Performance measurement in construction research & development: The use of case study research approach

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Abstract

The process of finding solutions to the research problem does not follow a clear sequential approach, but often takes unexpected turns due to the uncertainties of the research process and its outcomes. However, appropriate research design would be able to identify any problems and pitfalls that the researcher may come across during the process. In this regard, consideration of the research philosophy pertaining to the study helps a researcher in choosing the appropriate approach for a study. Not only the philosophical stance, but also the research problem under investigation and its underlying circumstances influence the selection of a research approach. Accordingly, this paper discusses the factors that drive the selection of a case study as the research approach with particular reference to the use of single case study to undertake an in-depth inquiry regarding the impact of performance measurement towards construction research and development. Further, this paper discusses the incorporation of multi-phase, multi-perspective and multi-method approaches within the single case study to build valid theory.

Keywords: Interpretivism, Single case study, Performance measurement, Research approach, Research and development

1. Background

Research and development (R&D) activities play an important role within the construction industry by developing advanced and new construction materials, processes and management methodologies to successfully address its stakeholder needs. Further, R&D activities help to enhance the effectiveness and efficiency of construction processes and address resource constraints and sustainable goals [1, 2]. Moreover, R&D activities facilitate the exploration and creation of new knowledge and capabilities within organisations to help them compete successfully in the marketplace [3]. Hence, prioritising R&D activities, creating longer term R&D
programmes and increasing investment on R&D activities have been identified as vital factors for the growth of the construction industry ([4, 5]).

Due to rising costs, time and other resource constraints, much attention is paid on identifying the actual contributions from construction R&D activities, justifying and showing the accountability of resources spent, and ensuring outputs are aligned with expected goals. The inadequacy of mechanisms to evaluate the success of R&D activities and the effective usage of funds has negatively affected these activities in construction (see [6, 7]). R&D has also become more complex, as it involves many stakeholders and has a wide range of interrelated activities [8]. Lack of communication and coordination between stakeholders and lack of clear objectives to address their requirements are evident within construction R&D. Consequently, these issues have lowered the investments for construction R&D and resulted in producing research results with low applicability.

It was revealed that, to address the issues within construction R&D, effective control and monitoring mechanisms are needed [7]. Thus, this study suggests the implementation of Performance Measurement (PM) within the construction R&D function to enhance its success (see [7]). The utilisation of PM systems within the construction R&D function would generate benefits including: evaluating the success of R&D activities; identifying the future improvement areas and required support for such activities; the proper allocation of resources, and improved communication, coordination and direction of employees towards common goals [7, 9]. Through the literature, it was identified that the concept of PM within construction R&D is not adequately exploited. Therefore, this study intends to address this gap with particular reference to its PM application. Accordingly, the aim of the study is to explore the influence and impact of performance measurement on the construction R&D function. To achieve this aim, following research questions are formulated:

- what is the importance of R&D to the construction industry?
- what is the current position of construction R&D function?
- what are the critical success factors of construction R&D function?
- how is the performance of construction R&D function measured?
- how can PM influence the performance improvement of construction R&D function?

This paper discusses the research methodology adopted for this study with particular reference to the use of single case study as the research approach. The paper first presents the philosophical stance pertaining to the study. Secondly, the selection of case studies as the research approach and rationale behind the use of single case study is presented. Next, the paper examines the phases and methods used during the single case study to build theory.

2. The research methodological design

The main intention of any research is to add value to the accumulated knowledge through the means of identifying, investigating and producing solutions to an unsolved problem [10]. The process of finding solutions to the research problem is “not a clear cut sequence of procedures
followed by a neat pattern, but a messy interaction between the conceptual and empirical world” (Bechhofer, [11] cited in [12]). Booth et al [13] also agree with this view stating that “research follows a crooked path, taking unexpected turns, even looping back itself”. Even though the research process is uncertain and risky, the appropriate research design would minimise the possibilities of any failure by identifying and forecasting problems and pitfalls that the researcher may come across. In addition, research design looks into the philosophical aspects of the research which in turn helps to identify the overall research strategy (collection, analysis and interpretation of data to draw up conclusions); evaluate various research methods and identify their limitations; increase the compatibility of research approaches and research techniques.

To design the research methodology logically and systematically, the researcher used Kagioglu et al’s [14] hierarchical model. This model nests the research philosophy, approach and techniques (Figure 1) where the outer ring “guides and energises the inner research approaches and research techniques” [14]. Adherence to the nested model ensured the chosen research philosophy, approach, and techniques are compatible with each other and as a whole cater for the requirements of this study.

![Figure 1: Nested approach [14]](image)

Following sections further describe the research philosophy and research approach pertaining to this study in detail.

### 2.1 Research philosophy

Gill and Johnson [12] stipulate that there is no one best approach to research but rather a compromise between the options based on the philosophical understanding or basic beliefs about the world. Agreeing with this view, Easterby-Smith et al [15] also recognises research philosophies as the base for effective research design and argues that failure to adhere to philosophical issues can affect the quality of the research negatively. There are two main research philosophies - Positivism and Interpretivism - which can be placed at the two extreme ends of a research continuum [15]. Three assumptions can be identified within these philosophical stances i.e. Ontology, Epistemology and Axiology. Ontology seeks to identify the nature of the reality; Epistemology shows how we acquire and accept knowledge about the world; and Axiology indicates the nature of the values the researcher placed on the study [15,
16]. The following section evaluates how positivism and interpretivism is characterised with the ontological, epistemological and axiological assumptions.

### 2.1.1 Positivism

Positivism takes the ontological assumption of reality as having a predetermined nature and structure. This is known as “realism” [17] or “objectivism” [18]. Further, the positivist lies on the epistemological assumption that the properties of reality needs to be measured through objective measures rather than interfering subjectively through sensation, reflection or intuition [15]. Moreover, the positivist believes that the process of research is value free in terms of the axiological assumption [16, 18]. Thus, the researcher would detach from the research environment and takes the role of an independent observer without interfering with the research environment and would not allow the values and bias to distort the research results. In addition, the positivist uses deductive method i.e. abstracting a concept prior to testing it through empirical evidence [12, 15, 16].

### 2.1.2 Interpretivism

The Positivistic approach which was originally used to study the natural science was criticised when applied within the social science as the latter deals with human behaviours. It is argued that humans cannot be treated as objects and theories that lead into definite laws due to the fact that humans are influenced by feelings and perceptions. Thus, conversely to positivistic studies, interpretivism is based on the ontological assumption that the external world does not have a predetermined nature or structure but is created by the perceptions and consequences of humans. This is known as “idealism” [19] or “subjectivism” [18]. Further, interpretivist lies with the epistemological assumption that the properties of reality can be measured through subjective measures by examining the perceptions of people [15, 16]. Thus, rather than searching for casual explanations or for external factors, interpretivist admire the different views that people place on their experiences. This makes the researcher more closely interactive with the research environment unlike in the positivist studies. Due to this close interaction, the interpretivist believes that the research is value laden, thus choice of what to study and how to study is determined by human beliefs and interests [15, 16]. Further, the interpretivist generates ideas and theories inductively by getting rich data from the study itself.

Interpretivism can be identified as the most appropriate research philosophy for this study due to a number of reasons. To achieve the aim the study the researcher was required to identify different views of the people regarding the importance, success factors and suitable performance measures related to R&D within the construction sector. Hence, the study valued and encouraged the free flow of ideas, opinions and perceptions of the people, and based on their experience within the research environment thus, considers the human interaction as the main driver of the study. Hence, the study takes the ontological assumption of ‘reality is not pre determined, but socially constructed’ and the epistemological assumption of ‘the knowledge is gathered by examining the views of the people’. In terms of the axiology, the study takes the value laden stance as it is believed that the researcher would add value to the study. The
characteristics of positivism and interpretivism based on ontology, epistemology and axiology and the philosophical stance pertaining to this study (shown with a red circle) are illustrated in Figure 2.

Figure 2: The philosophical stance pertaining to the study against the research philosophical continuum

Having identified the philosophical stance, the next section looks into the research approach governing to this study.

2.2 The research approach

There are number of research approaches where ones research can be based upon, such as experiments, surveys, case studies, action research, and ethnographical studies. Since the parameters are controlled and simplified with hypothesis, experiments are mostly associated with the deductive approach. Similar to experiments, surveys are also related to deductive approach [18]. Collins and Hussey [16] describe case studies as “an extensive examination of a single phenomenon”. Unlike the experiments which separate the phenomena from their context, case studies are carried out within the rich, real-world context which the phenomena occurs [20-22]. As opposite to experiments and surveys, ethnographical studies are rooted within the inductive method. In the ethnographical research, the researcher uses the socially acquired and shared knowledge to understand and interpret the human activities [16]. Thus, this approach is suitable to investigate the characteristics of people, their societies and customs. Action research is based on the assumption that the social world is changing constantly and the researcher and the research are also part of the change [16]. Therefore, the researcher will become a part of the environment under study whilst trying to solve practical problems [23-25] and influence the attitudes and behaviours of the participants [26].

From the above discussion, it is evident that research approaches tend to favour deductive or inductive method based on the way they build theory. From the discussions in Section 2.1.1 and 2.1.2 it was revealed that the interpretivist prefers inductive method whilst positivist prefers deductive method. Therefore, by considering these views it can be claimed that the research approaches are likely to be harmonised well with a particular research philosophy than the
other, thus the selection of the research approach needs to reflect the philosophical stance of the study. Accordingly, the researcher plots the research approaches against the philosophical continuum (see Figure 3).

![Figure 3: Research approaches within the philosophical continuum](image)

Having developed the relationship between the research approach and philosophy, the following section justifies the use of case study for this study.

### 2.2.1 Case studies as the research approach

According to figure 3, experiments and surveys are more towards positivism while case studies, action research and ethnography are more towards interpretivism. Since this study takes the interpretivism stance with regard to the philosophy, the use of experiments and surveys are unjustifiable. Accordingly the researcher has to make a choice between ethnography, action research, and case studies. The research under consideration does not intend to influence or change the attitudes or procedures of the participants or the environment as in action research. Further, it does not intend to study behavioural patterns or psychology of the participants as in ethnographical studies. Hence, the case study approach is preferred for this study to explore the PM applications within construction R&D over action research and ethnography.

In addition to the philosophical stance, the research questions posed in a study influence the selection of a research approach. Yin [21] stipulates that “how” and “why” type of explanatory questions favour the use of case studies whilst “what” type of questions support exploratory research. This study consisted of “what” and “how” type of questions (see Section 1) thus, by using the case study research approach, much insight can be obtained firstly by exploring and secondly by explaining the phenomenon under investigation.
Moreover, based on the degree of focus on the contemporary events as opposed to historical events, a researcher can decide a suitable research approach. As Yin [21] states, case studies are more suitable to study contemporary events. Since this study considers a contemporary phenomenon, i.e. the impact of PM towards construction R&D, the selection of case studies can be further justified.

The above section provided three rationales for the selection of case studies; firstly considering the philosophical stance coupled with the requirements of the study, secondly based on the research questions posed and thirdly due to the contemporary nature of the study. The section below further justifies the selection of case study research approach by providing the added benefits of case studies and elaborates on the design aspects of the case study for this study.

### 2.3 Case study design

The unit of analysis and scope of this study (see Section 2.3.2) requires the consideration of multiple perspectives from different categories of people involved in the construction R&D function. Furthermore, to find solutions to the research questions given in Section 1, and the exploratory and explanatory nature of the study, multiple data collection techniques were needed to cater for the varying purposes of the study. Thus, it became an advantage for this study to choose a research approach that assists an in-depth analysis by incorporating multiple methods. As Zonabend [27] asserts case studies are carried out in a way that incorporates the views of the “actors” of the case under consideration. Further, Gerring [28] stipulates that “one of the primary virtues of the case study method is the depth of analysis it offers” and the use of multiple sources of evidence for data collection [18, 21]. Thus, by using the case study research approach, the study gains the depth of inquiry as well as the utilisation of multi-methods as required.

Despite the advantages discussed above, case studies are criticised for biasness, use of incomplete evidence and for being time consuming and expensive [10]. Yet it can be argued that, if not properly designed the biasness can be included in surveys and experiments. Although case studies are considered as time consuming and expensive, careful design can minimise time and budget. In addition, case studies have a number of advantages which can offset their inherent drawbacks. As mentioned above, case study research approach embraces variety of evidence such as document reviews, interviews, and observations [10, 18] which is considered as a strength that increases the richness of the collected data whilst creating the prospects for data triangulation.

Having chosen case studies as the research approach based on the philosophical stance, research requirements, research questions, contemporary nature, and by considering the added benefits, the next section explains the compromise made between the use of single and multiple case studies.
2.3.1 Single vs. multiple case studies

As stipulated by Yin [21], case studies can be broadly divided into multiple and single and then depending on the number of unit of analysis, embedded (more than one unit of analysis) and holistic (one unit of analysis). A single case study approach is suitable when it investigates critical, unique, representative, revelatory or a longitudinal study [21]. A critical case can be used to challenge, confirm or extend a theory whilst the unique case represents a rare situation. As opposed to a unique case, a representative case captures a common situation or a “typical” project, thus, studying one case is sufficient to get an understanding about other situations. A revelatory case can be used to study a phenomenon that was inaccessible earlier. From a longitudinal case, the phenomenon will be studied over a time period observing how certain conditions have been changed with time. The study under consideration falls under the critical case as it sought to develop and refine a theory on the impact of PM towards construction R&D. The researcher argues that to develop a valid theory, it is critical or important to apply it to the existing situation and refine it. Thus, by taking the critical view, the abstracted concepts will be applied to the existing situation (i.e. the R&D function) and refine it.

Furthermore, this study takes a longitudinal approach as the phenomenon under consideration i.e. PM within construction R&D function is a dynamic process. One of the objectives of the study is to develop a Performance Measurement System (PMS) that could be used to identify the impact and influence of PM on the construction R&D function. To identify the actual impact of PM on the function, the PMS developed through the study needs to be tested on a R&D project, over a time period. Nevertheless, when considering the scope of a PhD, testing the PMS on a R&D project is not practical due to their life span. This is considered as a limitation of this study. As an alternative, it is expected to present the developed PMS to a group of experts through a workshop during the theory refinement stage of the case study, and thereby to assess the impact and influence the PMS could provide to R&D function. With such practical limitations a similar refinement and identification of the impact of key performance indicator’s (KPI) on a Knowledge Management environment was done by Pathirage et al [29]. In his study, a structured survey was used during the refinement stage to get the views regarding the impact of KPIs. Accordingly, by taking the longitudinal view, this study explored the current situation within construction R&D function, designed and proposed solutions to enhance the effectiveness of R&D activities and finally obtain the views of expertise on the anticipated benefits of the use of PMS.

The third rationale for the selection of single case study is based on the depth of coverage from this study. Generally speaking, by using multiple case studies, a researcher can increase the breadth of a study. However, the single case study provides the opportunity to explore the phenomenon in detail. Though single case studies are often criticised for not generalising conclusions, many authors argue that the number does not matter as long as the case study addresses its stipulated objectives [21, 30, 31]. Consequently, if it is designed and conducted appropriately, even a single case study would be able to contribute to the knowledge rather than a poorly designed multiple cases. By taking forward this argument, the researcher also believes that what matters is not the quantity of case studies (because the quantity cannot substantiate the
quality of the research work), but designing the case study to suit its scenario governed by the aim of the study. Since this study expects the continuous development and refinement of theory the researcher needs to carry out an in depth study by making a compromise between the breadth and depth. The depth of coverage using multiple data collection methods, multiple perspectives and at three different instances is further discussed in Section 2.4.

In brief, the study chose the single case study approach due to the criticality of the theory development and refinement of the phenomenon, the longitudinal view of the study and the depth of inquiry. The next section looks in to the unit of analysis pertaining to this study.

### 2.3.2 The unit of analysis

As asserted by Miles and Huberman [32], the unit of analysis of a study is a “phenomenon of some sort of occurring in a bounded context”. According to Collins and Hussey [16] it is the focal point where the variables, phenomena and the research problem referred to and about which the data is collected and analysed. Because of its importance, Miles and Huberman [32] identify the unit of analysis as the “heart” of the study. Remenyi et al [10] states that the decision of the unit of analysis is governed by the research questions of the study. The unit of analysis of a case study can range from an individual, group of people, to a process or relationship (see [10, 21]). It is advisable to establish the unit of analysis similar to a previous study by considering the literature in the subject area rather than establishing it arbitrarily [10, 21]. Accordingly, by considering the research questions posed for the study (see Section 1) and by considering the previous literature (see [33]) R&D function was selected as the unit of analysis of the study. R&D function was defined as the “set of activities necessary to effectively and efficiently initiate, co-ordinate and accomplish the product and process development activities of a company” [34]. Therefore, by fixing the unit of analysis at the R&D function, this study takes the single-holistic case study nature.

Having identified the unit of analysis, the researcher fixed the boundary of the study. Definition of the boundary helps the researcher to identify the scope of the study, for example to determine the limits of the data collection [21]. Construction R&D activities can take the form of academic research, industrial research and collaborative research between academia and industry. It was identified from the literature and expert interviews that collaborative research yields number of benefits [35, 36]. Thus, the unit of analysis was extended outwards to represent multiple organisations namely the universities and construction organisations which fall under the scope of the study. Accordingly the data was gathered from the individuals (academics and industrial partners) employed in those multiple organisations regarding the R&D function.

### 2.4 The case study process

As discussed in Section 2.3.1, the single case study approach was selected for this study. Accordingly, the researcher explored and understood the PM concept within the construction R&D function, without controlling the variables but rather taking into account the variables applicable and studying the inter relationships between R&D and PM. As noted by Strauss and
Glaser [37], theory building requires the ongoing comparison of data and theory. Adding to that, Lynham [38] asserts continuous refinement between theory and practice is also needed for the effective theory building. This section describes the case study process used for the theory building and refinement with particular reference to the stages and objectives of the case study.

As mentioned in Section 2.2, the deductive method starts by conceptualising the phenomenon followed by empirical observation to test it whilst inductive method starts with empirical observation to develop theory. Further, it was noted that the positivism research takes a deductive method whereas the interpretivism takes the inductive method. However, it was justified that the research under question take the interpretivist stance in terms of the philosophy (see Section 2.1). Therefore, should this study use a purely inductive method and generate the theory from the data itself? Eisenhardt and Graebner [20] provide much insight to answer this question by stating that case study research starts with a deductive approach and moves on to an inductive approach to build theory. The importance of having an initial definition of the research question prior to starting theory building was highlighted, otherwise the researcher can become overwhelmed by the amount of data gathered. Similarly Yin [21] asserts the need of pre-establishing a theory or conceptualising the phenomenon prior to data collection and analysis process. Accordingly, before starting the case study approach, the researcher conceptualised the PM in construction R&D function by deriving research questions through a comprehensive literature review and expert opinion. Thereafter, during the case study design and preparatory stage (refer Figure 4), a suitable case study was selected and the data collection protocols were prepared and piloted. With this background, the researcher started the actual data collection within the case study. The case study took multi-phase approach that consisted of three stages of data collection (refer Figure 4).

The first stage took on an exploratory nature by investigating the current status of construction R&D, application and need of PM within R&D, and exploring the success factors of construction R&D in general. For this semi-structured interviews were carried out. The second and third stages also took an explanatory nature. Accordingly, during the second stage, the critical success factors of construction R&D function was established by administering a questionnaire survey. The data from the first and second stage lead to the development of the PMS to identify the impact of PM towards construction R&D. During the third stage, it is expected to refine the theory developed through the case study and to suggest solutions for effective PM within the construction R&D function.
During the case process, the researcher adheres to a number of characteristics to enhance the completeness, validity and reliability of the study (refer table 1)
Table 1: Characteristics of an exemplary case (adopted from [10])

<table>
<thead>
<tr>
<th>Character</th>
<th>Description</th>
<th>How it is addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant</td>
<td>Case study is of interest to the relevant stakeholders</td>
<td>Through the literature and expert opinion, the need for PM within R&amp;D function was established. Further, paucity of research in this area created the need of further research.</td>
</tr>
<tr>
<td>Complete</td>
<td>Clear definition of research problem, identification of boundaries of the case study</td>
<td>Establish the research problem through a comprehensive literature review and refinement of the same through expert opinion. Through the research questions the study gained the focus and identified the areas to be explored. Identification of unit of analysis and scope of the case study ensured the proper establishment of a boundary.</td>
</tr>
<tr>
<td>Consider alternative perspectives</td>
<td>Collecting the relevant evidence from different perspective and triangulation of evidence</td>
<td>The evidence was gathered from principle investigators, researchers and industrial partners to corroborate the same issues. Triangulation of evidence in terms of source, methodology.</td>
</tr>
<tr>
<td>Display sufficient evidence</td>
<td>Present compelling and convincing evidence</td>
<td>Through the data analysis, the initial research questions and thereby the aim and objectives of the study was addressed. Creating links between the literature and empirical evidence, consideration of the different perspectives to corroborate the evidence.</td>
</tr>
<tr>
<td>Composed in an engaged manner</td>
<td>Ensuring the validity and reliability of the study</td>
<td>Number of good practices was adopted to ensure the reliability and validity of the study (member checking, preparation of interview guidelines, tape recording the interviews, piloting the survey etc.).</td>
</tr>
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</table>

In brief, it can be summarised that the initial concepts abstracted through the literature review and expert opinions were empirically observed, validated and will be refined by employing a multi-phase single case study approach, by considering multiple perspectives and by using multiple methods for data collection.

3. Conclusions

The paper explored the use of single case study research approach to evaluate the impact of PM towards construction R&D function. It was revealed that the proper understanding of the philosophical issues followed by a clear definition and design of research strategy are essential elements in developing successful research. Through the use of single case study, the paper emphasised that what matters is not the number of cases, but the appropriate design and selection of methods to investigate the research in question. Therefore, it can be concluded that the application of single case study to investigate the impact of PM in construction R&D function by incorporating multi-phase, multi-perspective and multi-method approaches will enable us to build up a valid theory due to the continuous comparison of empirical data with the study’s initial concepts (propositions) and the refinement of the developed theory within the same case study.
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