorised environment and technological perspective of uncertainty under project complexity. Overall, the factor model (Table 1) consisted of an integrative set of factors that contribute to project uncertainty in a building refurbishment project.

3.3. Strategies for Managing Project Uncertainty

The academic literature that focused on elements of project uncertainty also proffered the main attention towards 'How to manage project uncertainties'. The term 'managing uncertainty' appeared in many literature sources intended to convey that project uncertainty cannot be completely eliminated from the system but only managed to a certain extent [14,79]. The key process of uncertainty management begins with an effective risk management process [16]. However, traditional risk management systems, highly based on assumptions of static conditions, are not effective in dealing with uncertainty [80]. In the context of safety, the effectiveness of traditional safety approaches has been limited in the nature of uncertainty as they largely focused on prevention and protection [81]. The collective summary of strategies for coping with project uncertainty and their description are presented in Table 2.

Table 2. The uncertainty management strategies.

Element	Description	Source
Learning	Transfer unknown to known risk through experience and knowledge, lessoned learn from past events	[12,14,16,18,25,62,73,77,82–88]
Flexibility	Flexibility in responding to different situations through clarifying and managing anticipated trade-offs between multiple performance objectives	[6,14,16,25,82,83,85,89–93]
Adaptability	Adaptive action based on situational constraints and possibilities rather than relying on fixed plans and standards	[14,85,86,94]
Preparedness	Preparing to cope with unexpected events	[90]
Awareness	Awareness of changing situations in the environment and monitor performance against criteria	[90,92]
Sensemaking	Build systems thinking (think of multiple alternatives to reach a decision)	[14,18,25]
Collaboration	Facilitated interaction and coordination between project parties	[17,77,93]
Anticipation	Envision of future scenarios from different perspectives	[6]
Communication	Processes to communicate information throughout the organisation and between project partners	[16,17,25,50,90,95]
Autonomy	Self-determination of goals and rules to achieve them	[77,93]
Selectionist	Multiple explorations before making a decision to achieve an outcome	[87,88]
Leadership	Support trust-building, empowered personnel, and accept different opinions	[57,77]

All the strategies that were identified were grouped under main themes that appear with the description of each strategy in Table 2. Noteworthy, 12 main strategies for coping with uncertainty were identified. Most of the studies proposed 'learning' and 'flexibility' as effective methods of uncertainty management in a project environment. Communication, adaptability and sensemaking were also raised seven, six, and four times, respectively, in previous studies.

Apart from the aforementioned, two comprehensive uncertainty management concepts highlighted in the existing literature were *Resilience Engineering* (RE) [6,15,96] and *High-reliability Organisation* (HRO) [18,67,97]. Both concepts have gained substantial value in managing performance in uncertain, dynamic, and complex socio-technical systems [98,99]. Authors such as Pillay [100] have argued both these concepts need to be embraced to improve safety in construction projects. Interestingly, a thorough investigation of the theory of RE and HRO emphasised that strategies identified in Table 2 could be either categorised under the concept of RE or HRO (for example, see [101]). Both concepts, HRO and RE, are characterised by the human capability for adaptation, imagination, and mindfulness, which enable people to maintain performance and safety concurrently in an unexpected situation. This is achieved through flexibility in operation, learning, quick feedback through communication, rich awareness, imagination to anticipate, etc. [101]. Therefore, practising HRO or RE in a project work environment helps project managers cope with uncertainty in hazardous projects. However, there is a scarcity of studies pertaining HRO and RE in the context of construction [101]. This is a noticeable gap in the literature. There is an opportunity to investigate the role of HRO and RE in hazardous projects such as building refurbishment where project uncertainty is high.

3.4. Use of Uncertainty Factor Model and Uncertainty Management Strategies

Theoretically, the proposed uncertainty factor model and management strategies help researchers to identify the concepts in the field of project management, more specifically in the context of building construction and thus contribute to theory development. The proposed model and management strategies are also useful in practice. The assessment of uncertainty factors aids in actively managing project performance [23]. The application of the uncertainty factor model in a project would provide a basis to assess the uncertainty of construction refurbishment projects. Also, the model can be used as a tool that enables identification and anticipation of where uncertainty can arise in a hazardous environment, such as refurbishment projects. The identification of determinants of project uncertainty would help the risk evaluation process in the early phases of the project. Since project uncertainty could emerge at any phase of a projects life cycle, the use of the model at different stages would help to establish vigorous uncertainty management strategies which match each project phase.

Uncertainty management strategies presented in Table 2 involve an additional cognitive and behavioural process as opposed to basic risk management processes. In line with the strategies outlined, the project/safety manager could establish the required competencies in the project organisation to manage particular uncertainty in refurbishment projects. Practising these uncertainty management strategies in a project environment would help to keep the focus on project outcomes while performing in the midst of uncertainty. This potentially maintains a balance of safety and production.

The ultimate utility of the uncertainty factor model and uncertainty management strategies (Table 2) lies in its ability to enable project professionals to identify the changing shape of risk due to any inherent project uncertainty at different project phases and subsequently develop the required capabilities within the project team to cope with unforeseen risks. Eventually, from a safety management perspective, this would potentially help to reduce the number of incidents and injury claims in a project, thus improving overall project safety performance.

4. Conclusions

It is widely known that building refurbishment projects are inherent with project uncertainty. A lack of industry-specific factor models of project uncertainty can lead to poor uncertainty management and thus impact project performance. This research was aimed at conceptualising project uncertainty by conducting a systematic review for characterising project uncertainty in building refurbishment projects. At the time of the search, a total of 53 articles were identified, dating from the year 2000.

The literature analysis discovered 23 determinants of project uncertainty pertaining to construction refurbishment projects. Since the research sought to establish an industry-specific factor model, the research clustered the 23 determinants into four main categories of project uncertainty as (1) uncertain information, (2) uncertain complexity, (3) uncertain temporal, and (4) uncertain understanding. The study further revealed twelve strategies to address project uncertainty and to promote guaranteed project performance. Among the identified strategies, both 'learning oriented' and 'flexible' working environment were the most frequently raised among all the reviewed articles. As such, this study makes an expedient contribution to the body of knowledge on project uncertainty, specifically in construction refurbishment and project management literature. Practically, the study offered a glossary of terms where uncertainty can arise in a refurbishment project and reinforce the need for specific strategies and skills that the project team could deploy in a hazardous environment such as building refurbishment. Having a comprehensive assessment of project uncertainty helps a project manager grasp the dynamic nature of their project, better prepare for risks as the project progress and consequently enables the management of uncertainty to deliver a safe project.

There were several limitations in this study that should be recognised. The study was based on theoretical findings; searched strategies were limited to the inclusion criteria, and no critical appraisal using a scoring approach of the articles was presented. Therefore, the findings reported in this paper stand as a preliminary model and starting point for future research on assessing and managing uncertainty on building refurbishment projects. Furthermore, the authors acknowledge that the classification of determinants of project uncertainty into a taxonomy is highly subjective; confirmatory factor analysis is required to confirm the industry-specific factor structure prosed in this study. Subsequently, further studies will examine the holistic effect of project uncertainty on project safety performance. The scientometric visualisation map drawn from author keywords in this study revealed that there is a clear gap in investigating appropriate uncertainty management approaches in refurbishment projects. Indeed, further research is required in this field to elicit the pertinence of the management strategies proposed in this study.

The findings and patterns of this study, therefore, not only aid in enhancing the existing knowledge of project uncertainty in relation to construction refurbishment but also provides a comprehensive platform for the development of further studies in the field. Further, the factor model suggests that the proposed taxonomy has the ability to encourage uncertainty assessment and is a useful tool for industry practitioners in order to effectively manage project uncertainty.

Author Contributions: Writing—original draft preparation, U.R.; writing—review and editing, M.J., P.D. and M.P.; Supervision, M.J., P.D. and M.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the University of Newcastle International Postgraduate Scholarship (UNIPRS) and University of Newcastle Research Scholarship Central 50:50 (UNRSC50:50) Scholarship Scheme.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Hardie, M.; Miller, G.; Khan, S. Waste minimisation in office refurbishment projects: An Australian perspective. *Open Waste Manag. J.* **2011**, *4*, 21–27.
2. Ranasinghe, U.; Davis, P.; Pillay, M.; Jefferies, M. Uncertainty Induced Risks Influencing Safety Performance in Building Refurbishment projects: A Systematic Literature Review. In Proceedings of the CIB World Building Congress 2019, Hong Kong, China, 17–21 June 2019.
3. Sezer, A.A.; Bosch-Sijtsema, P. Actor-to-actor tensions influencing waste management in building refurbishment projects: A service ecosystem perspective. *Int. J. Constr. Manag.* **2020**, 1–10. [CrossRef]
4. Uotila, U.; Saari, A.; Junnonen, J.-M. Uncertainty in the Early Phase of a Municipal Building Refurbishment Project—A Case Study in Finland. *Buildings* **2020**, *10*, 137. [CrossRef]
5. Ali, A.S.; Rahmat, I.; Noordin, N. Uncertainty in the design process of refurbishment projects. *Built Environ.* **2009**, *6*, 35–43.
6. Saurin, T.A.; Rooke, J.; Koskela, L.; Kemmer, S. Guidelines for the management of complex socio-technical systems: An exploratory study of a refurbishment project. In Proceedings of the 21st Annual Summit of the International Group for Lean Construction, Fortaleza, Brazil, 29 July–2 August 2013.
7. Hughes, P.; Ferrett, E. *Introduction to Health and Safety in Construction*; Routledge: Abingdon, UK, 2012.
8. Sunil, S. *Sustainable Refurbishment*; John Wiley & Sons, Ltd.: Chichester, UK, 2012.
9. Ali, A.S.; Noordin, N.; Rahmat, I. The design process of building refurbishment on project performance. *Built Environ.* **2005**, *2*, 1–13.
10. Egbu, C. Management Education and Training for Refurbishment Work within the Construction Industry. Ph.D. Thesis, University of Salford, Salford, UK, 1994.
11. Padalkar, M.; Gopinath, S. Are complexity and uncertainty distinct concepts in project management? A taxonomical examination from literature. *Int. J. Proj. Manag.* **2016**, *34*, 688–700. [CrossRef]
12. Perminova, O. *Managing Uncertainty in Projects*; Abo Akademi University Press: Turku, Finland, 2011.
13. Loch, C.H.; Solt, M.E.; Bailey, E.M. Diagnosing unforeseeable uncertainty in a new venture. *J. Prod. Innov. Manag.* **2008**, *25*, 28–46. [CrossRef]
14. Perminova, O.; Gustafsson, M.; Wikström, K. Defining uncertainty in projects—A new perspective. *Int. J. Proj. Manag.* **2008**, *26*, 73–79. [CrossRef]
15. Cleden, D. *Managing Project Uncertainty*; Routledge: New York, NY, USA, 2017.
16. Saunders, F.C.; Gale, A.W.; Sherry, A.H. Conceptualising uncertainty in safety-critical projects: A practitioner perspective. *Int. J. Proj. Manag.* **2015**, *33*, 467–478. [CrossRef]
17. Karlsen, J.T. Project owner involvement for information and knowledge sharing in uncertainty management. *Int. J. Manag. Proj. Bus.* **2010**, *3*, 642–660. [CrossRef]
18. Ramasesh, R.V.; Browning, T.R. A conceptual framework for tackling knowable unknown unknowns in project management. *J. Oper. Manag.* **2014**, *32*, 190–204. [CrossRef]
19. Ali, A.S.; Rahmat, I. Methods of coordination in managing the design process of refurbishment projects. *J. Build. Apprais.* **2009**, *5*, 87–98. [CrossRef]

20. Rakhshanifar, M.; Hosseini, M.; Abdullah, A. Safety and Health in Refurbishment Works Including Partial Demolition. *Appl. Mech. Mater.* **2015**, *735*, 99–103. [CrossRef]
21. Danso, F.O.; Badu, E.; Ahadzie, D.K.; Manu, P. Health and safety issues and mitigation measures relating to adaptive-retrofits projects: Literature review & research implications for the Ghanaian construction industry. In Proceedings of the 31st Annual ARCOM Conference, Lincoln, UK, 7–9 September 2015.
22. Kashyap, M.; Anumba, C.J.; Egbu, C. Towards a decision support system for health and safety management in refurbishment projects. In Proceedings of the 4TH Triennial International Conference Rethinking and Revitalizing Construction Safety, Health, Environment and Quality, Port Elizabeth, South Africa, 17–20 May 2005.
23. Yacob, R.I.; Rahmat, I.; Saruwono, M.; Ismail, Z. Effects of uncertainty factors and refurbishment projects performance in relation to leadership quality of project managers. *J. Build. Perform.* **2017**, *8*, 2017.
24. Saunders, F.C.; Gale, A.W.; Sherry, A.H. Mapping the multi-faceted: Determinants of uncertainty in safety-critical projects. *Int. J. Proj. Manag.* **2016**, *34*, 1057–1070. [CrossRef]
25. Atkinson, R.; Crawford, L.; Ward, S. Fundamental uncertainties in projects and the scope of project management. *Int. J. Proj. Manag.* **2006**, *24*, 687–698. [CrossRef]
26. Hassanzadeh, S.; Marmier, F.; Gourc, D.; Bougaret, S. Integration of human factors in project uncertainty management, a decision support system based on fuzzy logic. In Proceedings of the European Safety and Reliability Conference, Troyes, France, 18–22 September 2011.
27. Winch, G.M. *Managing Construction Projects*, 2nd ed.; John Wiley & Sons: Chichester, UK, 2009.
28. McLain, D. Quantifying project characteristics related to uncertainty. *Proj. Manag. J.* **2009**, *40*, 60–73. [CrossRef]
29. Olsson, R. Managing Project Uncertainty by Using an Enhanced Risk Management Process. Ph.D. Thesis, Maraldaren University, Västerås, Sweden, 2006.
30. Loosemore, M.; Raftery, J.; Reilly, C.; Higgon, D. *Risk Management in Projects*; Taylor & Francis: Abingdon, UK, 2012.
31. Samset, K. Project Management in a High-Uncertainty Situation. Ph.D. Thesis, Norwegian University of Science and Technology, Trondheim, Norway, 1998.
32. Project Management Institute. *A Guide to the Project Management Body of Knowledge*; Project Management Institute: Philadelphia, PA, USA, 2017.
33. Dubois, A.; Gadde, L.-E. The construction industry as a loosely coupled system: Implications for productivity and innovation. *Constr. Manag. Econ.* **2002**, *20*, 621–631. [CrossRef]
34. Baccarini, D. Project Uncertainty Management 2018. Available online: https://www.researchgate.net/project/Project-Uncertainty-Management (accessed on 27 August 2019).
35. Bertelsen, S. *Complexity–Construction in a New Perspective*; IGLC-11: Blacksburg, VA, USA, 2003.
36. Wood, H.; Ashton, P. Factors of complexity in construction projects. In Proceedings of the 25th Annual ARCOM Conference, Nottingham, UK, 7–9 September 2009.
37. Noori, A.; Saruwono, M.; Adnan, H.; Rahmat, I. Conflict, Complexity, and Uncertainty in Building Refurbishment Projects. In Proceedings of the International Civil and Infrastructure Engineering Conference, Singapore, 2015; Available online: https://www.springer.com/gp/book/9789811001543 (accessed on 1 March 2021).
38. Yacob, R.; Saruwono, M.; Ismail, Z.; Pheng, L.S. Influence of Human Factors on the Uncertainties of Refurbishment Projects: A Proposed Conceptual Approach. *J. Eng.* **2018**, *2*, 9–17.
39. Ali, A.S. Complexity in refurbishment of services system for historical buildings in Malaysia. In Proceedings of the International Symposium on Advancement of Construction Management and Real Estate, Nanjing, China, 29–31 October 2009.
40. Nibbelink, J.-G.; Sutrisna, M.; Zaman, A.U. Unlocking the potential of early contractor involvement in reducing design risks in commercial building refurbishment projects–A Western Australian perspective. *Archit. Eng. Des. Manag.* **2017**, *13*, 439–456. [CrossRef]
41. Okoli, C.; Schabram, K. A guide to conducting a systematic literature review of information systems research. *Sprouts Work. Pap. Inf. Syst.* **2010**, *10*. [CrossRef]
42. Moher, D.; Liberati, A.; Tetzlaff, J.; Altman, D.G. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Int. J. Surg.* **2010**, *8*, 336–341. [CrossRef]
43. Moher, D.; Liberati, A.; Tetzlaff, J.; Altman, D.G.; PRISMA, G. Reprint—Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Phys. Ther.* **2009**, *89*, 873–880. [CrossRef]
44. Wang, M.; Wang, C.C.; Sepasgozar, S.; Zlatanova, S. A Systematic Review of Digital Technology Adoption in Off-Site Construction: Current Status and Future Direction towards Industry 4.0. *Buildings* **2020**, *10*, 204. [CrossRef]
45. 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]
46. Hsieh, H.-F.; Shannon, S.E. Three approaches to qualitative content analysis. *Qual. Health Res.* **2005**, *15*, 1277–1288. [CrossRef]
47. Creswell, J.W.; Creswell, J.D. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 3rd ed.; Sage Publications: Thousand Oaks, CA, USA, 2017.
48. Leong, C.W.K. Managing Epistemic Uncertainties in the Underlying Models of Safety Assessment for Safety-Critical Systems. Ph.D. Thesis, University of York, York, UK, 2018.

49. Kolltveit, B.J.; Karlsen, J.T.; Grønhaug, K. Exploiting Opportunities in Uncertainty During the Early Project Phase. *J. Manag. Eng.* **2004**, *20*, 134–140. [CrossRef]
50. Walker, W.E.; Harremoës, P.; Rotmans, J.; van der Sluijs, J.P.; van Asselt, M.B.A.; Janssen, P.; Krayer von Krauss, M.P. Defining Uncertainty: A Conceptual Basis for Uncertainty Management in Model-Based Decision Support. *Integr. Assess.* **2003**, *4*, 5–17. [CrossRef]
51. Zhu, J.; Mostafavi, A. Dynamic Meta-Network Modeling for an Integrated Project Performance Assessment under Uncertainty. In Proceedings of the Construction Research Congress, San Juan, Puerto Rico, 31 May–2 June 2016.
52. Ali, A.S.; Salleh, H.; Al-Zawawi, S.A.F. Coordination devices in the refurbishment design process: A partial-correlation approach. *J. Des. Built Environ.* **2009**, *5*, 19–30.
53. Yacob, R.; Saruwono, M.; Ismail, Z. Managing Uncertainty from Planning and Design to Construction Process of Building Refurbishment Projects: A Proposed Conceptual Approach. *Int. J. Sustain. Constr. Eng. Technol.* **2019**, *10*, 68–79. [CrossRef]
54. Ward, S.; Chapman, C. Transforming project risk management into project uncertainty management. *Int. J. Proj. Manag.* **2003**, *21*, 97–105. [CrossRef]
55. Oloke, D. Integrating Emerging Technologies for the Efficient Management of Health and Safety in Alteration and Refurbishment Projects. In Proceedings of the CIB W099 Belfast 2015, Ulster University, Belfast, Northern Ireland, 9–11 September 2015.
56. Holm, M.G. Service management in housing refurbishment: A theoretical approach. *Constr. Manag. Econ.* **2000**, *18*, 525–533. [CrossRef]
57. Yacob, R.; Saruwono, M.; Ismail, Z. A Review of Leadership Qualities among Building Refurbishment Project Managers. *Int. J. Eng. Technol.* **2018**, *7*, 126–131.
58. Saunders, F.C. Illuminating the Unknown: Mapping Project Uncertainty in Civil Nuclear Infrastructure. In Proceedings of the EPOC 2015 Conference, Edinburgh, Scotland, 24–26 June 2015.
59. Kiridena, S.; Sense, A. Profiling Project Complexity: Insights from Complexity Science and Project Management Literature. *Proj. Manag. J.* **2016**, *47*, 56–74. [CrossRef]
60. Gosling, J.; Naim, M.; Towill, D. Identifying and categorizing the sources of uncertainty in construction supply chains. *J. Constr. Eng. Manag.* **2012**, *139*, 102–110. [CrossRef]
61. Kemmer, S. Development of a Method for Construction Management in Refurbishment Projects. Ph.D. Thesis, University of Huddersfield, Huddersfield, UK, 2018.
62. Martinsuo, M.; Korhonen, T.; Laine, T. Identifying, framing and managing uncertainties in project portfolios. *Int. J. Proj. Manag.* **2014**, *32*, 732–746. [CrossRef]
63. Mokariantabari, M.; Adnan, H.; Hussin, M.; Abidin, Z.; Baharuddin, H.; Ismail, W. Assessment of complexity factors in briefing stage of refurbishment projects in Malaysia. In Proceedings of the IOP Conference Series: Earth and Environmental Science, Chulalongkorn University, Bangkok, Thailand, 24–25 April 2019.
64. Hon, C.K.H.; Chan, A.P.C.; Wong, F.K.W. An analysis for the causes of accidents of repair, maintenance, alteration and addition works in Hong Kong. *Saf. Sci.* **2010**, *48*, 894–901. [CrossRef]
65. Rahmat, I.; Ali, A.S. The involvement of the key participants in the production of project plans and the planning performance of refurbishment projects. *J. Build. Apprais.* **2010**, *5*, 273–288. [CrossRef]
66. Neale, B.S. Better value and safety for refurbishment projects through use of new standards. In Proceedings of the CIB W070 2002 Global Symposium, Glasgow, UK, 18–20 September 2002.
67. Saunders, F.C. Toward high reliability project organizing in safety-critical projects. *Proj. Manag. J.* **2015**, *46*, 25–35. [CrossRef]
68. Egbu, C.O.; Marino, B.; Anumba, C.J.; Gottfried, A.; Neale, B. Managing health & safety in refurbishment projects involving demolition and structural instability. In Proceedings of the CIB Working Commission, Glasgow, UK, 18–20 September 2002.
69. Oloke, D. Improving construction health and safety management in structural alteration and basement construction to existing structures. In Proceedings of the CIB W099 International Conference Achieving Sustainable Construction Health and Safety, Lund University, Lund, Sweden, 2–3 June 2014.
70. Bhuiyan, S.I.; Jones, K.; Wanigarathna, N. An approach to sustainable refurbishment of existing building. In Proceedings of the 31st Annual ARCOM Conference, Lincoln, UK, 7–9 September 2015.
71. Floricel, S.; Michela, J.L.; Piperca, S. Complexity, uncertainty-reduction strategies, and project performance. *Int. J. Proj. Manag.* **2016**, *34*, 1360–1383. [CrossRef]
72. Gidado, K.I. Project complexity: The focal point of construction production planning. *Constr. Manag. Econ.* **1996**, *14*, 213–225. [CrossRef]
73. Daniel, P.A.; Daniel, C. Complexity, uncertainty and mental models: From a paradigm of regulation to a paradigm of emergence in project management. *Int. J. Proj. Manag.* **2018**, *36*, 184–197. [CrossRef]
74. Hon, C.K.H.; Chan, A.P.C. Safety management in repair, maintenance, minor alteration, and addition works: Knowledge management perspective. *J. Manag. Eng.* **2013**, *30*, 04014026. [CrossRef]
75. Starbuck, W.; Farjoun, M. *Organization at the Limit: Lessons from the Columbia Disaster*; Blackwell Publishing Ltd.: Hoboken, NJ, USA, 2009.
76. Nota, G.; Aiello, R. Managing uncertainty in complex projects. In *Complexity in Economics: Cutting Edge Research*; Springer: New York, NY, USA, 2014; pp. 81–97.

77. Walker, D.H.; Davis, P.R.; Stevenson, A. Coping with uncertainty and ambiguity through team collaboration in infrastructure projects. *Int. J. Proj. Manag.* **2017**, *35*, 180–190. [CrossRef]
78. Bosch-Rekveldt, M.; Jongkind, Y.; Mooi, H.; Bakker, H.; Verbraeck, A. Grasping project complexity in large engineering projects: The TOE (Technical, Organizational and Environmental) framework. *Int. J. Proj. Manag.* **2011**, *29*, 728–739. [CrossRef]
79. Saunders, F.C.; Gale, A.W.; Sherry, A.H. Understanding project uncertainty in safety-critical industries. In Proceedings of the PMI Global Congress, Istanbul, Turky, 22–24 April 2013.
80. Fung, I.W.; Tam, V.W.; Chu, J.O.; Le, K.N. A Stress-Strain Model for resilience engineering for construction safety and risk management. *Int. J. Constr. Manag.* **2020**, 1–17. [CrossRef]
81. Wachter, J.K.; Yorio, P.L. A system of safety management practices and worker engagement for reducing and preventing accidents: An empirical and theoretical investigation. *Accid. Anal. Prev.* **2014**, *68*, 117–130. [CrossRef] [PubMed]
82. Petit, Y. Project portfolios in dynamic environments: Organizing for uncertainty. *Int. J. Project Manag.* **2012**, *30*, 539–553. [CrossRef]
83. Grote, G. Promoting safety by increasing uncertainty–Implications for risk management. *Saf. Sci.* **2015**, *71*, 71–79. [CrossRef]
84. Werner, J. An investigation of uncertainty dynamics within project management: Theoretical and empirical insights. Ph.D. Thesis, Heriot-Watt University, Edinburgh, Scotland, 2012.
85. Wall, T.D.; Cordery, J.L.; Clegg, C.W. Empowerment, performance, and operational uncertainty: A theoretical integration. *Appl. Psychol.* **2002**, *51*, 146–169. [CrossRef]
86. Grote, G. Safety management in different high-risk domains–all the same? *Saf. Sci.* **2012**, *50*, 1983–1992. [CrossRef]
87. DeMeyer, A.; Loch, C.H.; Pich, M.T. A framework for project management under uncertainty. *Sloan Manag. Rev.* **2002**, *43*, 60–67.
88. Pich, M.T.; Loch, C.H.; Meyer, A.D. On uncertainty, ambiguity, and complexity in project management. *Manag. Sci.* **2002**, *48*, 1008–1023. [CrossRef]
89. Chapman, C.; Ward, S. Why risk efficiency is a key aspect of best practice projects. *Int. J. Proj. Manag.* **2004**, *22*, 619–632. [CrossRef]
90. Geraldi, J.G.; Lee-Kelley, L.; Kutsch, E. The Titanic sunk, so what? Project manager response to unexpected events. *Int. J. Proj. Manag.* **2010**, *28*, 547–558. [CrossRef]
91. Saurin, T.; Bastos Costa, D.; Emuze, F.; Behm, M. Coping with the complexity of safety, health and well-being in construction. *Eng. Constr. Archit. Manag.* **2019**, *26*, 2509–2518. [CrossRef]
92. DEMeyer, A.; Loch, C.H.; Pich, M.T. Managing project uncertainty: From variation to chaos. *MIT Sloan Manag. Rev.* **2002**, *43*, 60–67.
93. Grote, G. Uncertainty management at the core of system design. *Annu. Rev. Control.* **2004**, *28*, 267–274. [CrossRef]
94. Reiman, T.; Rollenhagen, C.; Pietikäinen, E.; Heikkilä, J. Principles of adaptive management in complex safety–critical organizations. *Saf. Sci.* **2015**, *71*, 80–92. [CrossRef]
95. Olsson, R. In search of opportunity management: Is the risk management process enough? *Int. J. Proj. Manag.* **2007**, *25*, 745–752. [CrossRef]
96. Ranasinghe, U.; Jefferies, M.; Davis, P.; Pillay, M. Resilience Engineering indicators and safety management: A systematic review. *Saf. Health Work* **2020**, *11*, 127–135. [CrossRef] [PubMed]
97. Saunders, F.C.; Gale, A.W.; Sherry, A.H. Responding to project uncertainty: Evidence for high reliability practices in large-scale safety–critical projects. *Int. J. Proj. Manag.* **2016**, *34*, 1252–1265. [CrossRef]
98. Hollnagel, E.; Woods, D.D.; Leveson, N. *Resilience Engineering: Concepts and Precepts*; Ashgate Publishing, Ltd.: Farnham, UK, 2007.
99. Roberts, K.H.; Rousseau, D.M. Research in nearly failure-free, high-reliability organizations: Having the bubble. *IEEE Trans. Eng. Manag.* **1989**, *36*, 132–139. [CrossRef]
100. Pillay, M. Resilience engineering: A state-of-the-art survey of an emerging paradigm for organisational health and safety management. In *Advances in Safety Management and Human Factors*; Springer: Cham, Switzerland, 2016; pp. 211–222.
101. Harvey, E.J.; Waterson, P.; Dainty, A.R.J. Applying HRO and resilience engineering to construction: Barriers and opportunities. *Saf. Sci.* **2016**, *117*, 523–533. [CrossRef]