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Broader use of the Modern Methods of Construction (MMC) in the UK public sector: A Business Model Canvas (BMC) perspective

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ABSTRACT

The UK government is promoting the Modern Methods of Construction (MMC) by presumption in favour due to outperforming traditional methods in meeting key industry goals. Despite the public construction sector's recognition of the benefits, MMC uptake across this influential purchasing power is yet far from satisfactory. Such low adoption rates have been linked to MMC firms' business strategies contributing to public clients' indecision. To investigate such arguments, the study utilises a questionnaire survey and gathers responses from seventy-four decision-makers of UK-established MMC businesses. Results are then discussed in relation to the contingency theory from a Business Model Canvas (BMC) perspective, revealing the divergence between organisations outperforming others in the public sector, i.e. achieving fit. To the authors' knowledge, this is the first construction management study to empirically propose the relationships between the nine business model elements of the BMC in relation to a specific market. The findings of this paper suggest the critical role of the Target Customer element in reaching alignment with the external environment by acting as a receiver and provider of information, superseding the importance of solely focusing on communicating added values and extended capabilities. Our findings also suggest that MMC organisations outperforming others in the UK public sector are those who are understanding public clients' needs the most, and thus, continuously changing their business strategies to sustain alignment with any change in those needs. Overall, the paper proposes a three-dimensional consideration to achieve fit, namely, 1) internal consistency of the elements (inside-out), 2), changing external environment (outside-in), and 3) relationships between the nine elements (inside-in). The study depicts the problematic nature of the internal interrelations responsible for reaching fit in the UK public sector and deepens the understanding of how the nine BMC elements are supporting more informed and strategic decisions. Therefore, decision-makers are urged to pursue alignment by assessing the contingency of each decision made with respect to the proposed influences. Future research to focus on replicating the results in accordance with other theories involving technological and organisational change, maturity, and systems theory.

1. Introduction

The United Kingdom is witnessing a development crisis nurtured by the inability of traditional construction to overcome its ambiguities and complexities when managing multi-disciplinary tasks (Maslova and Burgess, 2022). Discrepancies in conventional construction methods have, for decades, bedevilled researchers to cast tools that can drive efficiency. This has led to the emergence of Building Information Modelling (BIM) (Yakhou et al., 2023), Digital Twins (Barkokebas et al., 2023), Internet of things (IoT) (Giovanardi et al., 2023), in addition to a spectrum of other technological implementations viewed through the lens of innovation. Despite these advancements stepping into the forefront of change, it has been contended that technologies alone can not drive a fundamental transformation in construction (Khosrowshahi and Arayici, 2012). The key aspect delimiting prevalent change in construction is its fragmented and disintegrated nature (Aranda-Mena et al., 2009; Zhang et al., 2023; Forcael et al., 2023). Arguably, the construction industry's fragmentation is not a modern challenge; in fact, it extends to be as old as the industry itself (Worrall et al., 2010). An approach to support a compelling change narrative, therefore, is by seeking methods that can address the industry's fragmentation.

Over the past decade, construction management research has witnessed an increase in publications relevant to the Modern Methods of Construction (MMC) (Ehwi et al., 2022). The use of MMC is directly

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linked to high-value outcomes and long-term implications (Farmer, 2016). As the research debate broadens, efforts are driven by a gradual shift to endorse more control over the main construction processes (Ayinla et al., 2022). The realised values are time reduction (Wasim et al., 2020), cost certainty (Agapiou, 2022), and longstanding environmental benefits (Salmi et al., 2022). Control, in this context, minimises onsite activities by offsetting risks and complexities through a pre-manufactured value philosophy when delivering construction projects. Such characteristic is appealing to innovation advocates seeking modernity (Farmer, 2016). However, and as ever, the adoption of innovations in construction is by no means forthright (Oluleye et al., 2023), where the uptake of MMC reflects a discouraging adoption rate of less than 8% across all new developments (Branson, 2020). Hence, explaining the lower-than-expected demand for MMC, despite the unprecedented need for efficiency in construction, may reveal the shortcomings that are leading to demand adoption-hesitancy.

The UK government has recently published the revised version of the Construction Playbook (HM Government, 2022), an important document that aims to mandate a range of policies towards advocating MMC adoption in the UK. This is after the controversial independent review by Farmer (2016), who was among the first to predict and proclaim the near failure of construction's capacity to meet the increasing needs, which is evident in the report's title 'Modernise or Die'. However, even in spite of the governmental interest and 'presumption in favour' (Marinelli et al., 2022), the appetite for MMC across the public sector is noticeably low (Charlson and Dimka, 2021; Agapiou, 2022). Public clients are considered part of an influential social system in the construction context (Coenen et al., 2022), dominating over private clients in their expenditures (Adam and Lindahl, 2017), and equating to over three times the size of private construction demand (Taylor, 2020). Literature is pronounced to distinguish public clients as influential in driving the adoption of innovations (Tezel et al., 2021), being referred to as change agents (Rosander, 2022). The low uptake of a construction methodology that is widely nominated to triumph over traditional methods, consequently, strengthens the rationale for more focus on the dynamics contributing to public clients' adoption-indecision.

It is rather logical to state that a radical change in a construction methodology, from onsite to being chiefly offsite, is associated with a change in the relative business strategies of the respective supply. However, the interaction where business models are successful and effective is reasoned to be problematic (Massa et al., 2017), with a lack of an optimum business model criterion (Tapaninaho and Heikkinen, 2022). In construction research, seminal works attempt to unravel the complexities of business models in relation to the adoption of innovation (Teece, 2010; Brege et al., 2014; Goulding et al., 2015). However, empirically examining the differences between MMC firms' business models and their ability to penetrate the UK public sector remain significantly intact and understudied research topics. Moreover, a highly relevant reality is the recent failure and collapse of MMC businesses in the UK due to the lack of achieving an economy of scale (Gardiner, 2020; Gerrard, 2021; Clark and Guzman, 2022). Hence, the question driving this research is why some MMC businesses are succeeding in penetrating the UK public sector while others are not.

The increasing research needs are addressed in this paper by empirically examining the factors contributing to the development of an effective business model with respect to penetrating the UK public sector, which is tangible by the number of awarded public construction projects and repeat business with public clients. The following sections present a) review of literature; revealing the importance and understudied nature of this research area, b) the theoretical standing; envisaging the context in relation to a specific theory as an attempt to explain reality, the methodological approach; explaining the rationale for choosing to quantitively collect and analyse data from established UK MMC businesses, and finally, discussion of the results in relation to previous efforts; providing answers for both research and practice incentivised by the need to uncover the dynamics between the business model elements and the likelihood of reaching a more comprehensive competency in the UK public sector.

2. Definition: MMC terminology

This study adopts the definition for the term 'MMC' as conveyed in the MMC guidance, a supplement to the UK government's revision of the Construction Playbook (HM Government, 2022). The guidance defines MMC as a comprehensive cluster of multiple construction innovations, which encompasses a variety of offsite and onsite techniques. Such methods are believed to stand as effective alternatives to traditional construction, presenting benefits in efficiency, productivity, and quality for both the construction sector and the public welfare (Government Commercial Function, 2022). Such definition aligns with the definition framework adopted by the Ministry of Housing, Communities and Local Government MHCLG (2019), which classifies MMC into seven different categories, namely:

- Category 1: *Pre-Manufacturing - 3D primary structural systems*
- Category 2: *Pre-Manufacturing - 2D primary structural systems*
- Category 3: *Pre-Manufacturing - Non-systemised structural components*
- Category 4: *Pre-Manufacturing - Additive Manufacturing*
- Category 5: *Pre-Manufacturing – Non-structural assemblies and sub-assemblies*
- Category 6: *Traditional building product-led site labour reduction/productivity improvements*
- Category 7: *Site process-led labour reduction/productivity improvements*

3. Modernity business models

A review of the literature reveals multiple calls for the unsuitability of present MMC organisations' business models, delimiting wider uptake of MMC. For instance, Ho et al. (2017) emphasise the need for effective MMC business models that can better communicate the benefits, Goulding et al. (2013) argue the essential ability of business models to adapt to modern and changing processes, and Saad et al. (2023) state the need for MMC businesses to reinvent their business models to drive public clients' confidence. Similarly, Darlow et al. (2022) discuss the ability of business models to steer and influence the overall market to use MMC as a construction alternative, aligning with Goulding et al. (2015), who report that MMC adoption rates are directly linked to how MMC businesses are justifying value. A business model, in this setting, has been described as a creator of a market rather than only an influencer (Brege et al., 2014). Osterwalder (2004) details the Business Model Canvas (BMC) by clustering a firm's key business activities into nine main themes. BMC is one of the most cited classifications that represent the critical components responsible for detailing a business model (Massa et al., 2017). Beyond the confines of being a buzzword (DaSilva and Trkman, 2014), the application of BMC is considered an effective and reliable unit of analysis to measure organisations' business performance and competency (Zott et al., 2011). The nine BMC elements, as adapted from Mokhlesian and Holmén (2012), are:

- Value Proposition: *Reflects the benefits of its products and services offered to its customers.*
- Target Customer: *The firm's understanding of its customer segments, their wants, and their needs.*
- Customer Handling: *The utilised means to reach and communicate with its customer segment.*
- Customer Interface: *Strategies adopted to sustain customer relationships.*
- Value Configuration: *Strategies used to manage the firm's resources and activities to function in relation to its vision and objectives.*
- Capabilities: *Hosts the core competencies of an organisation keen for*

achieving a competitive advantage and deliver the proposed values.

- Cost Structure: *The incurred monetary costs necessary for a firm to function and deliver business.*
- Partnership Network: *Necessary partners that extend a firm's ability to deliver business.*
- Revenue Model: *The firm's streams of revenue and ways it monetises it's products and services.*

4. Theoretical underpinning: Contingency theory

Contingency theory is a prominent concept in organisational management's body of knowledge, placing business competency at the centre of an organisation's success. The theory establishes a paradigm in which success is not defined by the number of factors adopted in their business processes but rather by the adoption of the appropriate ones (Miles, 2012). Tijani et al. (2021) report the effectiveness of the theory in explaining construction organisations' propensity to meet external demand. The theory, moreover, suggests that a single optimum strategy to achieve a competitive advantage does not exist (Nnaji and Awolusi, 2021). In contrast, it exemplifies that different environments require different business strategies, and higher business performance is subject to the fit across the contingency factors (Donaldson, 2001; Cigolini et al., 2022). Despite that the theory is flagged as an important theoretical underpinning in this vein of arguments (Liu et al., 2023), it is yet underdeveloped in the realm of construction management research (Alkilani and Loosemore, 2022). Hence, it is necessary to clearly define the business environment with respect to the explored contingencies and address any criticism associated with the use of this theory.

A firm's survival, in this context, relies heavily on its contingency with the business environment, which can be extended through the adoption of innovations (Tariq et al., 2019). It is reasonable to postulate that businesses offering an emerging innovation, consequently, would require a radical change in their business models to gain a greater market share and achieve a competitive advantage (Afraz et al., 2021). From a business model perspective, internal factors and the criterion of how these factors are managed within a firm, e.g. configuration of resources, partnerships, etc., are significantly correlated with the levels of competitive advantage (Xiaobin Zhang et al., 2023). Alkilani and Loosemore (2022) argue that selectively incorporating factors within business models can influence competency in construction organisations. The influence on the overall performance is justified by the complex internal-internal and internal-external interactions, as theoretically indicated (Turienzo et al., 2023).

Haftor and Climent Costa (2023), who explore business model transformations needed to embrace innovations, infer the importance of revealing the contingency factors and their influence on organisations' performance. The theory enables research to drive decision-makers deeper appreciation of the contingencies responsible for the susceptibility of organisations amidst change (Jones and Comfort, 2022). The concept, hereby, circulates around achieving 'fit', which in this study's context, is by revealing the factors responsible for internal and external contingencies that can lead to a higher level of business performance (Haglund and Rudberg, 2022), which may be measured by the number of awarded projects (Mahdavi et al., 2021). To understand how fit is established, this paper assumes that revealing the key connections among the business model elements, with respect to factors identified from past MMC literature, would enable the realisation of a business stratagem effective in penetrating the UK public sector.

The research focuses on the public construction sector as an external environment. A change in the external business environment would mean a change in an organisation's strategy and performance (Sharma et al., 2022). Viewing an organisation from the lens of contingency theory is, thus, through focusing on harmonising internal 'fit' between a firm's characteristics and congruence with the external business environment (Donaldson, 2001). Such a contingency perspective is an approach that provides valuable insights into both research and practice pursuing organisational studies (Haglund and Rudberg, 2022). Yang and Jiang (2023), who mobilises this theory, relate business competency as highly contingent with firms' characteristics when penetrating a specific market.

Criticism of contingency theory focuses on the meaning of 'fit' and argues its vagueness (Hallavo, 2015). This has been justified by the changing meaning behind fit in accordance with the changing contingencies and external environments (Lewin et al., 2004). The criticism stems from the fragility of the overall concept due to being influenced by a spectrum of internal and external factors, as a change in either would impact the overall contingency (Haglund and Rudberg, 2022). This paper responds to such critiques by introducing BMC as a key classification of elements, which adds more comprehension to the corresponding relationships (Stott et al., 2016). The introduction of the model extends the conventional boundaries of the theory to measure the contingency between the nine business model elements and their influence on the organisations' business competency, which in this context, is looking at the competitive advantage from the lens of the contingency theory (Carnahan et al., 2010). Moreover, scholars pioneering the theory in construction research are showcasing important and valuable insights (Brege et al., 2014; Tijani et al., 2021; Alkilani and Loosemore, 2022; Standing and Lamari, 2023). For instance, Brege et al. (2014), review the business strategies of five companies in Sweden and the influence of a changing market on their business models, and similarly, Rad et al. (2022) contribute to the theory by arguing a construction innovation in relation to a change in performance.

A review of the literature shed light on a plethora of articles and seminal works contributing to contingency theory. However, despite each piece being useful on its own, in summary, the literature's attention of revealing the interdependent functions that can extend businesses' abilities to better achieve a competitive advantage in the public sector from an MMC narrative is limited. This paper traces the factors that can pursue, and nurture fit under each of the BMC clusters and highlights the enablers among these factors in relation to the tendency of a higher market share in the UK public construction sector. This research, therefore, argues that the business competency of MMC organisations in the UK public construction industry is dependent on a set of features orchestrated by their internal consistency within a business model and their external congruence with the business environment.

5. Methodology

In this paper, the reality is believed to be autonomous, making this research objective and neutral in a particular note (Stahl, 2007). Ontologically, the dominant stance defining this methodology is that of a positivist, as authors are not influencing reality but discovering it (McKenna et al., 2011). Moreover, the epistemological approach of this paper is deductive, adopting a theory and operating within the boundaries of conceptualisation, aligning with Lumer (2005, p.222), who explains that "a proposition is true if it has been correctly verified". The following subsections detail the methodological process adopted in this study, starting with conceptualisation, and ending with portraying the results.

5.1. Conceptualising the relationships

A conceptual model has been developed to define the scope of this study (see Figure 1). The model stems from the nine business model elements within the BMC and intends to test whether a change in either of the BMC elements would result in a change in the business competency of MMC organisations, evidenced by their ability to penetrate the UK public sector.

Due to the lack of a business model conceptualisation revealing the relationship between the nine elements in an MMC context, this study proposes a generic relationship model as the study's frame of reference

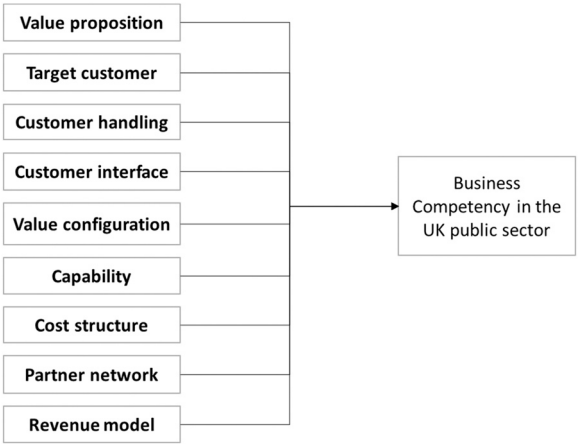

Fig. 1. A conceptualisation of the influence of the business model elements.

(see Figure 2). The model has been adapted from Mokhlesian and Holmén (2012), who tentatively report the relationships among the BMC elements relative to green construction. Given this rationale, an empirical investigation would extend such knowledge by assessing the appropriateness of the same model but for an MMC anecdote. Such conceptualisation, subsequently, enables a discussion on the relationships based on the contingency theory.

5.2. Sampling strategy

A purposive sampling approach has been utilised in this paper to track a higher quality (Tongco, 2007). The approach limits the inclusion of credible participants coupled with their ability to adequately contribute to this study's objectives (Campbell et al., 2020). To ensure a broader sampling strategy without compromising the realistic deliberation adopted in this research, a prequalification criterion has been applied to filter the suitability of participants' characteristics in relation to the level of pursued purposiveness (see Table 1). Purposive sampling, therefore, means that the societal margins are non-probable and non-random; on the contrary, these are subjectively framed, and participants have been carefully chosen to represent a specific population (Steinmetz, 2016). Accordingly, a network of connections has been developed in preparation for the data collection between January 2021 and December 2022.

Overall, a sample of six hundred decision-makers leading MMC organisations have been contacted by email, kindly requesting their contribution to the timely survey, which has been developed to be completed conveniently online. After multiple follow-ups, in total, seventy-four participants agree to take part, and responses are collected between October 2022 and January 2023 (see Table 2). The response rate is 12.3%, which is above the 10% threshold described as acceptable in contemporary studies (Nawrocka and Parker, 2009; Ormazabal et al., 2018). Undoubtedly, n = 74 may be argued as a low number of responses; however, the role, experience, and education of the respondents stand as a testimony of the quality of the responses (see Figure 3). For instance, the participants hold higher education degrees, i.e. PhD (3%), Master's (29%), Bachelor's (34%), as well as having considerable years of industry experience, i.e. over thirty years (34%), over twenty years (23%), and over ten years (16%). A review of research in construction management reveals a similar sample size, for example, n = 55 (Almohsen and Ruwanpura, 2016), n = 57 (Danforth et al., 2017), n = 65 (Okudan and Budayan, 2021), and n = 65 (Shealy et al., 2016). The low response rate can be justified by the extremely busy nature of these individuals, as often explained by non-responders themselves.

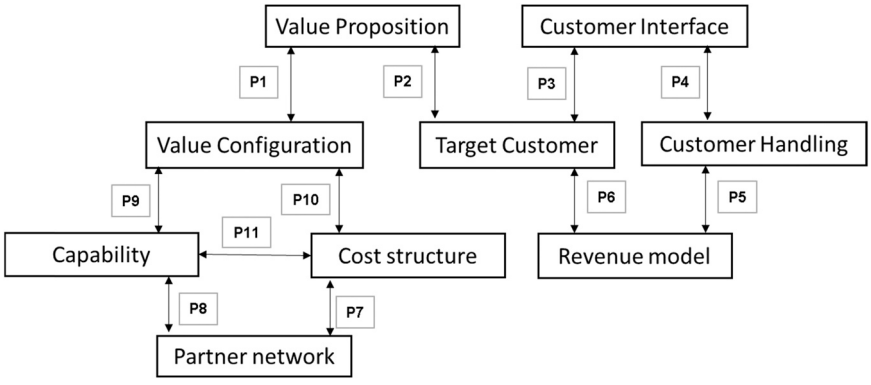

Fig. 2. Relationship propositions (P1-P11) between BMC elements (Adapted from Mokhlesian and Holmén, 2012).

Table 1
Conditions applied to sustain purposive sampling.

Condition	Corresponding measure
Geography: UK based Employed by a UK organisation	• UK business email. • Declaration required to proceed.
*Knowledge:*Individuals are decision-makers in their organisations and fully aware of their business processes.	• Only higher management roles are contacted. • Questions are all mandatory to complete the questionnaire.
Type: Organisation that is classified as an 'MMC business'.	• The type of organisation accepted is strictly offering MMC services and/or products.
*Terminological clarity:*Participants must demonstrate the MMC category which best describes their organisations.	• UK government's MMC definition framework has been adopted for clarity.

Table 2
MMC organisations' characteristics.

No. of Employees/Annual Turnover	Categorisation							
	Cat. 1	Cat. 2	Cat. 3	Cat. 4	Cat. 5	Cat. 6	Cat. 7	Total
More than 1000	**8**				**1**	**1**	**1**	**11**
More than £ 50 M	8				1	1	1	11
501–1000	**1**					**1**		**2**
More than £ 50 M	1					1		2
251–500	**5**	**1**		**1**				**7**
£ 10 M-£ 50 M	2			1				3
More than £ 50 M	3	1						4
50–250	**10**	**4**	**3**		**1**	**1**		**19**
£ 10 M-£ 50 M	7	4	3		1	1		16
£ 2 M-£ 10 M	1							1
More than £ 50 M	2							2
Up to 49	**13**	**13**	**1**		**1**	**4**	**3**	**35**
£ 10 M-£ 50 M	2	3						5
£ 1 M-£ 2 M	1	3				1	1	6
£ 2 M-£ 10 M	5	6	1		1	2		15
Less than £ 1 M	5	1				1	2	9
Grand Total	**37**	**18**	**4**	**1**	**3**	**7**	**4**	**74**

a. Source: Researcher's data

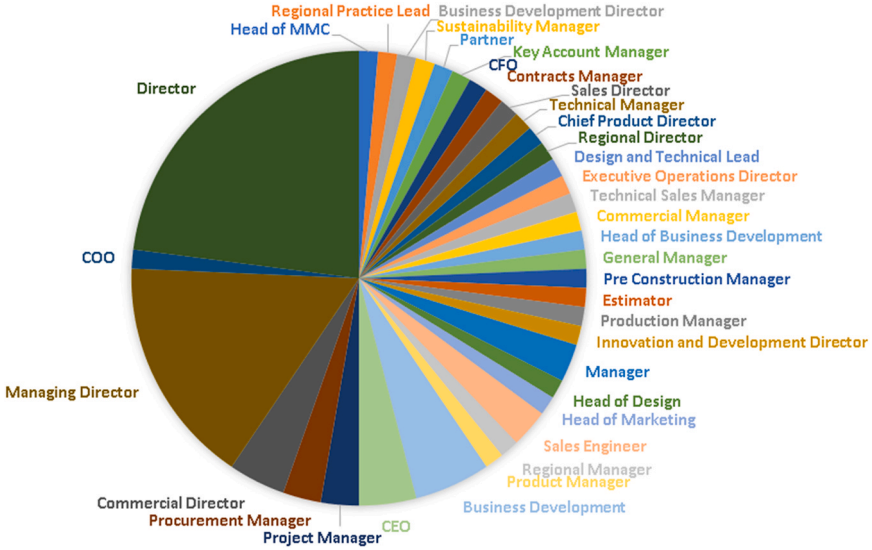

Fig. 3. Participants' roles.

5.3. Validity and data reliability

This subsection serves the paper by providing evidence pinpointing the validity and reliability of the quantitative data, constituently, through describing the research process and the application of popular statistical examinations. Firstly, a pilot study comprised four senior positions from the public sector, overviewing the questions and meaningfully judging the type of queries, the wording, the generalisation of variables, and the overall structure. Subsequently, the questionnaire is shared with five prospective participants, who, in turn, are encouraged to provide thoughts on the propensity of participants to a) adequately complete the survey, b) acknowledge the clear readability of wordings, c) sustain convenience in terms of duration, which are drafting procedures adapted from (Kezar, 2000). An exploratory factor analysis (EFA) led to reducing the variables to 28 and distributing them based on loadings into the nine factors and business competency measured through the market share (see Table 3).

Secondly, the data collected reflect internal consistency, as detailed in the popular statistical test by Cronbach (1951). The coefficient, as a rule of thumb, is deemed reliable subject to being greater than 0.6 for $n < 100$ (MacCallum et al., 1999). As shown in Table 4, the results are consistent, which proves the acceptable inclusion of factors under each of the nine BMC elements as clusters.

Moreover, the Kaiser-Meyer-Olkin (KMO) and Bartlett Test of Sphericity (BTS), examinations that are widely utilised in academic literature to confirm the suitability of factor analysis, reveal a $KMO > .5$ for the former, and $BTS < .001$ for the latter, meaning that the results are sufficiently acceptable in terms of sample adequacy and collinearity to be measured by the chosen variables (Beavers et al., 2013). Notably, the tests and procedures adopted in this subsection reveal the reliability and validity of the results, enabling the authors to advance to the following requisite (see Table 5).

5.4. Linear regression: Analysis

Selecting a linear regression mode of analysis in this study is driven by the need to contextualise the relationships between variables. The approach has a widespread use and popularity in statistical studies (Jammalamadaka, 2003). Its function, particularly, is to reveal the significance of relationships between dependent and independent

Table 3
Factoring of the variables measuring each BMC element.

BMC Element	Measurements	VP	TC	CH	CI	VC	C	CS	PN	RM	BC
We have to offer what public clients value	• We guarantee substantial quality compared to traditional construction	.789									
	• We offer environmental certificates with all our products and material	.807									
	• We guarantee substantial time savings	.577									
We have intentions to target public clients as our customers	• We are aware of the importance and influence of public clients		.529								
	• We fully understand public sector's needs and objectives		.661								
	• We regularly apply and seek a place on public procurement agreements		.890								
We have awareness and experience of the channels to reach public clients	• We are admitted in Public Procurement Agreements (PPA)			.849							
	• We have delivered public projects using PPA			.831							
	• We see PPA as effective channels to reach public clients			.786							
We have several routes to establish relationships with public clients	• We seek long-term relationships with the public sector				.780						
	• We continuously share success stories of MMC in the public sector				.633						
	• We employ competent personnel to advice public clients towards informed decisions				.688						
We have the necessary resources to pursuit and deliver value to public clients	• We acquire effective and compliant means of transportation					.802					
	• We pursuit value from reusing and repeating materials and processes					.717					
	• We responsibly source all our materials and components					.733					
We have the key capabilities needed that public clients see as important	• We offer a diverse set of design options to our clients						.768				
	• We have design options that fit into public clients' regional architecture						.570				
	• We have the capability to customise designs to suit public clients' choices						.803				
We have means to control and align costs that best suits public clients	• We ensure cost certainty due to the reuse of material and repetition							.838			
	• We ensure cost certainty by effective communication between design and production							.831			
	• We ensure cost savings by avoiding delays and controlling schedules							.814			
We have the partnerships that enables us to do business with public clients	• We attain a solid risk-transfer partnership with a competent supply-chain								.755		
	• We have partnerships with other industries to ensure knowledge-transfer								.715		
	• We align with other MMC providers' solutions and systems								.706		
We have revenue streams that reflect our continuity and survival	• We have additional solutions meant to increase our revenue streams									.777	
	• We offer other services to maximise our revenue streams									.819	
Business Competency in the Public Sector	• Number of public sector projects awarded										.660
	• Track-record and repeat business in delivering public client projects										.670

a. Source: Researcher's data

Table 4
Testing internal consistency with Cronbach's alpha (α) coefficient.

Constructs	Number of items	Cronbach's alpha (α)
Value Proposition	3	.656
Target Customer	3	.763
Customer Handling	3	.871
Customer Interface	3	.817
Value Configuration	3	.765
Capabilities	3	.655
Cost Structure	3	.896
Partnerships	3	.690
Revenue Model	2	.708

a. Source: Researcher's data

Table 5
Kaiser-Meyer-Olkin (KMO) and Bartlett Test of Sphericity (BTS).

Constructs	Bartlett's Test of Sphericity	Kaiser–Meyer–Olkin
Value Proposition	< .001	.670
Target Customer	< .001	.696
Customer Handling	< .001	.714
Customer Interface	< .001	.701
Value Configuration	< .001	.692
Capabilities	< .001	.610
Cost Structure	< .001	.707
Partnerships	< .001	.612
Revenue Model	< .001	.500

a. Source: Researcher's data

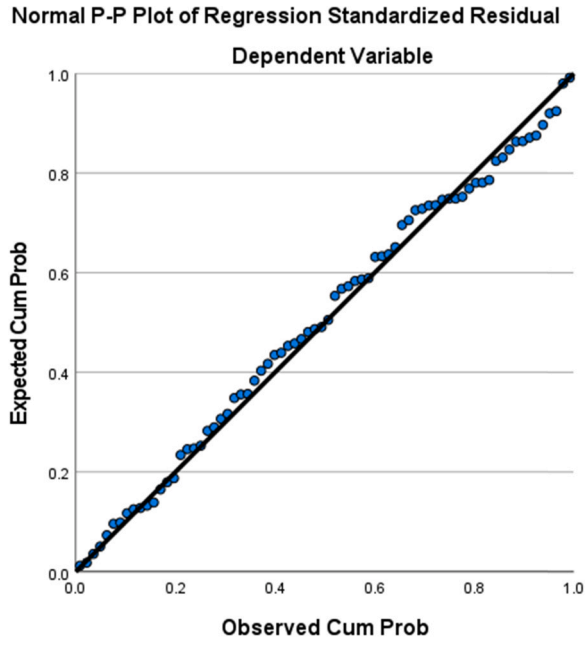

Fig. 4. The formality of residuals of 74 responses.

variables (Darlington, 1968). To achieve this, the statistical software by IBM, specifically SPSS 28.1.1, has been employed in accordance to its appropriateness (Ho, 2017). This subsection, hereby, serves this paper by validating the suitability of the chosen mode of analysis, in addition to revealing the statistical significance of the inclusive relationships conceptualised in the preceding subsections.

Initially, validating the linear regression analysis relevancy and appropriateness to the data collected is necessary. The employed software generates a regression standardised residual test, as shown in Figure 4, the dots' propensity to line along the diagonal indicates the residuals' normality. Moreover, the standard range of the residuals varies between − 2.257 and 2.382, which is within the − 3.29 and 3.29 array, and the Durbin-Watson test led to a score of 2.157, which is within the 1 and 3 range; these mean that the observations completed are independent (Kothari, 2004). Outliers, hence, do not exist based on the applied statistical tests, informing the researchers on the appropriateness of a linear regression mode of analysis to this particular set of data. Additionally, none of the Variance Inflation Factors (VIF) is above 10, which means that each of the studied group of variables test different relationships, and none are testing one similar relationship. The results of this analysis are shown in Table 6.

5.5. Relationships between the BMC elements

To study the relationships between the BMC elements, from this study's theoretical perspective of achieving fit, this subsection accommodates both a linear analysis between the nine BMC elements and the external business environment and a correlation analysis subsequent to the validity of the factor analysis, to reveal the relationships between the elements internally. This is done by examining the associations between constructs since the test does not depend on the variables' orders (Li et al., 2022). As hypothesised in the initial sections of this study, significant relations are argued to exist among all the BMC elements, where a change in one would mean a change in all and, thus, a change in fit. The results of the influences from each BMC element on the business competency in the public sector are shown in Figure 5.

After establishing the validity of the variables in terms of their groupings' reliability under each BMC element through factor analysis, and the successful determination of an association between all nine elements, the key relational propositions are assessed using a correlation model. The hypothesised propositions have been replaced with double-headed arrows to represent the model's relationships. As shown in Table 7, as an indicator of statistical significance, $p < 0.05$ is a condition associated with a highly significant and meaningful association (Hung and Lee, 2022). The correlation test used to understand the behaviour of each BMC element is Kendall tau-b, which is highly effective in studying the direction and strength of associations (Martins Gnecco et al., 2023). Statistically, a coefficient value of Kendall's tau test varies between − 1 and 1, the former indicating a negative relationship and the latter indicating a positive one, while a 0 value indicate independency. Finally, a value of > .35 is expected for a moderate and strong relationship between the elements.

The generic model adapted from Mokhlesian and Holmén (2012), theorises that all elements are dependent except for the Partnership Network element as an independent construct. The new model empirically infers the associations of high significance, i.e. $p < 0.05$, between the BMC elements. The relationships by Mokhlesian and Holmén (2012) are all confirmed as imperative except for propositions P2and P6; these are hence removed from the model. Additionally, 11 new relationships (N1-N11) are embedded in the new model due to meeting the significance threshold. As shown in Figure 6, relationships between the BMC elements are more complex and problematic than initially hypothesised.

6. Discussion

This section serves the study by presenting the new insights and arguing these in contrast to previous research efforts. The contingency theory posits that effective business practices and strategies are reliant on an organisation's internal and external environment. Perspectives provided herewith are those from the lens of this theory, which extends the implications of the study to discourse both practitioners and scholars, revealing the factors believed to be contingent upon firms' abilities to penetrate the UK public construction sector. A deeper understanding of how MMC organisations navigate and adapt their business processes to gain a higher competitive advantage, therefore, can gain insights into the divergences between businesses dominating the market share of public sector projects compared to those who lag in achieving similar

Table 6
Linear Regression results.

Coefficients[a] Model		Unstandardized Coefficients		Standardised Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	6.059	2.093		2.894	.005		
	VP	-.134	.117	-.128	-1.148	.255	.773	1.293
	TC	.413	.189	.467	2.190	.032	.212	4.714
	CH	-.039	.124	-.057	-.312	.756	.285	3.508
	CI	.203	.110	.280	1.851	.069	.420	2.381
	VC	-.165	.148	-.138	-1.117	.268	.634	1.577
	C	-.179	.119	-.166	-1.502	.138	.789	1.267
	CS	.148	.143	.137	1.037	.304	.551	1.814
	PN	-.069	.107	-.079	-.650	.518	.648	1.543
	RM	-.120	.102	-.127	-1.171	.246	.814	1.228

a. Dependent Variable: Business Competency
b. Predictors: VP: Value Proposition, TC: Target Customer, CH: Customer Handling, CI: Customer Interface, VC: Value Configuration, C: Capabilities, CS: Cost Structure, PN: Partnership Network, RM: Revenue Model.

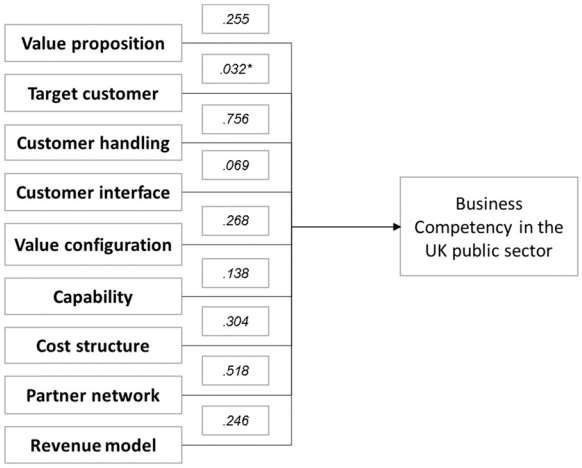

Fig. 5. Linear influence of each of the BMC elements.

business competency.

Findings advocate an association depicted through twenty relationships from the total potential thirty-six relationships among the nine business model elements of the BMC. The statistically significant relationships among these elements denotes that a simple change in one element is believed to change the overall business model and, thus, the entire business competency of the MMC organisation in its external environment. This aligns with the contingency theory, which suggests the lack of one optimum strategy to manage an organisation, where the relationships between BMC elements highlight the problematic and complex dynamics involved in achieving internal consistency. This subsection, hereby, serves the study by making sense of the findings in relation to these internal relationships.

The findings of this paper suppose a domino effect of the BMC from the lens of the contingency theory, as any change in one BMC element would lead to either single or multiple additional changes in the other elements, which will then directly impact the overall business competency of the MMC organisation. To build on the previous findings of this paper, it is reasonable to revisit the Target Customer element deemed significant in predicting the likelihood of a higher market share in the public sector. Such a realisation does not entirely agree with the contention of Osterwalder et al. (2010), who imply that all nine BMC elements are vital to drive business success. Our findings, however, are consistent with Ladd (2018), who emphasise that the Target Customer element is the most significant among all other elements. This comes as surprising especially that the logical assumption would better favour value offerings and propositions. Instead, the business competency of organisations' solely focusing on offering more values reflect a trivial prospect to penetrate the market, which is consistent with the statement "more is not better" (Ladd, 2018, p.66). The arguments presented herewith explain that the BMC can be seen as a chain of interdependent

Table 7
Relation between BMC elements measured by Kendall's tau b.

Relationships	Kendall's tau_b	Significance (2-tailed)	95% Confidence Intervals	
			Lower	Upper
VP < – > TC	.096	.282	-.059	.246
VP < – > CH	.022	.807	-.132	.175
VP < – > CI	.149	.093	-.004	.296
VP < – > VC	.211	.024	.060	.354
VP < – > C	.265	.004	.116	.402
VP < – > CS	.214	.021	.062	.356
VP < – > PN	.215	.015	.064	.357
VP < – > RM	.003	.973	-.151	.157
TC < – > CH	.662	< .001	.566	.740
TC < – > CI	.614	< .001	.509	.702
TC < – > VC	.172	.062	.019	.317
TC < – > C	.186	.040	.033	.330
TC < – > CS	.180	.050	.027	.324
TC < – > PN	.264	.003	.115	.401
TC < – > RM	.154	.080	.000	.300
CH < – > CI	.517	< .001	.394	.621
CH < – > VC	.048	.601	-.106	.200
CH < – > C	.091	.315	-.064	.241
CH < – > CS	.043	.638	-.111	.195
CH < – > PN	.068	.437	-.086	.219
CH < – > RM	.208	.018	.056	.351
CI < – > VC	.192	.038	.039	.335
CI < – > C	.228	.012	.077	.368
CI < – > CS	.208	.024	.056	.350
CI < – > PN	.184	.036	.031	.328
CI < – > RM	.086	.331	-.069	.236
VC < – > C	.240	.012	.089	.379
VC < – > CS	.311	.001	.165	.444
VC < – > PN	.284	.002	.136	.419
VC < – > RM	-.097	.293	-.247	.057
C < – > CS	.246	.009	.096	.385
C < – > PN	.265	.003	.116	.402
C < – > RM	.133	.143	-.022	.280
CS < – > PN	.227	.013	.076	.368
CS < – > RM	.083	.368	-.072	.233
PN < – > RM	.172	.051	.019	.317

a. Estimation is based on Fisher's r-to-z transformation.
b. VP: Value Proposition, TC: Target Customer, CH: Customer Handling, CI: Customer Interface, VC: Value Configuration, C: Capabilities, CS: Cost Structure, PN: Partnership Network, RM: Revenue Model.

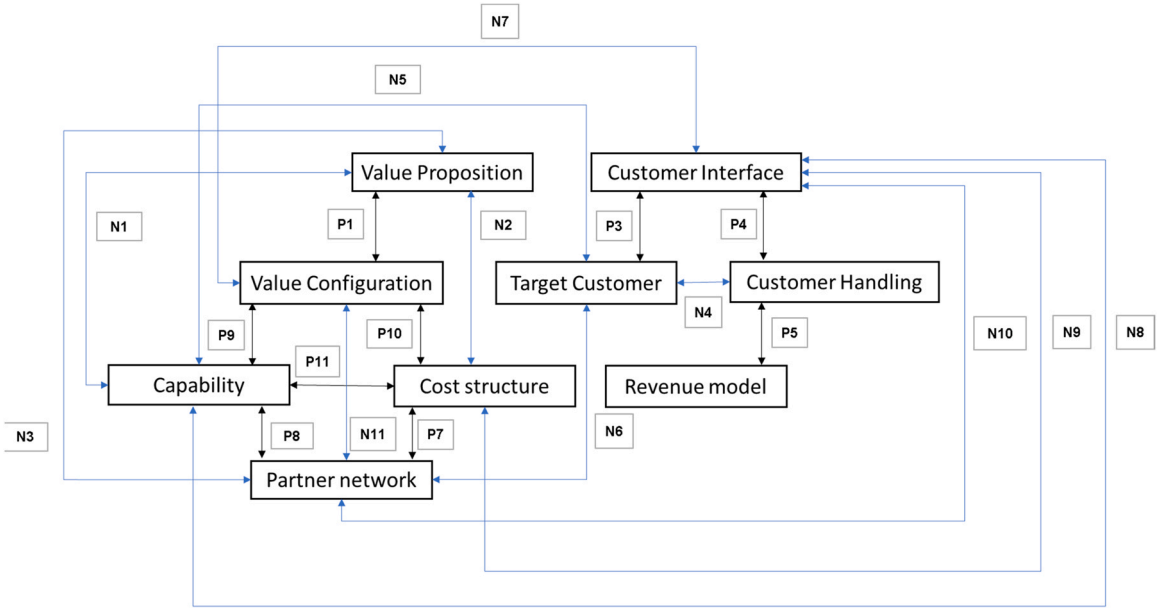

Fig. 6. New relationship propositions among the BMC elements.

elements, and the significance, in this context, is not through studying the influence of each element alone but understanding the dynamics that are dictated by the overall impact of the interaction between these elements internally. For instance, a change in the Value Proposition element is believed to directly influence the Partnership Network element, which in turn influences the Target Customer element responsible for predicting the business competency in the public sector. Internal consistency, therefore, is mediated by these internal interactions within the business model and is directly linked to achieving external congruence with the firms' targeted market, and any decision made by the firm internally will directly dictate its competency in that external environment.

The findings of this paper suggest that an organisation generates a set of assumptions that shape its preliminary internal decisions; these are then aligned with the firm's business environment. Such assumptions are experimented within the market, and their success is measured against the business competency of the organisation. This argument supports Gledson (2022, p.1097), who states, "success at the implementation stage is subject to much organisational uncertainty, not least because those who have made decisions to implement, are often different from the implementers". Achieving adequate business performance is an indicator of the business model fit and is reached by changing the initially established assumptions based on the information gained on the Target Customer and the ability to leverage such information to reinforce demand's confidence. Confidence, moreover, is contingent upon a satisfactory understanding of demand, which aligns with Jonsson and Rudberg (2014, p.67), who states, "the process choice must be made based on what the market requires". A change in the initial assumptions, however, means exposing the organisation to a set of new uncertainties, where the decisions made, in response, will then dictate a sequence of multiple changes in all the BMC elements in pursuit of fit. Hence, it is reasonable to relate these findings with the contagion effect of business models orchestrated by the interactions between the BMC elements responsible for MMC firms reaching fit and their tendency to enhance their business competency.

Achieving fit, therefore, is by achieving harmony among all elements within a business model, and fit can then be reached upon alignment. Findings infer that such alignment is not only approached through adequately understanding public clients and building their confidence but also through understanding the connections responsible for changes between elements internally. This is not achievable without adequately understanding the relationships between all the BMC elements and how each cope with a variety of factors in a continues re-creation of congruence and consistency. Embracing the contingency theory, consequently, reveals that decisions should not be made in isolation of the determined relationships; in contrast, a management strategy is encouraged to seek alignment with the contingency problems supported by the distinct nature of the target market. These arguments align with the findings of Pan et al., (2019, p.34), who argue; "strategies should be formulated with cohesiveness so as to maximise synergies". This study, therefore, contradicts previous construction management research efforts favouring outcomes over internal business processes when seeking fit and resembles that lacking an understanding and awareness of the internal business model relationships make managerial decisions locked in the premises of trial and error in relation to a changing environment, and hence, leading to the external outcomes controlling internal business interactions and not vice-versa (Haglund and Rudberg, 2022).

7. Theoretical and practical implications

This study informs both research and practice on the high sensitivity of the influence of every single change in the initial assumptions on the overall business competency of MMC firms. This paper contributes to contingency theory, therefore, by deriving the unpredictability of the business model interactions, as slight variations imposed would lead to a vastly disruptive outcome. Being the first study to theorise the relationships between the BMC elements and their influence on the external environment in an MMC anecdote, this study intends to simplify the complexity of these internal interactions by providing a model that describes the direct influence imposed by each change on another across the closely tied elements of the BMC, which in turn, would yield better articulation of the major changes in MMC firms' business competency.

With respect to the practical implications, it is worth revisiting the main motive behind this research, which is the low adoption rates of MMC in an influential construction market, which is believed to contribute to the insolvency of firms amidst the increasing peril of insufficient demand. This paper assumes that changes exist within business models inside-out and outside-in; however, the relationships among the BMC elements in the MMC-public sector narrative remain constant, informing us of three-dimensional influences, namely a)

internal consistency influencing environment, b) external congruence influencing internal consistency, and c) relationships among the elements influencing both internal and external fit. These findings, therefore, provide insights for decision-makers driving organisational activities to embrace the required alignment by assessing the contingency of each decision made with respect to the derived fixed influences. The deeper understanding of how the nine BMC elements are interrelated would therefore critically influence making more informed and strategic decisions when penetrating the UK public sector. Eventually, this paper thrives on assisting MMC businesses to understand the key interactions and embrace these to their advantage by overcoming construction conventionality and seeking business prosperity through driving broader demand.

8. Conclusion

This paper initially explores the contingent factors that are classifiable across each of the nine BMC elements in relation to MMC. Secondly, a classification is then established through tests meant to confirm the suitability of factor analysis to place each factor under the correct grouping. Subsequently, the study individually examines the factors with respect to their linear statistical significance as predictors for MMC organisations' business competency in the UK public sector. Finally, each of the nine BMC elements has been studied and critically analysed in relation to their external congruence, internal consistency, and relationships with one another. The results of this paper inform research and practice on the ability of MMC businesses to adapt their business models to achieve better fit amidst non-static business environments from the lens of contingency theory. This section, therefore, includes concluding remarks, the limitations, and areas for future research.

The study shows the significance of the Target Customer element in achieving alignment with the external environment when seeking fit. This paper demonstrates that the importance of understanding demand supersedes the importance of solely focusing on communicating the relative advantages associated with the innovation and firms' capabilities. It is, therefore, the flow and fit of meaning in accordance with demand's orientation and not the meaning itself that drives business competency. Specifically, this study suggests a three-dimensional consideration to reach a business model fit, being the internal consistency of the elements (inside-out), the influence of a changing external environment (outside-in), and the level of interdependence of the relationships between the nine elements (inside-in). Such a theoretical contribution to the contingency theory allows this paper to propose the first conceptualisation of the relationships between the BMC elements relevant to the MMC narrative in the UK public sector.

Overall, it is important to treat the findings of this study with caution, as limitations may exist. Conclusively, the limitations of this paper vary to comprise a special focus on the UK public construction sector, which confines generalisation. Moreover, the sample size (n = 74) may be low if seen in isolation of the characteristics of the responders, where a more extensive and more diverse sample of organisations, indeed, would yield better validity to the same arguments. Finally, replicating the results through a more controlled experiment that considers the size and nature of awarded public projects may be a critical validation of the results, an aspect that was not possible in this study. Future research is encouraged to:

a) Pursue the dynamics involved in achieving fit relative to construction innovations and the influence of fit on their widespread adoption.
b) Critically investigate the BMC elements from the lens of other seminal theories that deal with technological and organisational change, maturity, and systems theory.
c) Illuminate the subsequent intra-organisational challenges relevant to the broader adoption of construction innovations in the UK public construction sector.

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