Survey Studies in Construction Project Engineering

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Abstract. Construction project engineering provides us with both specialist knowledge and the skills and competencies necessary in decision-making concerning construction company management and carrying out construction projects, which requires reliable information and a wealth of knowledge on technical, societal, legal and economic conditions in the aspect of carrying out the process of construction, in addition to the skills necessary to make managerial decisions under market conditions while accounting for the expectations and preferences of developers and users alike. Survey studies can be a source of this data. This paper presents the results of the author's research experience and proposals concerning the possibility of applying survey studies in construction project engineering. The author presented the results of many years of her original studies and analyses of the potential for applying survey methods in construction project engineering, a methodological and analytical approach typical for studying social phenomena and processes which is rarely used in the technical sciences. The author argues that the methods are appropriate and can be helpful in construction project engineering and, as a result, can support decision-makers in the process of making decisions. The author analysed and described the possibility of applying survey studies in both research and practice in the field of construction project engineering and proposed a typology of survey studies in said field. Survey methods are a source of valuable data, either individually or when paired with other methods, and can provide information that is then studied by researchers. The conclusions of these studies can be used to diagnose and prognosticate phenomena and problems or to control processes. Most importantly, such studies and their results support decision-makers in the difficult process of making decisions. When designing and carrying out survey studies, one should always inspect the soundness of the survey's design and measurement quality (reliability and accuracy). Further studies should focus on developing measurement reliability verification methods adequately to the most common research problem groups in construction project engineering. There also exists a practical need to develop proposals of survey question sets that correspond to the most commonly observed research problems in construction project engineering.

1. Introduction

Survey study methods should always be carefully selected and be well-suited to the problem and subject under study. In survey studies, the subject of study is the individual, as we study their opinions, views, needs and preferences. At the construction site, we are primarily dealing with work performed by individuals (workmanship, construction services) performed for individuals (the developer, the client, the user). There are dependencies, relations and connections between construction project participants, in addition to numerous external factors [1]. Technical and engineering matters mutually interweave and blend with economic, market-based or societal ones. Survey studies, performed in the form of either qualitative or quantitative studies, are the primary approach to investigating the attitudes and preferences...
of consumers or of obtaining specialist expert opinions. The process of designing and carrying out these studies is critical, as is the verification of procured data. Survey studies are typically a starting point for further research and analyses of specific problems in construction project engineering, as demonstrated in [2, 3, 4].

Construction project engineering provides both specialist knowledge and the skills and competencies necessary in decision-making, concerning both managing a construction company and carrying out construction projects, which requires reliable information and a wealth of knowledge concerning technical, societal, legal and economic conditions in the aspect of managing the construction process and the skill of making managerial decisions under market conditions while accounting for the expectations and preferences of both developers and users. Survey studies can be a source of this information [5, 6].

This paper presents the results of research experiments and the author's proposals concerning the suitability of applying survey studies in construction project engineering. The author analysed and described the potential of applying survey studies in the study and practice of construction project engineering and proposed a classification of survey studies for use in this field.

2. Overview of survey studies in construction project engineering

2.1. Expert opinion polls
Opinion polls focused on experts—who are specialists in a given field—are often used in construction project engineering research. The role of these studies is critical and their suitability is undeniable in at least two cases:
- during initial research stages, aimed at identifying the problem under analysis;
- at the stage of data procurement aimed at, among other things, conducting multi-criteria analyses or to design expert systems in academic papers, and ultimately delivering practical tools for practical application, which, among others, took place in the case of [7,8].

In the first case, survey studies are performed on a group of specialists, typically practitioners and professionals (e.g. construction site managers). The studies are meant to answer the question whether the problem that attracted the researchers' attention during literature studies and reviews remains inadequately solved from an academic and professional perspective (a lack of effective methods and tools of solving it), and also whether it poses a problem (how significant is it?) to the groups and persons who encounter it in their everyday work (e.g. practitioners at a construction site). The studies are intended to diagnose emergent problems, their state and the manner of their practical solution, any missing tools that might solve them, needs (e.g. in terms of an IT system), and act as a stimulus for greater engagement with the subject as a part of further academic study (problem, situation, the phenomenon is modelled and appropriate research methods will be either selected and applied or formulated). As a result of academic research, the model and the methods will be validated and practitioners will, after a certain time, propose an answer to the problems in question, for instance in the form of a useful specialised decision-making support tool. Therefore, survey studies focusing on expert opinions are the first key stage in construction project engineering research.

In the second case, survey studies are also used as a tool to procure data from experts. This type of data can prove critical in applying specific methods to given research problems. These methods can be utilised at the stage of constructing the model of the phenomenon under study. In this case, survey studies are used to, for instance, assess parameters and their weights or to formulate a set of rules for use in expert systems. The proper selection of experts—individuals who are competent, highly knowledgeable and experienced in the subject under study (as documented by the number of years an expert has worked in a given specialisation) and their motivation to participate in the study. Groups of trusted experts selected for participation in such studies typically constitute several persons (up to ten).
During the model's validation, expert opinion surveys focus on assessing the model's output and the possibility of the model's practical application (Figure 1).

![Diagram of survey study process]

**Figure 1.** Scheme of a sample application of survey studies in academic research

2.2. User and client opinion surveys
User and client opinion surveys typically target both potential, current and former clients. Supporting the market decisions of developers, designers and construction contractors is one of the critical roles that survey studies play in construction project engineering. To this end, it is necessary to collect the opinions of potential clients about their needs and preferences concerning construction products,
including goods and services, as well as ratings of already purchased products by current and former clients.

2.3. Cross-sectional and longitudinal surveys
Survey studies can either be performed once or be repeated multiple times while using the same questionnaire. Surveys that are repeated multiple times can be carried out in the form of panel or tracking surveys. Such studies are conducted at a specific time interval, which typically does not change.

Panel studies are based on several rounds of measurements of the same population with the intent to study and explain the dynamic of a certain change or investigate the characteristics of individuals or organisations. In this method, the results of surveys performed several times at justified time intervals, using the same tool—the questionnaire—are compared with each other. In the case of panel studies, the essential role of survey studies is to monitor change. If the survey is repeated at a predefined, regular interval, it is possible to continuously monitor changes, e.g. market changes.

Tracking studies also belong to the longitudinal studies group; however, they differ from panel studies in that they are performed on an analogously selected research sample that is composed of different respondents.

In summary, the panel survey method is a longitudinal study method that is repeated on the same target population at a certain interval using the same questionnaire, while tracking surveys employ the same research tool—the questionnaire—and the population and structure of the survey are defined identically, but the study is performed on individuals who have not participated in previous surveys.

The results of studies that were performed three times over the course of the last fifteen years and were intended to assess the opinion of the residents of Lublin's housing estates concerning occupancy and maintenance in respect to renovation demand were presented in [9].

2.4. Qualitative and quantitative studies.
Depending on the type of research material and how it is analysed, we can distinguish qualitative and quantitative studies.

Quantitative studies are based on questionnaires composed solely of closed questions which are scaled and constrain the answers of the respondents so that they can choose only one answer. In these studies, it is possible to perform a statistical analysis of data.

Scaling answers is the most difficult task here, which is why quantitative studies are often preceded by qualitative studies that employ open questions. In such cases, qualitative studies provide information about the possible answers that respondents can give to each problematic question and can form a basis for formulating variable values for the quantitative study questionnaire. The objective of qualitative studies can be determining market parameters, analysing the nature of decision processes, identifying motivating factors and attitudes that affect consumer behaviours. If qualitative studies are used to formulate guidelines for quantitative studies, they are performed ahead of them.

Survey studies performed using interviews or surveys can be limited only to data collection, or can be performed in two stages, i.e. as qualitative studies followed by quantitative studies, with the reverse order being used rarely, or they can focus solely on qualitative data.

The following section of the paper will briefly discuss the aspect of applying survey studies for marketing purposes from the perspective of a construction company.
In construction companies, managers make a broad range of decisions, ranging from the conceptualisation of services to selling them and maintaining communication with clients. Reliable information is required to make proper decisions and adopt a good marketing strategy for a construction company operating in a competitive market. Such information can be provided by survey studies, which in this case can be described as the systematic collection, analysis and presentation of data with the intent to improve the decision-making process of a construction company.

The author proposed examples of subjects for study that construction companies should investigate either independently or by commissioning studies from specialist research facilities:
- demand for the company's services and whether it has a rising or declining trend,
- changes and fluctuations in domestic and foreign market demand,
- factors that affect client-developer decisions during contractor selection,
- client preferences concerning services, their characteristics, the process of performing the service (technology, materials) and its completion time,
- client satisfaction surveys, if they are not satisfied, then why,
- client profiling, who they are, how do they behave during and after purchasing the company's services, the course of the purchase decision process,
- client purchasing power,
- market trends, their causes and effects,
- new technical and technological solutions and their public perception,
- technological and material solutions used by the competition,
- external conditions the company operates in, including societal, political and economic conditions,
- studying the structure and segmentation of the construction market,
- the company's market position, opinions of the company and its services, the company's image among its clients,
- competitive companies and how they operate, what do clients think about them and their services, comparison of the organisation, management and strategy of competing companies,
- construction service pricing and its attractiveness to clients,
- service distribution (sales point network) and its effectiveness,
- promotion, including advertisement, pre-tests of advertisements, advertisement effectiveness,
- studying financial, material and human resources, surveying the company's employees and cooperants.

When a construction company surveys client demand, preferences and satisfaction, it is advised to investigate not only the fact of performing a construction service, but also the construction materials that were used and their parameters. Similarly, construction material manufacturers, when investigation client demand, preferences and satisfaction, should focus not only on the material itself, but also on the construction service. In the case of design and construction companies and real estate development companies, it is advised to study demand and preferences concerning the parameters of buildings that are being designed among future users (the image of the perfect product in the client's eyes).

Furthermore, one of the functions of management is human resources controlling. Here, internal survey studies can be used to control staff in terms of competencies, work ethic, reliability, cooperation and client interaction skills.

The typology and applications of survey studies differ depending on the represented discipline and specialisation. For instance, in sociology, one can find a general typology of survey studies in a renowned publication of the Institute of Philosophy and Sociology of the Polish Academy of Sciences [10]:
- public opinion polls (e.g. election polls),
- market surveys, marketing or consumer surveys (e.g. consumer preferences for specific products),
- academic studies (cognitive goal, e.g. public opinion and attitude polls).

When formulating an analogous division for the purposes of applying survey studies in construction (particularly in construction project engineering), two types of surveys can be distinguished (Figure 2).

1. Survey studies, as an element of academic research and one of the links of the chain of the academic research process, are performed:
   a) at the stage of identifying the academic and practical problem (immediately after or in parallel to a review of the literature);
      expert opinion surveys, e.g. among site managers:
      - analysis of the state of the art, problem overview,
      - analysis of the degree to which the problem has been solved in practice,
      - analysis of the suitability of methods that were previously used to address the problem,
   b) during the model construction stage (description of an interesting aspect of reality in the form of a mathematical model);
      expert opinion surveys focusing on:
      - parameter selection, module structure,
      - determining inter-parameter dependencies,
      - assessment of parameters that are difficult to measure and their significance,
      - formulating a base of rules for expert systems,
   c) during the expert opinion model validation stage in terms of:
      - assessing the output of the model and its possible practical application,

2. Market and marketing studies,
   in this case, data procured from samples are subjected to statistical analysis and its results and conclusions aid the construction company in making accurate decisions;
   these include user or potential client surveys, e.g.
   - demand surveys,
   - preference surveys,
   - client satisfaction surveys,
   - room comfort of use surveys, e.g. due to noise,
   - thermal comfort surveys.

Figure 2. Fields of interest for survey studies in the construction sector
Below is a presentation of a cycle of publications wherein survey studies played an essential, complementary role. In [11], its authors presented the results of a study in which a group of expert specialists assessed dependencies between factors that affect the criterion of benefits to society and the benefits derived from preserving cultural heritage via a survey study questionnaire. These criteria were a part of a group of parameters employed in the analysis and rating of alternative forms of use for the adaptive reuse of the Stara Polana heritage site in Zakopane, Poland. Other parameters, associated with, among other things, acoustics, vibrations or thermal comfort, were assessed on the basis of studies that employed specialist technical devices. Interdisciplinary studies were the basis for multi-criteria analysis based on a hybrid model of selecting a form of use in the adaptive reuse project of a heritage site presented in [12]. Expert opinion surveys will also be used during the stage of assessing the impact of and dependencies between measureable and difficult-to-measure parameters, something which the authors are currently investigating. This publication is an example of good academic and utilitarian cooperation, wherein the complementary application of different methods, including surveys, is necessary to solve the research problem at hand.

3. Survey study classification in construction project engineering

The role of survey studies in construction project engineering is primarily informative, i.e. it is the procurement of information. It is based on collecting, processing and transferring information with the aim of supporting decision-making. Based on a review of the literature and her own academic experience, the author defined the potential applications for survey studies in construction project engineering. This section presents a classification of survey studies and discusses their application, the possibilities of doing so and the functions they can perform.

Below is a proposed classification of questionnaire-based survey studies in construction project engineering; the following studies are distinguished (fig. 2.1) and can be divided by:

1. By respondent type:
   - surveying experts and specialists in a given field;
   - surveying potential, former and future clients and users;

2. By recurrence:
   - cross-section (non-recurring) studies;
   - longitudinal (recurring) studies;

3. By research field:
   - studies of construction projects;
   - studies of construction companies and their environment;

4. By survey method:
   - questionnaire;
   - interview;

5. By information source:
   - opinion polls;
   - studies in the form of recording project data (e.g. duration, cost);
   - quantitative (numerical);
   - qualitative (descriptive);

6. By outcome application:
   - after performing a statistical analysis, a study's results can be used to directly diagnose problems and make decisions;
   - survey study results are complementary, supplementary or performed in parallel to studies using specialist technical devices (e.g. the measurement of vibrations, humidity, airtightness, insulation and concern, for instance, user thermal comfort) and are a supplementation of technical studies.
   - study results (e.g. parameter ratings reported by experts) serve as input data for a different research method or mathematical model, e.g. in multi-criteria analysis or compiling databases for expert systems.
In this article, the author uses the general term "survey study", yet the discussion applies both to questionnaire-based studies and those based on engaging in conversation—interviews—with the application of interview forms (Figure 3).

**Figure 3.** Survey study classification in construction project engineering

Table 1 presents examples applying survey studies in construction project engineering.

**Table 1.** Examples of the application of survey studies in construction project engineering.

| SURVEY STUDY CLASSIFICATION | SURVEY STUDY APPLICATION IN CONSTRUCTION PROJECT ENGINEERING |
|-----------------------------|-------------------------------------------------------------|
| By respondent type:        |                                                             |
| 1. Surveying experts, specialists in a given subject. Potential result applications: | 1a) Problem identification and diagnosis                      |
|  a) direct (e.g. as statistical data) | 1b) Expert assessment of difficult-to-measure parameters and decision-making support, primarily used in academia |
|  b) input data for other methods, e.g. expert systems (rule databases), multi-criteria analyses (weight and parameter ratings) | 2. Supporting market decisions of construction companies (developers, contractors) |
| 2. Surveying future, current and past clients |                                                             |
| By recurrence:             |                                                             |
| 1. Cross-sectional studies | 1. Support in ongoing decision-making                      |
| 2. Longitudinal studies (recurrent) | 2. Monitoring market changes, their cause and effect         |
| By field of study:         |                                                             |
| 1. Construction project | 1. Construction project management support                  |
| 2. Construction company    | 2. Supporting management and marketing within a construction company |
3. Conclusions
This paper presents the potential application of survey studies and their results in construction project engineering. The author presented the results of many years of her studies and analyses of the potential of applying survey methods in construction project engineering—a methodological and analytical approach used in the study of social phenomena and processes, which is rarely used in the technical sciences. The author presented a justification of the suitability of these methods for use in construction project engineering and supporting decision-makers in making decisions.

Survey study methods are a source of valuable data, either independently or when combined with other methods of collecting information that is then analysed by researchers, with their conclusions and the final results of the analysis finding application in diagnosing and estimating phenomena and problems, and in process controlling. However, as previously stressed in this paper, it supports decision-makers in the difficult process of making decisions.

The author analysed and described the potential applications of survey studies in the research and practice of construction project engineering.

The suitability of analysed methods and techniques is undeniable in at least two cases.
1. Survey studies, as an element of academic research and one of the links of the chain of the academic research process, are performed:
   a) at the stage of identifying the academic and practical problem (immediately after or in parallel to a review of the literature);
      expert opinion surveys, e.g. among site managers:
      - analysis of the state of the art, problem overview,
      - analysis of the degree to which the problem has been solved in practice,
      - analysis of the suitability of methods that were previously used to address the problem,
   b) during the model construction stage (description of an interesting aspect of reality in the form of a mathematical model);
      expert opinion surveys focusing on:
      - parameter selection, module structure,
      - determining inter-parameter dependencies,
      - assessment of parameters that are difficult to measure and their significance,
      - formulating a base of rules for expert systems,
   c) during the expert opinion model validation stage in terms of:
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in this case, data procured from samples are subjected to statistical analysis and its results and conclusions aid the construction company in making accurate decisions;
these include user or potential client surveys, e.g.:
   - demand surveys,
   - preference surveys,
   - client satisfaction surveys,
   - room comfort of use surveys, e.g. due to noise,
   - thermal comfort surveys.

The author hopes this paper will contribute to an even greater propagation of survey studies in construction project engineering. They are valuable and useful tools that require knowledge and experience in their use, as well as care to ensure high measurement quality via verification processes.

When designing and carrying out survey studies, one should verify the correctness of the study design and measurement quality (reliability and accuracy). Further studies should point to the development of
verifying measurement reliability adequately to the most commonly emerging problem groups of construction project engineering. There is also a need to formulate sample survey questionnaires that correspond to the most common construction project engineering problems. Further study should also answer the need for a broader presentation of mathematical methods applied in the analysis of survey study results and the collected data, and which are later used during subsequent stages of the research process.

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