WARSAW UNIVERSITY OF TECHNOLOGY Index 351733
FACULTY OF CIVIL ENGINEERING
COMMITTEE FOR CIVIL AND WATER ENGINEERING
POLISH ACADEMY OF SCIENCES ISSN 1230-2945

DOI: 10.24425/ace.2021.137185

ARCHIVES OF CIVIL ENGINEERING

Vol. LXVII ISSUE 2 2021

s. 551–579

Research paper

PMBoK vs. PRINCE2 in the context of Polish construction projects: Structural Equation Modelling approach

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Abstract: This paper discusses the approaches of Polish construction managers in terms of their preferences for the use of the two most popular project management (PM) standards and methodologies, namely PMBoK and PRINCE2. Our empirical survey was carried out in a group of managers and construction experts and involved 192 Polish SME companies from the Polish construction sector. The answers to the questionnaire were carefully analysed and interpreted with the use of the Structural Equation Modeling (SEM) Method. The results show what can affect the choice of management methodology, with a particular focus on such latent variables as PM flexibility, rigidity, knowledge and control. Our study provides empirical evidence which contributes to more effective management of investment projects undertaken by construction companies. The most important conclusions from our study are that PMBoK is more likely tied to flexibility and knowledge and PRINCE2 to rigidity and control. However, it does not necessarily mean that PMBoK has an advantage over PRINCE2. Simply put, the choice of the right methodology may depend on a number of other additional factors, such as: project size, its specific environmental conditions, size of a company implementing specific project, etc. Therefore, under certain conditions (e.g. for larger and more complex projects, etc.) it may be advisable to rely on the PRINCE2 methodology.

Keywords: PMBoK, PRINCE2, construction project management, construction sector, project management (PM), structural equation modelling, SEM.

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1. Introduction and knowledge gap

These days the development of projects cannot be done without the use of procedural methods for their management. They are used by virtually all organisations that are project-oriented in many different areas of business operations. These organisations train their project managers, equipping them with an appropriate methodological knowledge necessary for successful implementation of project tasks. These managers are then confronted with business reality and market environment and have to make their own choices, which often boil down to hundreds of small decisions, with a view to securing the success of entire projects which they are engaged in. In order to simplify their decision-making process they use whole collections of ready-made solutions, which are referred to as project methodologies. Since there are quite a few of these methodologies managers need to have an adequate knowledge of their applicability which is not an easy task. In this paper we discuss some issues (i.e. aspects concerning project management) that might help managers to make the right choice between the two most popular project management methodologies, namely PMBoK (*Project Management Body of Knowledge*) and PRINCE2 (*Projects In Controlled Environments*), with a focus on their applicability in different contextual settings/conditions. Obviously, we are fully aware of the fact that there are numerous project management methodologies and standards used by construction managers. In fact, Sobieraj [48] enumerates as many as 20 different methodologies and standards recommended by professional construction institutions. Of particular note, however, is the PM² methodology developed and supported by the European Commission, which incorporates elements from globally accepted standards and best practices while being light, easy to implement and suitable for any project. The paper aims to discuss the most important aspects of both methodologies, from the perspective of the construction industry. In particular, we discuss such issues as flexibility, rigidity, knowledge and control. The use of project management methodologies and standards is intended to support the entire construction-investment process. However, there are some factors related to project themselves (e.g. their size or nature of the environment in which they are realised, level of complexity, etc.) which may determine the selection of the appropriate methodology - and this paper is dedicated specifically for the purpose of examining these issues. More specifically, we strive to describe the relationships taking place in the area of construction investment processes with the use of structural equations modelling (SEM).

The paper envisages two main objectives. The first one is to identify the variables/factors that characterise managers' preferences for the use of a specific standard or methodology. The second is

to determine the strength and direction of the associations between these variables. The basis for the study is the hypothesis that flexibility and rigidity of management, as well as knowledge management and control aspects play an important role in shaping specific choices in this regard [17], [48].
In the subsequent section, we review the key areas of knowledge and competence identified in the literature that are important from the standpoint of both methodologies, and then we compare some of the characteristics of both methodologies in the context of the responsibility in management of construction projects, and their specific guidelines and characteristics.

2. Theoretical background

There are practically no comprehensive and coherent solutions and guidelines covering the entire investment-construction process in the Polish construction sector [30], [48], [49]. This issue was repeatedly raised by numerous construction practitioners and politicians over the last three decades up until now [49]. In 1998, there was even released a desideratum which was supposed to orientate the whole preparation of relevant legislative drafts in order to significantly improve the investment process in the Polish construction industry [48]. Back in the day, the Ministry of Construction and Regional Development commissioned a study entitled: *The assumptions of the legislation setting out the rules for preparation and organisation of construction investment process financed from public funds*. However, the draft regulation has never come to fruition since it had not gained an adequate political support. The whole idea was revisited several times in later years. Some guidelines/regulations were addressed in the *Act on the National Development Plan for the years 2004-2006* [30]. Many important problems were studied and described thanks to the implementation of the goal-oriented project entitled: *National system for managing construction investment projects financed with the participation of public funds and the EU aid* [30], [49]. Its results contributed to the establishment of several important principles for the management of construction projects, the scope of which was covered by the *Public Procurement Act* [48]. Moreover, in his paper J. Kulejewski [30] proves that these principles were developed on the basis of the world standards and methodologies of project management, including the PMBoK standard and the PRINCE2 methodology. This actually highlights the universality of both approaches. In other words, their use is not limited only to IT projects, even though it is the sector in which they are most commonly used [17], [30], [48]. J. Kulejewski [30] studied the level of knowledge and world practices concerning the management of investment construction projects, which served to issue appropriate recommendations for the sector through a series of findings and conclusions. These findings indicate which standards and/or

methodologies should be used when managing investment construction projects. In his recommendations, J. Kulejewski [30] referred to a number of methodological approaches, namely:

- manual entitled *Project Cycle Management* - a general methodological approach elaborated for the European Commission, allowing for efficient preparation of construction projects. It indicates an effective way of managing investment-construction projects, e.g. defining problems, indicating objectives, describing desired results, explaining how to plan specific activities, preparing project time schedules and budgets, etc.;
- **PMBoK**, the most recognisable international management standard, reflecting the canon of knowledge on construction project management, which translates into the so-called functional action programmes [40]. These programmes translate the concept of strategy into concrete organisational actions and daily employees' and workers' activities. Also, PMBoK provides relevant management tools and techniques, and guidelines directed to investment and construction project managers;
- **PRINCE2** - guidelines with regards to organisation of the investment project management system from the perspective of both project investors/owners and project supervisors (i.e. project manager).

The literature indicates a growing importance of the impact of both of these methodologies on the course of construction-investment processes in the competitive construction market [1], [13], [16], [19], [56], [58]. Both methodologies are viewed as tools in achieving project profitability [36]. Also, success itself is described and interpreted differently in each of these methodologies. PMBoK, for example, has a process-oriented approach to project implementation and is willingly used in construction industry by managers from around the world [21], [58]. A characteristic PMBoK's feature is the fact that it defines project as a set of activities which are carried out in order to produce a unique product or service. In turn, the PRINCE2 methodology identifies project as a management environment and is more focused on the aspects related to project management documentation. However, similarly to PMBoK, it indicates a specific goal which consists of delivering business products, defines business cases, identifies time horizons over which such goals are to be achieved - and of course - the resources that are required for their realisation. In the background, there is also always a company which is supposed to monitor some predefined objectives within a predetermined time period.

The theoretical foundations for considerations about differences between PMBoK and PRINCE2 can be found in the papers by R.M. Wideman [53], S. Matos and E. Lopes [35], and more recently by E. Karaman and M. Kurt [27] who strived to compare both of these methodologies.

In a project-oriented industry such as construction, an adequate knowledge about project management is an absolute necessity [22], [49]. The key to success for any project (not necessarily related to construction) is to identify the pivotal factors that affect its completion. Also, what is worth emphasising is that typically project managers are very keen to reach out to approaches that have already been tested out [49]. Thanks to appropriate project methodologies (i.e. management techniques and good practices) project managers and entire project teams can significantly increase their chances of being successful with project implementation [59]. Such proven approaches facilitating project management (i.e. increasing project management effectiveness and ensuring success in its implementation) are PMBoK and PRINCE2 [48]. Both of them constitute very reliable sources of knowledge about project management [35], [47].

There is also a considerable amount of literature on both PMBoK and PRINCE2. For example, J.S. Chou, N. Irawan, & A.D. Pham [9] performed a multinational study (with the use of the SEM methodology) with which they explored the contribution of the PMBoK for construction engineering projects. They elucidated the relationship between PMBoK techniques/tools/skills (TTSs) and project success (PS) in the construction sectors of Taiwan, Indonesia, and Vietnam. Valuable knowledge on the application of the PRINCE2 methodology in construction can also be found in the papers of S.I. Tongguang & J.I. Fanrong [52], and by S. Kang & S. Kim [24]. In the Polish literature this topic was explored by M. Górski, A. Dziadosz & D. Skorupka [17], who compared both methodologies in the context of investment project risk management. They drew attention to significant differences between both methodologies. From their perspective it appears that the choice as to which standard or methodology should be employed should depend on the specificity of a particular project. For example, PMBoK appears to be more popular among construction managers since it gives sort of ready-made tools to solve very specific problems, e.g. those used for project risk mitigation [17], [48]. On the other hand, the PRINCE2 methodology, as an alternative to PMBoK standard, is more oriented towards the investment-construction processes themselves, preparation of time schedules, and thereby also towards the pursuit of the standardisation and projects' repeatability [17].

The fact of the matter is that there is no clear indication as to which methodology is more preferable. However, already from the description of the aforementioned authors, one can see that in the case of the PRINCE2 methodology, more attention is paid to the preparation and the standardisation of constructon-investment processes, thereby seeking to maintain greater control over the

implementation of construction projects. More specifically, in the case of PRINCE2 there is less room left for management flexibility [17], [48]. Turns out that precise programming of all activities (which is characteristic for PRINCE2) does not leave much space for decision making during an implementation of investment projects. In the area of project management, both methodologies seem to be equally eagerly used by managers, however, each of them defines individual stages of a project in a different way. The PMBoK standard is primarily based on the use of the so-called good practices within defined areas of knowledge, and in contrast to PRINCE2 it also addresses the resource and procurement management [35], [48]. In turn, the PRINCE2 methodology is based on the so-called controlled environment, i.e. preparation and maintenance of a full and strict documentation, rigorous definition of project assumptions, knowledge of all risk factors (i.e. hence a great emphasis is put in the case of the PRINCE2 methodology on the area of risk management), which must be known even before a given project is launched [17], [48]. Also, PRINCE2 provides an entire instrumental apparatus for assessment of the profitability of a specific project as well as to manage its course and closure [42]. Moreover, in the PRINCE2 methodology the area of risk management is prioritised, and is related to each of the 8 processes that constitute the backbone of this methodology (i.e. the so-called *risk flows*) [17], [42]. Also, it places great emphasis on the identification, an ongoing verification and documentation of risks by creating the so-called *Risk Log* already in the *Project Preparation* stage [17], [48]. Both the premises of undertaking a project (i.e. its business case) and the risk analysis are updated after each management stage.

According to R.M. Wideman [53], PMBoK standard has a descriptive nature (i.e. specificity) that focuses more on explaining project management techniques in detail, whereas PRINCE2 provides a perspective view, describing in detail how project management techniques should be organised and implemented. While the Guide to PMBoK offers a loose, general approach to the integration of *Knowledge Areas*, PRINCE2 indicates how to organise them in an effective way. In fact, PRINCE2 stresses that *using these elements in this way is the most effective way to reduce project risks and ensure quality within the project* [47].

In light of what was argued by J.M. Siegelaub [47] and later by M. Górski, A. Dziadosz & D. Skorupka [17]- knowledge-based companies (i.e. those that place more emphasis on the role of knowledge management) would be more inclined towards the use of the PMBoK standard, whereas those that concentrate themselves on organisational issues, risk management and therefore control, would rather opt for the PRINCE2 methodology. In addition, H.R. Kerzner [28], followed by O. McHugh and M. Hogan [36]- argued that *flexibility is about the freedom of choice with regards to a specific project management standard or methodology*. Put differently, each organisation has to tailor

its PM standard and/or methodology to its specific requirements [28]. In this respect, both PMBoK and PRINCE2 can be regarded flexible when it comes to their design and can be adapted to specific needs of each organisation, however many organisations choose, adapt and implement processes that meet their requirements solely with the use of the PMBoK standard [36]. The PM knowledge laid out in the PMBoK standard includes the following aspects of management: integration, scope, time, cost, quality, human resources, risk, communication, and procurement [44]. Having found that these elements of knowledge about PM significantly influence projects' results, F.Y. Ling, S.P. Low, S. Wang & T. Egbelakin [32] recommended their use for measurement purposes. Since many PM tools and techniques prove to be project-specific, simple understanding and application of the ones that are related to good practices turns to be insufficient for effective PM [48]. Therefore, in order to examine what are the benefits of using a particular standard or methodology in the construction industry, it becomes necessary to carry out an appropriate empirical study [48]. In order to carry out such an assessment, it is necessary to take into account the CSFs (critical success factors) for a project, which can be defined, for example, in terms of time, cost and/or quality [49]. J.S. Chou, N. Irawan, & A.D. Pham [9] argue that they can be reflected by means of either attributes or metrics expressed in absolute or relative terms. The scope of a project can be linked to its results, time to its schedules, costs to its budget and quality to its performance [48]. Human resources are associated with individual project participants, communication is associated with the flow of information related to the implementation of the project, the risks are specific to the project, and procurement involves the purchase of goods and services from organisations other than those implementing the project [44]. In order to meet the requirements and expectations of customers and stakeholders, project managers must effectively combine, unify, consolidate and integrate different construction activities and processes [48]. H. Doloi, K.C. Iyer & A. Sawhney [11] argue that researchers tend to view project management processes as separate elements with well-defined interfaces.

The proper implementation of indicated phases and stages of a project requires the adoption of a specific management standard or methodology, specifying appropriate sets of actions/activities. In the literature, amongst the most popular and comprehensive approaches in this field are the PMBoK standard and the PRINCE2 methodology. Standards represent collections of guidelines that can be considered as general rules and principles. They can be used without continuity, i.e. selectively, for different project management areas. The methodology, on the other hand, is a set of rules defining the way a specific work is performed (i.e. procedures leading to the achievement of a specific goal). It also provides the tools necessary to implement the work and knowledge related to these rules. For example, the PMBoK standard allows for a selective and flexible application of its individual

principles (components). It is not as restrictive as the PRINCE2 methodology. Moreover, both approaches define project success in a different way, e.g. the competences of project managers are different, the process of defining project requirements is different, etc.

It is worth summarising the most relevant differences between both approaches in terms of different aspects of project management, taking into account general differences, PM responsibilities, guidelines and specificities, etc.):

PMBoK Standard

- measures success in terms of specific product and project quality, timeliness, compliance with budget, customer satisfaction, etc.;
- ascribes the achievement of benefits to the sponsor, and the project manager is only responsible for the scope of a project. According to PMBoK - delivering a solution that does not necessarily bring the expected benefits still might be considered a success;
- allows to formulate requirements already after the start of a project. The scope of requirements can be defined during the whole project life cycle;
- provides greater flexibility and significantly increased competence and authority of the project manager, who makes independent decisions and is usually the leader of the project team;
- empower project managers with greater flexibility in managing construction projects;
- can be implemented selectively or progressively;
- encompasses components such as: WBS (Work Breakdown Structure) and project charter; WBS is a deliverable-oriented breakdown of a project into smaller components. A work breakdown structure is a key project deliverable that organises the team's work into manageable sections.

PRINCE2 Methodology

- recognises success only when the intended benefits have been achieved. Benefits are measured at every stage of a project. It is often possible to achieve the results and benefits from the project only after its completion, and it is very easy for project teams to focus on the results. The linkage between the results and benefits should be clearly specified and made evident to all parties involved;
- delegates part of the responsibility for achieving specific benefits to project managers; according to the rules specified in the PRINCE2 methodology, a result that does not deliver the expected benefits is not considered a project manager's success. The benefits are confirmed after each stage;

- assumes that requirements must be known before a project is initiated, which means less flexibility, since the conditions accompanying the projects may change any time. The basis for initiating a project is its business case;
- envisages reduced managerial autonomy and limited decision-making authority. A project manager does not always lead the project team (although according to this methodology it is acceptable). Decisions are made, for example, by the company's CEO, as well as by individual stakeholders in the entire value chain (e.g. by suppliers, etc.).
- implies that management processes can be applied directly. The description that PRINCE2 provides is more comprehensive and complete in its nature;
- recommends that a project should be completed in its entirety or not completed at all; PRINCE2 methodology lacks such flexibility as PMBoK standard. However, not all PRINCE2 elements have to be employed, yet the basic guidelines (if it was decided to use PRINCE2) should be adopted in their entirety;
- places importance on preparation of the project description. Under PRINCE2, it is absolutely essential that such a description is established.

In view of the PMBoK standard, delivering a compliant product must be considered a success. These requirements do not have to be specified before a given project is initiated. The PRINCE2 methodology, on the other hand, is more restrictive as it specifies that only projects which (in addition to providing a product/service) ensure that certain predefined project-related benefits are met - can be considered a success. From the perspective of the expectations that it is supposed to meet, we see three centres that define possible benefits associated with a project. These are: the company implementing the project (i.e. project contractor), its users (in many cases it is simply the investor) and suppliers. They determine the benefits, although of course specific project teams (i.e. particular individuals) are involved in the actual implementation of a given project, and specific authority and responsibilities are delegated to them. Such authority is also given to the project manager who is responsible for the implementation of the project and achievement of the objectives and benefits defined in it. When it comes to the PMBoK standard, it allows to launch a project without defining its requirements. They can be defined throughout the entire project’s life cycle. In turn, according to PRINCE2 this is not possible, because already before the commencement of a project, it should be decided whether it is profitable or not (project-related activities should be rationalised in some way), and whether its implementation should be carried out or not.

PRINCE2 is a process-based approach to project management (from the very outset to its final stage). According to the PRINCE2 methodology, the construction process is defined as a structured set of

activities aimed at achieving a specific goal. It defines in detail 7 top-level processes: Project Preparation, Strategic Project Management, Project Initiation, Stage Control, Product Supply Management, Stage Border Management and Project Closing.

PRINCE2 differs from PMBoK in that it assumes that projects' objectives are achieved by separating the managerial aspects of projects' activities from specialist tasks such as design, construction, etc. The specialist aspects of each project type can be easily integrated into the PRINCE2 methodology and used in conjunction with it, providing a secure, holistic platform for construction project works. The PRINCE2 methodology can be applied to any project, regardless of its scale, type, geographical location and/or corporate culture. At the same time, PRINCE2 is an integrated structure consisting of the processes covering planning, delegation, monitoring and control of the six aspects of project effectiveness. On the other hand, the use of PMBoK standard can be perceived as the *Lego bricks stacking* [48]. This metaphor actually addresses the very essence of project management, especially in construction industry.

In practice, any knowledge that facilitates the management of a project can potentially contribute to its success or can increase its intrinsic value. We believe that there is a great deal of interest in exploring more closely the differences between PMBoK standard and PRINCE2 methodology, especially with regards to those aspects that relate to PM flexibility/rigidity, knowledge and control. Based on the above-mentioned theoretical considerations, we noted that both methodologies vary with each other, mostly due to the degree of flexibility (e.g. delegation of authority to project managers, reduced managerial autonomy and limited decision-making authority), rigidity (importance on preparation of the project description, application in entirety or selectively, etc.), knowledge (e.g. good practices within defined areas of knowledge), and control (e.g. requirements have to be specified before a project is initiated, level of managerial autonomy & decision-making authority). We believe that these areas, to which we attach importance, are in fact the anchor points of every project [48]. Obviously not every project is the same and it is important to have an appropriate project management knowledge in order to know which methodology to use in a particular case. We believe that the above mentioned project characteristics should determine which specific methodology or management standard should be applied. Therefore, the following hypotheses are proposed regarding the application of PMBOK and PRINCE2 methodology by investment-construction project managers:

H1.Flexibility shows a positive association with the use of PMBoK standard methodology.

H2.Rigidity shows a positive association with the use of PRINCE2 methodology.

H3.Knowledge management is positively associated with the use of PMBoK standard methodology.

H4.Control has is positively associated with the use of PRINCE2 methodology.

3. Research method

With our study, we want to show some important differences between PMBoK and PRINCE2 from the perspective of construction management practitioners and we rely on the Structural Equations Modelling (SEM) approach. Structural equation modelling allows for an estimation and testing of simultaneous relationships between multiple independent and dependent variables, e.g., simultaneous paths, multiple regressions, or confirmatory factor analysis (CFA). Structural equation modelling evaluates the fit of a model to the pattern of relationships in the data. In our study, we employ this specific research method, because it is a comprehensive statistical approach that is used for hypothesis testing of the relationships between observed and latent variables. More importantly, it allows for modelling of complex data structures, combining t-tests, analysis of variance and multivariate regressions. Structural equation models are often used to assess unobservable "latent" constructs. Since in our study we use latent constructs, SEM seems to be an ideal approach to verify the proposed research hypotheses. Figure **1** shows a schematic diagram summarising the overall research method.

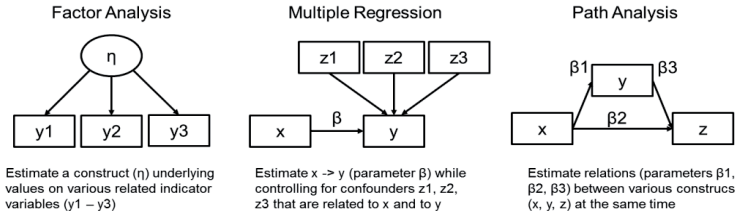

Figure 1. A schematic diagram summarising the overall research method

It is worth noting that over the years SEM has become more and more frequently used in construction studies. The increasing use of the SEM methodology in construction research is covered by B. Xiong, M. Skitmore & B. Xia [55], who conducted a comprehensive and reliable review of such SEM-based construction studies. The use of SEM in construction research is not a new phenomenon. This methodology has helped to deepen the understanding of some important research topics related to construction management. For example, M.B. Sarkar, P.S. Aulakh & S.T. Cavusgil [46] used this methodology to study mediation effects, employing such variables as clarity of roles and global behavioural processes in construction. K. Molenaar, S. Washington & J. Diekmann [39] examined factors related to contractual disputes between owners and contractors. S.K. Lee and J.H. Yu [31]

applied the SEM methodology to analyse the impact of three-dimensional variables on Project Management System implementation and user satisfaction and the extent to which they affect construction management performances. In turn, L.R. Yang, J.H. Chen & H.W. Wang [57] used SEM to assess the impact of information technology on project success. H. Son, Y Park, C. Kim & J.S. Chou [50] employed the SEM approach to measure the acceptance and utilisation of mobile computing devices among construction professionals in South Korea, and Y. Park, H. Son & C. Kim [41] examined the impact of pre-selected variables such as organisational support for the adoption of online training by construction professionals. In turn, K. Cho, T. Hong & C. Hyun [8] employed the SEM methodology to analyse the overall relationship between project performance and a construction project's characteristics. Finally, J.S. Chou, N. Irawan, & A.D. Pham [9] used the SEM methodology to determine the effects of PMBoK techniques/tools/skills (TTSs) on project success (PS). Of course, there is much more of this type of research with the use of SEM - we only provide a small sample of this collection to illustrate the usefulness and popularity of this particular study method.

More specifically, the concept of Structural Equation Modelling refers to a class of multidimensional statistical parametric models, in which structural and measurement frameworks specified on the basis of the confirmatory factor analysis (CFA) are interrelated with each other. One of the main advantages of structural equations is the possibility for testing research hypotheses with high complexity of associations between variables, by including latent variables (in addition to observable ones) in the model. This may also be extremely important for striving to identify complex interrelationships between the processes occurring during the implementation of complicated construction projects. A more advanced understanding of the statistical basis of the SEM was addressed by K.A. Bollen [4] and D. Kaplan [26]. A complementary and informative summary of the SEM notations is also provided by D. Iacobucci [20]. In general, SEM as a scientific methodology is very useful in explaining the relationship between certain variables or factors. For example, J.S. Chou, N. Irawan, and A.D. Pham [9] employed this method to study the associations between project's scope and the time allocated to its management, cost, quality, procurement, risk and human resources management, respectively. It is also a very versatile technique for both scientific research and experimental studies, and its application in construction research has gained in popularity over the years. Every statistical analysis method, however, has its strengths and limitations and it is important to understand these properties and characteristics in order to make suitable choices among available alternatives. This is particularly true in the case of SEMs, since there are many traps waiting for a reckless researcher in terms of sample sizes, assessment of construction validity, correct measurements, etc. An application

of the SEM can be done using a multi-step procedure, namely the model specification, model identification, model estimation, model testing, and model modification [5].

In order to perform an empirical analysis showing how construction managers perceive the impact of a specific construction project management methodology on the progress of the projects underway, we have developed a questionnaire which contains several questions concerning the assessment of the impact of the PMBoK standard and the PRINCE2 methodology on successful projects' implementation. The questions were aimed at determining the importance of various important and very diverse issues concerning the implementation of construction projects, e.g. defining clear project objectives, selecting a project manager, project schedule, knowledge management, etc. In other words, we study how Polish construction managers perceive the two most recognisable project management methodologies - PMBoK and PRINCE2 – and their personal preferences in this regard. In order to ensure as much representativeness of the targeted sample as possible and its adequacy in relation to the studied phenomenon, reliable surveys were conducted among 215 representatives of the management staff of the SME engaged in the construction sector in Poland. However, several questionnaires were rejected due to the lack of some data/information in the questionnaires. Only 192 correctly filled in questionnaires were accepted for further analysis.

3.1. Study sample and data collection

The study sample is composed of respondents from micro, small, medium and large companies from all over Poland. The structure of the sample is as follows: over 26% (51 respondents) are from Mazowieckie Voivodeship[4], over ~4-6% from Kujawsko-Pomorskie, Świętokrzyskie, Dolnośląskie, Podkarpackie, Podlaskie, Pomorskie, Śląskie, and Warmińsko-Mazurskie. The least numerously represented is the voivodeship Zachodniopomorskie (2.6%). The survey composition shows certain level of diversity in terms of the number of people employed in the companies under study. The most numerous turned out to be the small companies (with 11 to 50 employees), constituting 35.42% of the surveyed sample and medium companies (with 51 to 250 employees), accounting for 31.77% of the sample, respectively.

Table 1. Structure of the survey sample by voivodeship and number of employees

VOIVODESHIP	Number of employees					
	1-10	11-50	51-250	over 251	TOTAL	%
dolnośląskie	3	5	3	0	**11**	**5,73**

[4] A voivodeship is the highest-level administrative division of Poland, which corresponds to a province. Mazowieckie Voivodeship is the largest and most populous of the 16 Polish provinces.

kujawsko-pomorskie	4	3	4	2	**13**	**6,77**
lubelskie	1	2	4	0	**7**	**3,65**
lubuskie	1	6	0	1	**8**	**4,16**
łódzkie	3	0	5	0	**8**	**4,16**
małopolskie		4	4	1	**9**	**4,69**
mazowieckie	3	18	15	15	**51**	**26,56**
opolskie	4	2	0	1	**7**	**3,65**
podkarpackie	2	6	2	0	**10**	**5,21**
podlaskie	2	2	4	3	**11**	**5,73**
pomorskie	2	3	5	1	**11**	**5,73**
śląskie	2	6	2	0	**10**	**5,21**
świętokrzyskie	2	4	4	2	**12**	**6,25**
warmińsko-mazurskie	1	3	6	0	**10**	**5,21**
wielkopolskie	2	1	1	5	**9**	**4,69**
zachodniopomorskie		3	2	0	**5**	**2,6**
TOTAL	**32**	**68**	**61**	**31**	**192**	**100**
%	**16,67**	**35,42**	**31,77**	**16,14**	**100**	

3.2. Variables and data analysis

The empirical survey was conducted between January and July 2015 on a sample of 192 respondents, comprising managers and directors of construction companies from the Polish construction industry. The structure of the research sample was made up of respondents that were selected in view of the number of completed investment projects in the construction sector. The survey was held at the Forum of Construction Managers. More specifically, the survey was conducted among companies that are members of such organisations as Polish Association of Construction Industry Employers (PZPB)[5], Polish Association of Construction Managers (PSMB)[6] and Polish Association of Developers (PZFD)[7]. According to CSO data, the potential population of construction companies in Poland oscillates around 479,000 [3]. The members of PZPB, PSMB and PZFD are -101, 69 and 221 companies, respectively. Some of these companies are members in two or all three of the above organisations. In case of a single company, the questionnaire may have been filled in by the managerial staff consisting of more than 10 people - especially in those large companies such as Dom Development, Robyg, Warbud, Unibep, Strabag or Skanska, etc.

In order for the survey to provide reliable conclusions, we had to select an appropriate number of respondents. The minimum sample size is determined by the sample design and depends on several factors, such as the size of the population (1), expected proportion of the phenomenon under study in the population (2), confidence level (3) and standard error of estimate (4). Therefore, since the survey

[5] https://pzpb.com.pl/o-zwiazku/firmy-czlonkowskie
[6] http://www.psmb.pl/czlonkowie
[7] https://pzfd.pl/czlonkowie-pzfd

is about the opinion of companies' managers from the construction sector, it is necessary to know the number of construction companies in the entire country. Regarding the expected proportion of the surveyed phenomenon in the entire population, we assume such measure to be 50 per cent, since our survey refers to miscellaneous issues in construction and, in particular, opinions in this regard among construction managers[8]. The reason for this is that we had no specific expectations about relative frequencies of the analysed problems in the surveyed sample, having in mind the context of the opinionated topics, in relation to the entire potential population of construction companies in Poland. Not having such knowledge, we assumed the level of 50 per cent to be the most accurate.

Regarding the confidence level (i.e. which tells us how certain we can be about the outcomes and whether there are applicable to the whole population), we made a default assumption of 95 per cent (hence $\alpha = 0.05$). In terms of the standard error of the estimate, it is equal to 7 per cent, i.e. meaning that the obtained results of the survey may deviate from the actual values in the entire population by 7 per cent. Having all the above data, we could examine how many respondents should take part in the survey. A specific formula is used for this purpose (minimum sample size): $n = \frac{P(1-P)}{\frac{e^2}{Z^2} + \frac{P(1-P)}{N}} = 196$

where:

P – expected proportion of the phenomenon under study in the population;

e – standard error of estimate;

Z- the value calculated on the basis of the adopted confidence level (which is 95 per cent, therefore Z= 1.96). The confidence coefficient is the confidence level stated as a proportion, rather than as a percentage.

N – the size of the population.

Our questionnaire survey was directed to a larger number of companies, but we managed to collect complete responses from 192 companies. The standard error = $\sqrt{pxq/n} = \sqrt{50x50/192} = 3.6$.

More specifically, we have selected answers to 14 questions/variables, which we believe are relevant for this particular analysis. The results of the questionnaire survey form the basis for an in-depth analysis of the differences between PMBoK and PRINCE2. The questionnaire questions were of a single-choice, closed-ended nature, and all answers were based on a seven-point *Likert* scale (1= strongly disagree, 7= strongly agree). Table 2 summarises the questionnaire questions and the

[8] In statistics the frequency of an event i is the number n_i of times the observation occurred/recorded in an experiment or study.

(observable and latent) variables behind them. These variables are used to develop a model that quite accurately describes the relationships between different management constructs, such as project management methodologies, flexibility, rigidity, control and knowledge.

The design of our study is novel, and therefore the topic is not directly referenced in the work of other researchers. However, each of the questions refers to one of the 4 selected project management areas, namely flexibility, rigidity, knowledge and control. Why exactly have we selected these 4 management areas? All 4 areas/domains are closely related to project management and are reflected in the descriptions and guidelines of the practice management methodologies covered in our survey. In other words, the level of flexibility, rigidity, as well as the required level of knowledge or control are recommended in the methodologies themselves and their guidelines [48]. Each project management methodology places a different emphasis on each of the four above management areas (i.e., either minor or major). Moreover, previous literature and logical implication from the guidelines from both methodologies themselves, suggest that PMBoK is more related to areas such as flexibility and knowledge [19], [21], [27]. In turn when it comes to PRINCE2, there is more emphasis put in that methodology on PM rigidity and control - as opposed to the flexibility and knowledge that are characteristic for PMBoK [48].

Table 2. Questionnaire questions and the (observable and latent) variables behind them

Flexibility		**Rigidity**	
Var	Question	**Var**	Question
f1	The role of project manager	**r1**	Participation of the entire company management
f2	The orientation towards management flexibility	**r2**	Rigid requirements and clear time schedule
f3	Requirements may be known after entering a project	**r3**	Success must be clearly defined
	Control		**Knowledge**
Var	Question	**Var**	Question
c1	Monitoring the environment on an ongoing basis	**w1**	Professional experience gained on major national and international construction sites
c2	Recording and analysing all occurring events	**w2**	Courses, training, qualifications acquired
c3	Record and analyse innovative concepts of investment project management	**w3**	Qualified and mobile personnel
c4	Monitor the operation of competitors	**w4**	Work experience (seniority)

In turn, Figure 2 shows the histograms of exogenous variables reflecting flexibility and rigidity. Presenting the variables in a visual form makes it easier to form an opinion on the responses of the managers taking part in the survey.

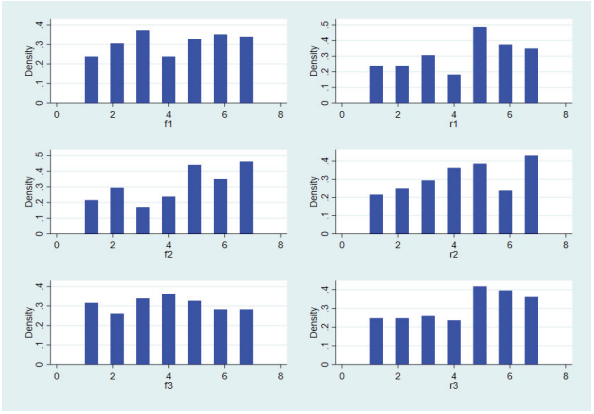

Figure 2. Histograms showing the density of exogenous variables reflecting flexibility and rigidity

Table 3 displays some descriptive statistics for the variables: flexibility (f_1, f_2, f_3) and rigidity (r_1, r_2, r_3), including the mean, median, and standard deviation.

Table 3. Descriptive statistics for the variables: flexibility and rigidity (mean, median and standard deviation)

	r1	**r2**	**r3**	**f1**	**f2**	**f3**
Min.	1.000	1.000	1.000	1.000	1.000	1.000
1st Qu.	3.000	3.000	3.000	2.750	3.000	2.000
Median	5.000	4.000	5.000	4.000	5.000	4.000
Mean	4.365	4.328	4.365	4.161	4.521	3.969
3rd Qu.	6.000	6.000	6.000	6.000	6.000	6.000
Max.	7.000	7.000	7.000	7.000	7.000	7.000
St.Dev.	1.9478	1.9423	1.9744	1.9737	2.0024	1.9469

In line with the theoretical considerations on project management methodologies described in the previous section, we have developed a theoretical SEM model to verify the initial hypotheses that construction project managers who place more emphasis on flexibility are more likely inclined towards PMBoK than PRINCE2. This is because of the fact that PMBoK leaves more room for flexibility in solving problems such as e.g. choosing the right, experienced project manager, delegation of more managerial skills to site managers, providing more flexibility in planning, etc. On

the other hand, wherever there are some issues that require greater management rigidity in the projects, e.g. setting clearer project objectives, stricter schedules and more detailed determination of individual stages of project implementation or taking care of the quality of project documentation, one can expect an association of such projects with the PRINCE2 methodology.

The theoretical SEM path model (A), which refers to the above hypotheses in the form of a system of equations for estimation, takes into account two endogenous observed variables, i.e. the importance of the PRINCE2 methodology (the variable denoted as *mc1*) and the importance of the PMBoK methodology (the *mc2* variable). The estimation of the SEM models themselves can be performed under the maximum likelihood method (ML), the least squares (LS) method or the asymptotic distribution free (ADF) method. The way in which such models are calibrated should largely depend on such issues as the nature of the data itself (with particular reference to their distributions) and the sample size. When dealing with multidimensional normal distributions it is advisable to use the maximum likelihood (ML) method. On the other hand, when a distribution does not meet this condition, depending on the size of the sample, either the least squares (LS) method (for a sample of more than 2500 observations) or the ADF method (for a sample of more than 100 observations, and some say that for more than 200 observations) are considered the most appropriate ones [29]. Every estimated model should also be evaluated with regards to its *goodness of fit* (GoF) and the significance of the obtained parameters. In addition, K.A. Bollen [4] and then D. Kaplan [26] proposed detailed guidelines on the criteria for assessing the path models. Moreover, there is a whole host of different measures to assess the estimates and the degree of models' goodness of fit. For example, their assessment can be determined by comparing their estimations with two other extreme models, i.e. the baseline and saturated model. Such comparisons are made with the use of dedicated SEM software packages. For the purpose of our study we use STATA16 software, which features with a built-in interface which is dedicated specifically for the SEM model estimation. Generally, the most important SEM goodness of fit measures are those that compare the estimated model with the baseline model, e.g. the RMSEA (*Root Mean Squared Error of Approximation*) and CFI (*Comparative Fit Index*), TFI (*Tucker-Lewis Index*) or SRMR (*Standardized Root Mean Squared Residual*). Detailed goodness-of-fit (GoF) assumptions are presented in Table 4.

Table 4. Assumptions of the Goodness of Fit (*GoF*)

Goodness of Fit (GoF)	**Source**
$p > 0.05$	[2]
RMSEA <0.05 good fit	[2], [18]
RMSEA <0.08 acceptable fit	[2]
Value greater than 0.80 suggests a good fit	[14]
CFI > 0.9 means satisfactory fit	[2], [18]
TLI > 0.9 means satisfactory fit	[2], [14]

For models with RMSEA measures smaller than 0.08 the fit is considered satisfactory [2]. The calculation and interpretation of other *goodness of fit* measures, i.e. CFI, TLI, are explained in the paper by Y. Xia and Y. Yang [54]. The SEM model can be evaluated on the basis of the RMSEA indicator. Unlike most goodness of fit measures, the RMSEA calculation does not compare the estimated model with the baseline one. It follows the following formula:

$$RMSEA = \sqrt{\frac{T_h - df_h}{(N-1)df_h}} \tag{1}$$

T_h – chi-square statistic of the estimated model,

Df_h – number of degrees of freedom of the estimated model,

N – number of observations

In general, the lower the RMSEA value calculated on the basis of the estimated model, the better is its goodness of fit. It is assumed that if the RMSEA value is lower than 0.08, the model exhibits a good fit with the data.

4. Results

Figure 3 shows a schematic diagram of the structural equations model which illustrates the interdependencies set out in the initial H1 & H2 hypotheses presented earlier.

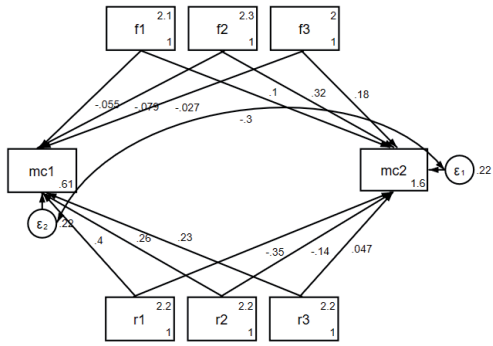

Figure 3. SEM model (A). A schematic diagram of the structural equations model which illustrates the hypotheses (H1 & H2)

Our theoretical SEM model (A) is expressed with the following equations:

$$mc1 = \beta_1 f1 + \beta_2 f2 + \beta_3 f3 + \beta_4 r1 + \beta_5 r2 + \beta_6 r3 + \varepsilon \quad (2)$$

$$mc2 = \beta_7 f1 + \beta_8 f2 + \beta_9 f3 + \beta_{10} r1 + \beta_{11} r2 + \beta_{12} r3 + \varepsilon \quad (3)$$

where: - mc1, mc2 are observed endogenous variables, and - *f1, f2, f3, r1, r2, r3* – are observed exogenous variables. Variables denoted by the letter *f* express flexibility in project management, whereas variables denoted by the letter *r* express management rigidity under the assumptions of project management methodologies,

- β_i – standardized beta coefficient compares the effects that each independent variable separately exerts on the dependent variable (i. e. *mc1* and *mc2*).

The results of the model estimation with the use of the ADF method (due to the sample size below 200), based on the collected survey data, are presented in Table 5.

Table 5. Estimated parameters of the model (A)

Association	Parameter	$\hat{\beta}$	*s.e.*	*p*-value	Compliance with theoretical assumptions
mc1 <- f1	β_1	-.0552872	.05844	0.344	COMPLIANCE WITH PRINCE2
mc1 <- f2	β_2	-.078375	.05748	0.173	COMPLIANCE WITH PRINCE2
mc1 <- f3	β_3	-.0276223	.05581	0.621	COMPLIANCE WITH PRINCE2
mc1 <- r1	β_4	.4072934	.05130	0.000***	COMPLIANCE WITH PRINCE2
mc1 <- r2	β_5	.2693585	.05160	0.000***	COMPLIANCE WITH PRINCE2
mc1 <- r3	β_6	.2274039	.05303	0.000***	COMPLIANCE WITH PRINCE2
mc2 <- f1	β_7	.1076331	.0623924	0.085	COMPLIANCE WITH PMBoK
mc2 <- f2	β_8	.3437064	.06137	0.000***	COMPLIANCE WITH PMBoK
mc2 <- f3	β_9	.1993451	.05959	0.001***	COMPLIANCE WITH PMBoK
mc2 <- r1	β_{10}	-.3765454	.05477	0.000***	COMPLIANCE WITH PMBoK
mc2 <- r2	β_{11}	-.154725	.05509	0.005**	COMPLIANCE WITH PMBoK
mc2 <- r3	β_{12}	.0500957	.05662	0.376	IMPARTIAL RESULT
mc1<->mc2	cov(e.mc2,e.mc1)	-.2771661	.06986	0.000***	NEGATIVE ASSOCIATION

In turn, Table 6 shows the goodness of fit (GoF) of both A & B SEM models.

Table 6. Goodness of Fit (model A and model B)

Fit statistic	Model A Value	Model B Value	Description
Discrepancy			
chi2_ms(0)	0.000	211.054	model vs. saturated
p > chi2		0.000	
chi2_bs(13)	1023.999	4040.622	baseline vs. saturated
p > chi2	0.000	0.000	
Population error			
RMSEA	0.000	0.081	Root mean squared error of approximation
90% CI, lower bound	0.000	0.066	
upper bound	0.000	0.095	
pclose	1.000	0.000	Probability RMSEA <= 0.05
Baseline comparison			
CFI	1.000	0.970	Comparative fit index
TLI	1.000	0.962	Tucker-Lewis index
Size of residuals			
SRMR	0.000	0.033	Standardized root mean squared residual
CD	0.888	0.996	Coefficient of determination

The results of the model A estimation shown in Table 5 indicate that when it comes to the explanatory variable *mc1* (i.e. PRINCE2 methodology) - standardised beta coefficients show negative values in case of the exogenous variables associated with *management flexibility* f_i and positive ones for the variables representing the *rigidity approach* r_i. However, only the latter (i.e. variables r_1, r_2, r_3) proved to be statistically significant. Moreover, exactly the opposite is true in the case of the explanatory variable corresponding to the PMBoK methodology (i.e. *mc2* variable), since standardised beta coefficients for *mc2* regressors take exactly the opposite signs compared to *mc1* regressors (one exception the variable r_3 with a coefficient approaching zero and being statistically insignificant); a slightly positive beta coefficient for the r_3 variable can be interpreted as having little positive meaning in the case of PMBoK (although the description of the methodology assumes that a precise definition of the project does not necessarily have to take place, at least when the project is already launched). It is worth emphasising that both project management methodologies are only guidelines and recommendations showing managers how to proceed with the projects, meaning that they are not imperatives determining managerial actions. Moreover, the results show that those managers who attached more importance to issues such as the role of project managers, orientation towards management flexibility and the possibility to define project requirements after entering a project, at the same time showed more interest in PMBoK (endogenous variable *mc2*). On the other hand, those for whom the PRINCE2 methodology proved to be more valuable, attributed higher weight on the Likert scale to the participation of the entire company's management in the project, rigid requirements and a clear schedule and definitions of success. This is evidenced by an association (statistically significant) of the above mentioned variables with the preferences towards the PRINCE2 methodology (endogenous variable *mc1*). The results obtained from the model A confirm the research hypotheses (**H1** and **H2**) presented in the theoretical part, although some variables turned out to be statistically insignificant, and in this regard the standardised beta index in the equation mc2 <- r3 yields impartial results $(\hat{\beta} = .05009, p > .05)$.

In practice, it is difficult to estimate a SEM model with the use of maximum likelihood (ML) or the least squares (LS) method, since the requirements of multidimensional normal distributions make it hard to achieve. In such case one can apply the Bootstrap procedure [12], [23]. The Bootstrap method involves drawing multiple samples from the original data, thereby allowing for an empirical verification of the parameters' distribution for each of the obtained samples. When dealing with a smaller sample size, such method increases the reliability of the obtained results. Therefore, on the

basis of the data available, we also applied a bootstrap with 2000 samplings, relying on the ADF method. This allowed for the estimation of the parameter values, which are average values for all samples. The obtained results are presented in Table 7, which contains calculated estimates of parameters, standard errors and their associated *p*-values. It is also worth noting that our model B is based on the confirmatory factor analysis (CFA) and, in addition to PM flexibility and rigidity, it includes two additional latent variables: knowledge (denoted by letter w) and control (denoted by letter c), that are described in Table 2. CFA allows to examine the interrelationships at the level of the studied implicit research constructs reflecting the scientific problems under study.

Table 7 Estimated parameters of the model (B)

Association	**Parameter**	$\hat{\beta}$	*s.e*	***p*-value**
mc1 <- MGMT	β_1	.8673795	.0200756	0.000
mc2 <- MGMT	β_2	-.895781	.0171019	0.000
f1 <- FLEXIBILITY	β_3	.8594051	.0238008	1.7e-285
f2 <- FLEXIBILITY	β_4	.8802546	.0216651	0.000
f3 <- FLEXIBILITY	β_5	.8363324	.0262165	2.6e-223
r1 <- RIGIDITY	β_6	.8882879	.0190199	0.000
r2 <- RIGIDITY	β_{15}	.7058966	.0394808	1.70e-71
r3 <- RIGIDITY	β_{16}	.7197581	.038318	1.02e-78
c1 <- CONTROL	β_7	.8908426	.0160044	0.000
c2 <- CONTROL	β_8	.8558884	.0199374	0.000
c3 <- CONTROL	β_9	.8903905	.0158835	8.36e-81
c4 <- CONTROL	β_{10}	.8620511	.0193984	6.93e-70
w1 <- KNOWLEDGE	β_{11}	.953362	.0073227	0.000
w2 <- KNOWLEDGE	β_{12}	.9527783	.0073869	0.000
w3 <- KNOWLEDGE	β_{13}	.9560697	.0069872	0.000
w4 <- KNOWLEDGE	β_{14}	.9539468	.0072452	0.000
cov(Flexibility,Rigidity)		-.778237	.04018	1.42e-83
cov(Flexibility,Control)		-.780918	.0356759	3.3e-106
cov(Flexibility,Knowledge)		.7783018	.0339059	1.3e-116
cov(Flexibility,MGMT)		-.904804	.0256156	2.7e-273
cov(Rigidity,Control)		.9700004	.017294	0.000
cov(Rigidity,Knowledge)		-.9701581	.0147556	0.000
cov(Rigidity,MGMT)		1.000902	.0207377	0.000
cov(Control,Knowledge)		-1.001126	.0055997	0.000
cov(Control,MGMT)		1.012926	.0129844	0.000
cov(Knowledge,MGMT)		-1.004892	.0110472	0.000

Figure 4 shows model B in a graphical form, which allows a visual assessment of the interrelationships between latent variables, including the observable variables. The results confirm all hypotheses in our study:H1:($\hat{\beta} = -.904804$, $p < 0.05$), H2:($\hat{\beta} = 1.000902$, $p < 0.05$), H3:($\hat{\beta} = -1.004892$, $p < 0.05$), & H4:($\hat{\beta} = 1.012926$, $p < 0.05$). This can actually be verified by observing the direction of the interdependences resulting from CFA shown in Figure 4.

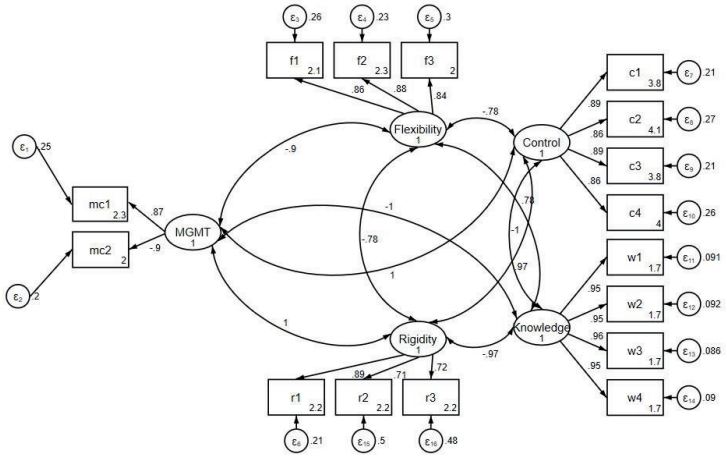

Figure 4. SEM model (B). A schematic diagram of the structural equations model which illustrates the hypotheses (H1, H2, H3, and H4)

Model B can be expressed by means of a system of 16 equations (4-19), which are arranged in the following way:

$$mc_1 = \beta_1 MGMT + \varepsilon_1 \quad (4), \quad mc_2 = \beta_2 MGMT + \varepsilon_2 \quad (5), \quad f_1 = \beta_3 Flexibility + \varepsilon_3 \quad (6),$$

$$f_2 = \beta_4 Flexibility + \varepsilon_4 \quad (7), \quad f_3 = \beta_5 Flexibility + \varepsilon_5 \quad (8), \quad c_1 = \beta_6 Control + \varepsilon_7 \quad (9), c_2 = \beta_7 Control + \varepsilon_8$$

$$(10), \quad c_3 = \beta_8 Control + \varepsilon_9 \quad (11), \quad c_4 = \beta_9 Control + \varepsilon_{10} \quad (12)$$

$$w_1 = \beta_{10} Knowledge + \varepsilon_{11} \quad (13), \quad w_2 = \beta_{11} Knowledge + \varepsilon_{12} \quad (14), \quad w_3 = \beta_{12} Knowledge + \varepsilon_{13} \quad (15),$$

$$w_4 = \beta_{13} Knowledge + \varepsilon_{14} \quad (16), \quad r_1 = \beta_{14} Rigidity + \varepsilon_6 \quad (17), \quad r_2 = \beta_{15} Rigidity + \varepsilon_{15} \quad (18),$$

$$r_3 = \beta_{16} Rigidity + \varepsilon_{16} \quad (19)$$

The values of RMSE, CFI, TLI and SRMR measures indicate a good fit of both models (i.e. model A & B) with the data.

5. Limitations of the study

One of the limitations of the research method we have employed is the risk of its application in a non-optimal way. Hence, there is a common (frequent) tendency to overestimate the conclusions drawn from the SEM analysis, for example, in terms of both its strength and the validity of the results. It is important to stress that structural models are usually only approximations of the reality [6][7][34][33][38]. On the other hand, the same holds true for all statistical models.

When conducting SEM analysis, a common mistake is to omit some variables [10], [15] that would better explain the causal processes and other features of the model. As a consequence, there is a risk of biased parameter estimates and inaccurate estimates of standard errors [25], [37], [45]. And although our models exhibit good fits to the data, this in no way guarantees that all relevant variables were incorporated into the model. Another important issue is that SEM captures the residual terms, which to some extent reflect the presence of unmeasured impacts on a particular variable under study. On the other hand, specifying covariances between residuals does not necessarily address the issue of biased parameter estimates and inaccurate standard errors. Put differently, the problem of omitted variables, is not solved by an inclusion of the residual parameters in the model. Moreover, the number and types of covariances encompassing the residual terms are also subject to certain limitations [51]. To estimate a model with an acceptable fit, an important contributing factor is the residual variance and covariance terms, without whose influence many models would exhibit rather poor fits or other types of problems (e.g. unacceptable estimates). In fact, such residual parameterisations often only mask the limitations of an incomplete model. Therefore, an important limitation of our results are: the high probability of omitted variables and their prejudicial effect on parameter estimates, standard errors and broader structural inference [51].

6. Conclusions

This paper seeks to use the modelling of structural equations for describing the relationships taking place in the area of investment-construction projects/processes in Poland so as to illustrate the linkages between the two competing management methodologies, i.e. PMBoK and PRINCE2. In the paper we stress that the PMBoK standard and the PRINCE2 methodology prove to be very effective not only in IT projects but also for construction projects. The guidelines contained in the PMBoK canon and the PRINCE2 methodology are universal in nature and are suitable for managing all kinds of projects, including investment projects. Generally speaking, PMBoK is a reference guide that shows how to manage a project, but it also addresses the scope of activities related to project managers. Therefore, it is not targeted at the company's management. PRINCE2, on the other hand, is directed to all stakeholders (i.e. the company's management as well as customers and suppliers in the value chain). The PMBoK standard is more useful in terms of recommended managerial behaviour, while the PRINCE2 methodology is more suitable for creating project descriptions, documentation, and assessing risks [17].

With this empirical study, we have learned several important aspects of managerial preferences when selecting project management methodology/standards. We have introduced 4 research hypotheses (H1-H4) claiming that flexibility and knowledge are more closely related to PMBoK (H1 & H3) while PM rigidity and control are rather associated with PRINCE2 methodology (H2 & H4). H1 and H2 hypotheses were confirmed with the path model (model A), and all (H1-H4) hypotheses were confirmed with the confirmatory factor analysis (CFA) [model B], with the use of the latent variables such as flexibility, rigidity, knowledge and control, and demonstrating their associations with each of the two examined methodologies respectively (PRINCE2 - *mc1* endogenous variable, PMBoK - *mc2*).
Finally, it is worth noting that PM standards and methodologies provide construction managers with a whole apparatus of tools they need to perform their managerial tasks/activities. Our research provides insight into those aspects that change the perspective on the choice of a particular PM standard or methodology in terms of the importance of such PM aspects as flexibility, rigidity, knowledge and control within an organisation.
It is worth emphasising that although the conclusions refer to the Polish conditions (the whole survey is based on the questionnaire survey which was conducted among Polish managers), the conclusions we formulate here are strongly backed by the theoretical considerations and supported by the guidelines laid in PM methodologies and standards themselves. The study itself is merely a practical verification showing that both compared methodologies are employed according to their intended purposes. Hence, it can be assumed that the conclusions formulated here should also apply to other geographic realities.
The related future line of research could focus on exploring construction managers' in-depth understanding of alternative management, such as the PM2 methodology mentioned in the introduction, and to compare managers' general knowledge in this regard with performance of the companies they work for. Our belief is that there is a close relationship between managers' level of knowledge in this area and the performance of the companies they work for. The study could show how an overall knowledge and application of management methodologies and standards translate into concrete results.

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PMBoK i PRINCE2 w kontekście polskich przedsięwzięć budowlanych: Podejście oparte na modelowaniu równań strukturalnych

Słowa kluczowe: PMBoK, PRINCE2, zarządzanie projektami budowlanymi, sektor budowlany, zarządzanie projektami (PM), modelowanie równań strukturalnych, SEM.

Streszczenie:

W artykule omówiono różnice pomiędzy dwiema najczęściej stosowanymi metodykami zarządzania projektami, a mianowicie standardem PMBoK i metodyką PRINCE2. Po pierwsze, dokonano dogłębnego przeglądu literatury dotyczącej zastosowania obu tych metodyk w zarządzaniu projektami budowlanymi. Po drugie, artykuł odpowiada na pytanie, co może decydować o specyficznych preferencjach menedżerów budowlanych w zakresie wyboru konkretnej metodyki zarządzania projektami. W tym celu przeprowadziliśmy badanie ankietowe wśród 192 przedstawicieli kadry kierowniczej małych i średnich przedsiębiorstw (MSP) działających w sektorze budowlanym w Polsce. W badaniu uwzględniamy szereg zmiennych latentnych, takich jak elastyczność, sztywność, wiedza i kontrola, z których każda składa się z 3-4 zmiennych obserwowalnych. Po dokonaniu przeglądu literatury doszliśmy do wniosku, że choć istnieje kilka prac porównujących obie metodologie, to według naszej najlepszej wiedzy nikt do tej pory nie przeprowadził kompleksowego badania empirycznego opartego na metodologii takiej jak modelowanie równań strukturalnych (SEM), uwzględniającego standardy i metodologie zarządzania oraz biorącego pod uwagę przeprowadzone w tym zakresie badania ankietowe, odwołujące się do opinii samych menedżerów budownictwa. Wcześniejsze badania dotyczyły zmiennych, które niekoniecznie są związane ze specyfiką metodyk zarządzania projektami. My wprowadzamy zestaw zmiennych, które są wykorzystywane do pomiaru efektywności zarządzania projektami. Sama ankieta miała bardziej rozbudowany charakter i zawierała wiele pytań, a tylko część z nich dotyczyła samych metodyk zarządzania projektami (tj. PMBoK i PRINCE2) i zmiennych, które teoretycznie można z nimi powiązać. Tak więc ankieta składa się z 4 obszernych grup pytań obejmujących szereg bardziej szczegółowych pytań; w sumie ankieta obejmuje 4 zmienne ukryte i 14 pytań, a za nimi aż 14 zmiennych obserwowalnych i kilka pytań metryczkowych. Wyniki ankiety zostały zweryfikowane z wykorzystaniem metodologii SEM, a dokładniej z wykorzystaniem modelu ścieżki oraz modelu konfirmacyjnej analizy czynnikowej, który pozwalaja na analizę wzajemnych zależności pomiędzy zmiennymi latentnymi. Każda ze zmiennych latentnych, na których opieramy nasze badanie, jest w pewnym stopniu uzasadniona na poziomie teoretycznym w kontekście każdej z badanych metodyk zarządzania projektami budowlanymi. Ponadto staramy się w sposób bardzo rzetelny i szczegółowy przedstawić samą metodę badawczą SEM w aspekcie badań budowlanych, zwracając uwagę, że metoda ta jest jedną z najczęściej stosowanych w badaniach naukowych i może być wykorzystywana do badania wielu różnych zagadnień naukowych, w tym również tych związanych z budownictwem. Ujmując to bardziej

szczegółowo, zastosowana metoda badawcza pozwala zarówno na tworzenie modeli regresji, modeli ścieżek (*path analysis*), jak i na zastosowanie konfirmacyjnej analizy czynnikowej (*confirmatory factor analysis*).

Received: 23.12.2020, Revised: 12.03.2021