THE IMPORTANCE OF PRE-FABRICATION AND ITS COLLABORATION WITH BUSINESS INTELLIGENCE WITHIN FUNCTIONAL DISCIPLINES: IN THE CASE OF UK

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ABSTRACT

The following study mainly investigates the importance of pre-fabrication along with the collaboration of business intelligence that supports in the effective completion of the project**.** The nature of the research paper is quantitative research design where it emphasizes on the use of statistical tools and techniques for revealing the findings of the study. The instrument that is utilized in the collection of the data is through a survey questionnaire where the targeted participants are the employees that are working in the construction industry in the UK. The sample size that is selected for distributing the questionnaire survey is 500 in which 469 individuals has provided with the survey and accounts for 93.8% participants. Therefore, the results have revealed that the use of business intelligence tools in the construction industry enables in reducing risk as well as saving cost. In addition, the prefabrication strategy enables in saving cost and reducing risk through its factors of designing, production and on-site installation. In addition, business intelligence has been found to have significant moderation effect between the prefabrication and project agility. Specifically, it was found to be significantly moderating between on-site installation and reduction of risk along with moderating the effects on production and saving cost. However, the limitation that is observed in the study is that the qualitative approach can also be incorporated into the study for gaining in-depth information on prefabrication and the collaboration of business intelligence.

Keyword: *Prefabrication, business intelligence, construction industry, Construction, Cost reduction, Project Risk*

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INTRODUCTION

In recent years, many countries or regions are showing significant interest in prefabrication as a sustainable production strategy for the purpose of meeting the construction demand. There are several challenges in the construction industry that are causing attention to prefabrication. These challenges mainly comprise of the sharp pressures of cost along with the environmental problem (Chauhan et al., 2019). Prefabricated buildings are referred to the types of building that are assembled through utilizing the factory-produced components after its delivery in the construction site. The benefits of prefabrication are that improves the construction quality, reduced labour and reducing the environmental influence (Li, 2020). Prefabrication is an emerging construction technique that is being practised in different regions throughout the different regions of the world such as Sweden, Malaysia, Singapore and others. However, the process of prefabrication is a highly complicated process as it includes the involvement of new stakeholders such as the local authorities, manufacturers and transporters. These complexities lead to inefficiencies and uncertainty in prefabrication and thus present challenges in planning and effectively controlling (Li et al., 2018). Therefore, the construction industry is under pressure for responding with innovation and changes. This requires the organization to be agile by incorporating effective strategic, operational and tactical decisions. The decision-making process requires dealing with larger data, knowledge and information. The support on the decision-making process is highly dependent on the business intelligence which supports the management through a strategic and tactical level (GhalichKhani and Hakkak, 2016). In this respect, there is a considerable number of studies that are conducted on prefabrication and business intelligence. However, there is no consensus regarding the collaboration of business intelligence on prefabrication. Therefore, the following research is focused towards understanding the importance of pre-fabrication along with the collaboration of business intelligence that supports in the effective completion of the project.

LITERATURE REVIEW

It is widely assumed that the adoption of prefabrication is the next step towards the evolution of the construction industry. It is argued that prefabrication in construction helps in lowering the cost of the project while ensuring that the project is delivered at a faster pace along

with reducing the minimal waste along with reducing the level of risk involved in the project. However, it is also argued that the prefabrication leads to a higher cost as it requires highly skilled labour, high cost in prefabrication production along with additional transportation cost (Li et al., 2018). In this respect, Shen et al. (2019) has conducted a study for investigating the cost-benefit analysis of public housing in Beijing. The study highlighted that the prefabricated houses are increasingly becoming popular as it has the potential of improving the construction environment, productivity and quality. The results of the study have demonstrated that the costs in prefabrication are higher and the environmental benefits are efficient which depicts the importance of prefabrication of public housing. In this respect, the first hypothesis is developed for the research:

H1: Pre-fabrication housing production has a significant and positive influence on the project agility

In the contemporary business environment, the use of technology is critically required for managing change and innovation. In this perspective, business intelligence has become highly important in the construction industry. The term business intelligence is referred to as the knowledge or capability for gathering and storing data that provides business with the information in making the decision (Girsang et al., 2018). Moreover, the study conducted by Amusan et al. (2018) has indicated that the growth in information technology and communication has led to numerous success to the construction industry as it had contributed towards the innovative success. The use of business intelligence tools can support in reducing the complexity, improving the efficiency, cost controlling, reducing risk and efficient operations. An effective tool of business intelligence is the business information modelling (BIM) which improves the practices of design, procurement, prefabrication, construction and post-construction (Oraee et al., 2019). In this perspective, the following hypothesis is designed:

H2: Business intelligence has a significant and positive influence on the project agility

Business intelligence tools are being widely utilized in the construction industry where the BIM is applied in various fields which comprise of prefabrication, design verification and quantity calculation. In respect to prefabrication, the business intelligence tools lead to simplifying the processes along with enhancing the workflow between the designers and constructors (Yoo, Kim and Choi, 2019). Similarly, the study conducted by Li et al. (2019) has indicated the importance

of the BIM for the prefabrication area in construction as it not only involves in the sharing of the 3D model in the design stage but also has the ability to perform service-oriented architecture which ranges from deconstruction and recycling. Therefore, in this perspective, the third hypothesis is developed on the basis of business intelligence plays a mediating role in prefabrication and project agility:

H3: Business intelligence has a significant mediating role between the association of pre-fabrication and project agility

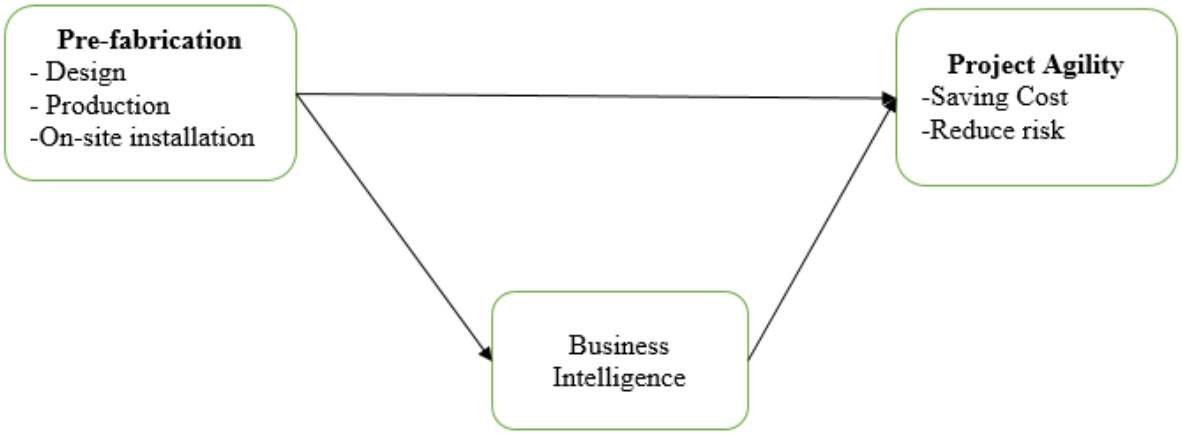

Figure 1: Conceptual Framework

METHODOLOGY

The focus of the research paper is primarily towards understanding the importance of pre-fabrication along with the collaboration of business intelligence that supports in the effective completion of the project. The nature of the research paper is quantitative research design where it emphasizes on the use of statistical tools and techniques for revealing the findings of the study. The instrument that is utilized in the collection of the data is through a questionnaire survey where the targeted participants are the employees that are working in the construction industry in the UK. The purpose behind the selection these particular respondents as they have the desired knowledge for demonstrating the importance of pre-fabrication on the completion of the project along with the moderating influence of the business intelligence. The sample size that is selected for

distributing the questionnaire survey is 500 in which 469 individuals has provided with the survey and accounts for 93.8% participants. The instrument used for conducting the statistical analysis through Smart PLS. The technique applied for conducting the analysis is through structural equation modelling (SEM) which involves in conducting the validity and reliability analysis, discriminant validity and path regression analysis. The latter aspects are associated with the Confirmatory Factor Analysis (CFA) where the researcher has confirmed the validity along with the reliability of the undertaken factors. Therefore, Cronbach Alpha, Average Variance Extracted (AVE), and HTNT ratio have been computed.

RESULTS AND FINDINGS

Convergent validity and reliability analysis

The first technique that is applied to the data is the convergent validity and reliability analysis. The techniques for conducting the validity and reliability analysis are the outer loadings, Cronbach's alpha and average variance extracted (AVE). The results on the convergent validity and reliability are presented in table 1 in which the first technique that is applied is outer loadings. The outer loadings mainly examine the absolute contribution of the items on the specific variable where the value must be greater than 0.6 (Firtria, 2019; Istiariani and Arifah, 2020). In this perspective, the outer loadings for entire items are determined to be above 0.6 which indicates that each item has made an absolute contribution to its specific variables. The other test that is applied on the results is the Cronbach's alpha which evaluates the internal consistency of the variables and must be above 0.6 for indicating that the variables are reliable (Al Saadi and Suleiman, 2020; Mulyana et al., 2020). In this perspective, the Cronbach's alpha is computed to be above 0.6 which depicts that the variable is internally consistent. The last set of tools is the AVE where it identifies the variance of the variables and the value must be higher than 0.5 (Basheer et al., 2019). In this respect, the value of AVE is determined to be higher than 0.5 which thus depicts that the variables are valid and reliable.

Table 1: Convergent validity and reliability analysis

Variables	Items	Outer Loadings	Cronbach's Alpha	AVE
Business Intelligence	BI1	0.863	0.847	0.766
	BI2	0.882		
	BI3	0.880		
Design	DES1	0.883	0.865	0.787
	DES2	0.903		
	DES3	0.876		
On-site Installation	OI1	0.884	0.872	0.797
	OI2	0.919		
	OI3	0.874		
Production	PR1	0.797	0.814	0.730
	PR2	0.896		
	PR3	0.866		
Reduce Risk	RC1	0.665	0.789	0.543
	RC2	0.659		
	RC3	0.650		
	RC4	0.846		
	RC5	0.836		
Saving Cost	SC1	0.909	0.904	0.840
	SC2	0.931		
	SC3	0.909		

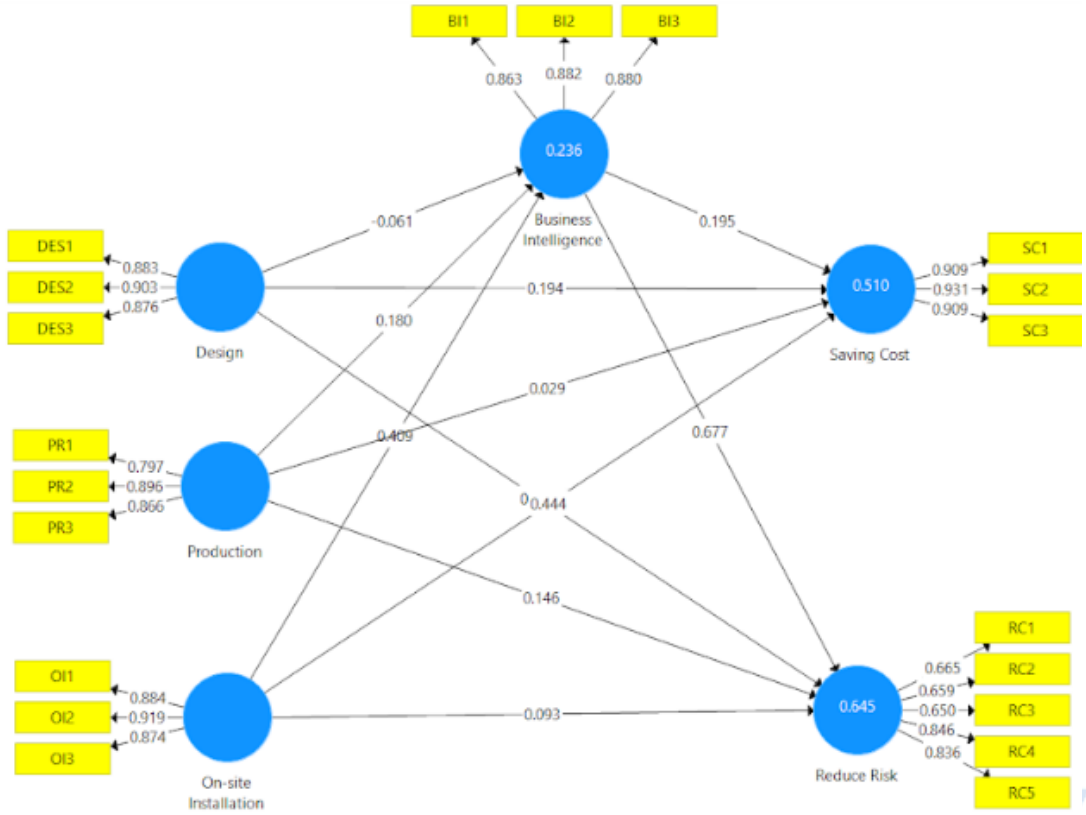

Figure 2: Confirmatory Factor Analysis

Discriminant validity

The purpose of discriminant validity is to mainly evaluate the degree of distinctiveness among the variables where it is critical for the variables do not have high correlation analysis for preventing multicollinearity issues (Ab Hamid, Sami and Sidek, 2017). In this respect, the Heterotrait-Monotrait (HTMT) ratio is applied for evaluating the level of distinctiveness among the variables. The association of the variables is measured where it was determined in the study of Hussein and Baharudin (2017) that the value must be less than 1.0. As shown in table 2, the values in the HTMT ratio is identified to be lower than 1.0 where the highest value is recognized to be 0.906 which is between business intelligence and reduce risk. Therefore, it can be concluded that the variables are distinct from each other and do not possess the multicollinearity issue.

Table 2: HTMT ratio (Discriminant validity)

	Business Intelligence	Design	On-site Installation	Production	Reduce Risk
Business Intelligence					
Design	0.347				
On-site Installation	0.537	0.729			
Production	0.429	0.677	0.617		
Reduce Risk	0.906	0.438	0.586	0.565	
Saving Cost	0.535	0.620	0.757	0.514	0.605

Path Coefficient

The most important technique that is applied to the analysis of the path coefficient analysis where its results are identified below. The purpose of the path coefficient was to mainly determine the influence of prefabrication on the project agility along with evaluating the moderating role of business intelligence. The significance threshold that is identified for illuminating the significant influence on mainly three confidence interval which are 90%, 95% and 99%. Therefore, the p-value of the variable must be below the value 0.10 for indicating a significant influence. In terms of the conceptual framework, the independent variable of the study is prefabrication where there are three factors used which consist of design, on-site installation and production. The dependent variable in the study is project agility which is measured through reduced risk and saving cost. Business intelligence is determined to be the moderating variable.

As per the results in table 3, business intelligence has been found to have a significant influence on reducing risk [r=0.69, p=0.00] and saving cost [r=0.20, p=0.000]. As per the design, it is only identified to have a significant influence on saving cost [r=0.19, p=0.000]. The variable on-site installation is found to have significant influence on business intelligence [r=0.41, p=0.000], reduce risk [r=0.10, p=0.033] and saving cost [r=044, p=0.000]. The variable production is found to have significant influence on business intelligence [r=0.18, p=0.005] and reduce risk [r=0.14, p=0.000]. In respect to the moderating influence of business intelligence, it is determined

to have a significant and positive influence between on-site installation and reduce risk as value is computed as 0.28 and significance value is determined as 0.000. Moreover, business intelligence is found to have significant moderating influence between production and reduce the risk [r=0.12 and p=0.005]. In addition, business intelligence also significantly moderates between on-site installation and saving cost [r=0.08, p=0.006] and also between production and saving cost [r=0.04 and p=0.022]

Table 3: Path Coefficient

	Beta	T Statistics	P Values
Business Intelligence -> Reduce Risk	0.69***	21.40	0.000
Business Intelligence -> Saving Cost	0.20***	3.57	0.000
Design -> Business Intelligence	(0.06)	0.95	0.345
Design -> Reduce Risk	0.02	0.40	0.689
Design -> Saving Cost	0.19***	3.70	0.000
On-site Installation -> Business Intelligence	0.41***	6.52	0.000
On-site Installation -> Reduce Risk	0.10**	2.13	0.033
On-site Installation -> Saving Cost	0.44***	7.56	0.000
Production -> Business Intelligence	0.18***	2.79	0.005
Production -> Reduce Risk	0.14***	4.01	0.000

Production -> Saving Cost	0.03	0.53	0.595
Design -> Business Intelligence -> Reduce Risk	(0.04)	0.94	0.350
On-site Installation -> Business Intelligence -> Reduce Risk	0.28***	5.97	0.000
Production -> Business Intelligence -> Reduce Risk	0.12***	2.82	0.005
Design -> Business Intelligence -> Saving Cost	(0.01)	0.86	0.388
On-site Installation -> Business Intelligence -> Saving Cost	0.08***	2.74	0.006
Production -> Business Intelligence -> Saving Cost	0.04**	2.29	0.022

*** Significance at 1%; ** Significance at 5%; * Significance at 1%

Model Summary and predictive relevance

Table 4 reflects on the model summary where there are basically three models that are involved in the research which consist of business intelligence, reduce risk and saving cost. The model summary is analyzed through the R-square or coefficient of determination which determines the variance of the variables (Zhang, 2017). In this respect, the R-square for business intelligence is computed as 23.63% which depicts that the variables of prefabrication explain or predicts business intelligence by 23.63%. Similarly, the r-square value of reducing risk is computed as 64.50% whereas saving cost r-square is computed 51.01%. The predictive relevance of the model is evaluated through the Q-square in which the value must be above 0 for indicating predictive relevance (Valaei and Nikhashemi, 2017). As shown in table 4, the value of q-square for all three models is above 0 which indicates that the model is predictive relevant.

Table 4: Model summary and predictive relevance analysis

	R Square	R Square Adjusted	Q-square
Business Intelligence	23.63%	23.14%	0.171
Reduce Risk	64.50%	64.19%	0.337
Saving Cost	51.01%	50.58%	0.419

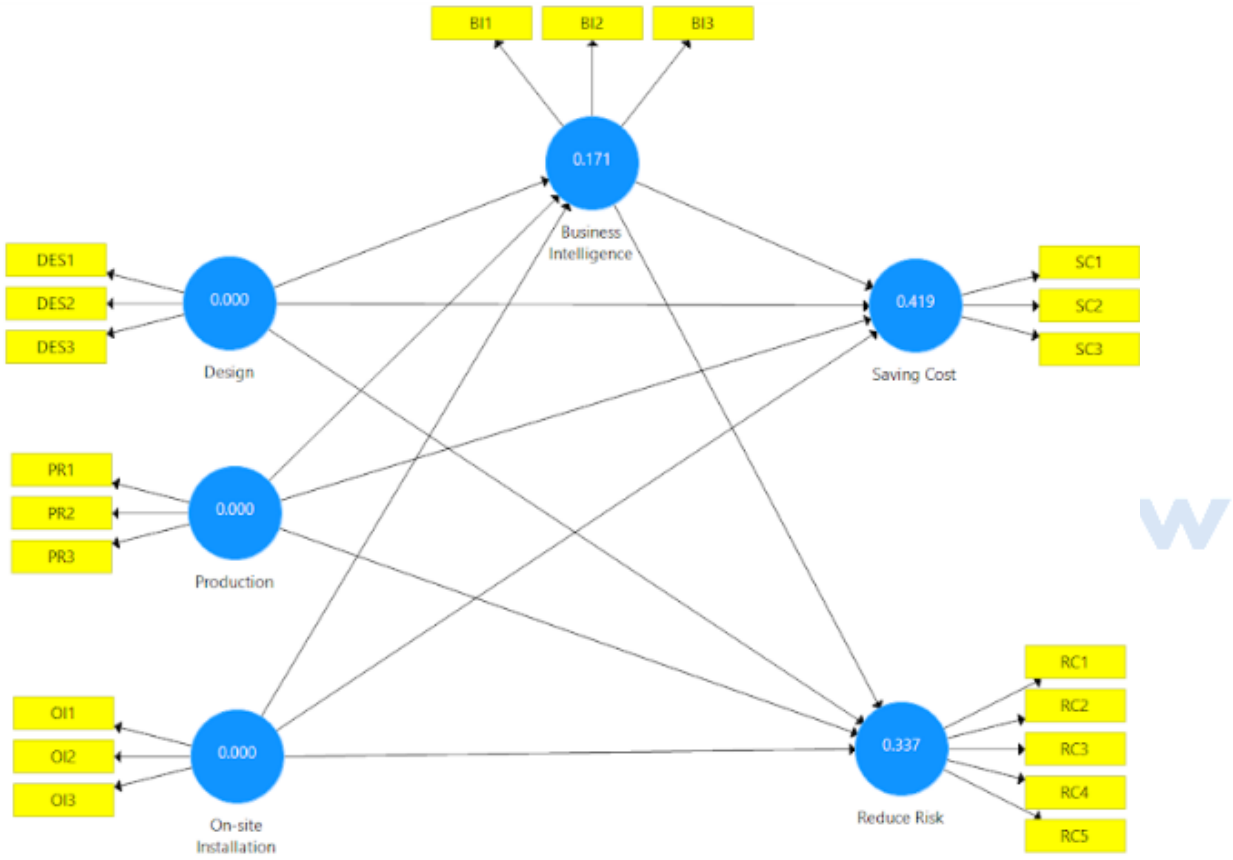

Figure 3: Blindfolding Technique

Hypotheses Testing

H#	Hypothesis	Results
H1	Pre-fabrication housing production has a significant and positive influence on the project agility	Partially Accepted
H2	Business intelligence has a significant and positive influence on the project agility	Accepted
H3	Business intelligence has a significant mediating role between the association of pre-fabrication and project agility	Partially Accepted

CONCLUSION

Prefabrication has become a sustainable production strategy for meeting the demand of construction where its attention has been significantly increasing over the year due to environmental problems and pressure of cost. There are wide benefits of prefabrication which comprises of improving the quality construction, reducing labour costs and improving the sustainability. However, the process of prefabrication is highly complex as it comprises of challenges in planning and effectively controlling. Thus, the following study mainly investigates the importance of pre-fabrication along with the collaboration of business intelligence that supports in the effective completion of the project. The approach for conducting the study is through developing the questionnaire survey and distributing among the employees in the construction industry particularly in the UK. The data is analyzed through the SmartPLS where the SEM technique is applied for revealing the findings. The results have revealed that the use of business intelligence tools in the construction industry enables in reducing risk as well as saving cost. In addition, the prefabrication strategy enables in saving cost and reducing risk through its factors of designing, production and on-site installation. In addition, business intelligence has been found to have significant moderation effect between the prefabrication and project agility where it has been able significantly to moderate between on-site installation and reduction of risk along with moderating the effects on production and saving cost. The limitation that is observed in the study is that the qualitative approach can also be incorporated into the study for gaining in-depth information on prefabrication and the collaboration of business intelligence.

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