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Development of Theoretical Framework for Improving Implementation of Design Management Within Malaysian Construction Industry

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ABSTRACT

Design Management is a systematic method of managing design process through integration of multiple stakeholders in a construction project. Its role and activity are about bringing ideas together, connecting, integrating, communicating, innovating and collaborating design activities, people, processes and resources that are related to the project. Project success can be measured either by objectives or subjective measures where both have their own contribution towards project management success and product outcome success. For this study, project success takes into consideration both measures. This is due to design-caused defect was found as the highest contribution in project defect when measured by cost. The aim of this research is to determine the relationship between design management and project success. For this research, the components of this theoretical framework were developed based on the theories and empirical evidence relating to design management and project success measure. The outcome shows that 41processes had been classified into 7 project stages: project initiation, preparation of design outline, conceptual design, detail design development, procurement, construction and project operation and 6 components of success measure had been identified: Objective measure consists of time and cost and subjective measures look into quality, health and safety, functionality and end-user's, client's, design teams and construction team satisfaction.

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1. Introduction

Design is an activity in which the outcome can be in terms of product, services, building or any other objects that we may encounter in our daily lives.The most important mission of design is to produce physical objects that meet the aesthetic and functional expectations, as well as the economic and technical requirement in production [40]. The author also stated that managing the process of designing is done by defining the values to be met, translating them into design brief and guiding the designers in theirunderstanding of the requirements. Design stage is crucial in most projects especially in construction industry since this is the phase of collecting requirements and understanding the needs of stakeholders. Dvir *et al*., [15] described that preparation and proper planning of design has strong positive effect on meeting project timeline, budget, and objectives, thus it indirectly contributes to customer's benefits. On the contrary, lack of preparation in early design stage may contribute to negative impact towards the later project stage such as frequent design change, buildability issues, increase of cost, and client's dissatisfaction. As the project is progressing, it is also essential to have a good management of design to facilitate the process of managing design information between designers, contractor, and material suppliers. Good design management may also reduce the risk for rework during construction stage since rework is one of the contributors of cost growth in total project cost. As such, probably through good practice of design management, better outcome can be anticipated, cost growth can be prevented, and project success is made possible.

Project success is extensively discussed by researchers around the world and is traditionally determined by 'project completion within scope, cost, quality, time and resources' (PMBOK). These three criteria or better known as 'iron triangle' has been dominating the definition of project success for long and it has often been related to project management success. However, with theemergence of new research that view project success through different dimensions, the overall perception of project success has now changed to a more holistic view. Instead of merely focusing on the 'iron triangle', project success is now being evaluated from a broader scope which includes subjective criteria such as product functionality, high quality, and end user's satisfaction. Dvir [14] described that project success shall be measured by 4 criteria: i) meeting design goal, ii) benefit to customer, iii) commercial success and iv) future potential. Lipovetsky *et al*., [28] also described that success dimensionsin meeting design goals and benefit to the customer as the most important measures of project success among stakeholders in a project.

According to Andersen *et al*., [7], design management is now a significant function within construction industry due to failure of other available system in integrating design process with construction process. They further discussed that design management has several roles in construction that may require involvement from different personal and professional backgrounds. Thus, they highlighted roles of design management, and describe one of them as integrators of design and construction. Tzortzopoulos *et al*., [44] similarly linked design management with managerial practice that focus on improving design process using systematic design methods, focuson outcome and importance of collaboration within different stakeholder. They also mentioned that there is still inadequate design management research whichemphasizes on roles, barriers and the processes involved in managing design.

Literature review at the early stages of the research revealed that for issues in Malaysian construction industry problems were highly associated withdesign either directly or indirectly and this reduced the possibility to achieve project success. The problems identified have been categorized based on the nature of the problem, i.e., project delay, cost overrun, low quality, and end- user dissatisfaction. These problems are said to be interrelated with the efficiency of managing design

process from project inception to completion. Pretorius *et al*., [36] in their study on 'Design management for projectsuccess' described that system thinking in design management during design process plays an important role for the success of a project. This is further supported by Josephson and Josephson *et al*., [19] who found that design-causeddefect as the biggest category in construction defect when measured by cost. Tzortzopoulos *et al*., [44] revealed that inappropriate planning, poor design reviews, inconsistent process and design, poor quality, conflict between designers and contractor interest, arethe problems and issues that relate to design management. Thus, one requires clarity of roles, responsibilities, and availability of skilled design managers to overcome these issues.

Malaysia has had its fair share of the aforementioned issues and problems especially on quality, delays and cost overrun. Abdul-Rahman *et al*., [1] in his study on 'Delay mitigation in Malaysian construction industry' found that delays were mainly found during construction phase (45%), commissioning phase (19.7%), tendering phase (16.4%) and design stage (14%). Their findings also deduced causes of delays which include changes and/or additional works, shortage of labor and skilled workers, poor documentation and no written procedures, poor design, poor communication, misunderstanding and others. Furthermore, according to Kandei *et al*., [22], quality issues normally involved application of quality standard, management commitment, communication, design and planning activities and relationship between construction player. [1] described cracks on Middle Ring Road 2 (MRR2) as an example of design deficiencies which results in low construction quality. The defect was due to negligence on design team and it required an estimated of RM20 million for repair works [2]. Details of problems in construction industry will be discussed according to nature of problem as follow:

1.1 Delay

One of the most common problems in construction is delay. Delay will not only impact the completion, but it may also affect total cost and end user expectation. Delay can be caused either due to external or internal causes. Alaghbari *et al*., [4] described delay as caused by owner, designer, contractors, and consultants as internal factors while delays other than those four parties are considered as external factor. Abdul-Rahman *et al*., [1] has described causes of delays which includes; authority approval, client influence resulting in many changes and additional works, incomplete contract documents, design problem due to poor design, not enough material, poor documentation, poor communication, misunderstanding and the list goes on.

1.2 Quality

CIMP 2006-2015 by CIDB has highlighted issues on quality under Strategic Thrust 3; Strive for the highest standard of quality, occupational safety and health, and environmental practices [11]. Mahmood *et al*., [29], mentioned that quality in construction is interconnected with compliance to specification and should be fit for use. There are many complaints regarding construction product by end user especially on shoddy workmanship. Sometimes lack of quality could further lead to defects and also failure of the building. Ahzahar *et al*., [3] described 9 factors that contributes to building defects as construction materials, defect during construction, corruption, lack of supervision, faulty design, climatic condition, lack of maintenance, building type and change in use and also location of building.

1.3 Cost Overrun

Sometimes, cost of rectifying defect could be higher than the first time build cost. Thus, it is worth to identify the underlying causes of cost overrun as they may be linked with other factors as well. Memon *et al*., [30] in their study, summarized 10 most important factors that cause cost overrun accordingto rank namely; i) Poor designs and delays in design, ii) Unrealistic contract duration and requirement, iii) Lack of experience, iv) Late delivery of material and equipment, v) Relationship between worker and management, vi) Delay in preparation and approval of drawing, vii) Inadequate planning and scheduling, viii) Poor site management and supervision, ix) Mistakes during construction and x) Changes in material specification.

The issues presented above justify the needs to conduct a study on designmanagement since most of the problems were highly associated with design either directly or indirectly. Design should be managed starting from project initiation, designing phase, procurement phase, construction phase and also upon completion. Therefore, this research was conducted in order to study whether or not design management has any possibility in contributing to quality of end product, satisfaction of client and end user and also completion within time and cost thus contributes to project success. Through the development of the theoretical framework, the author aims to explore therelationship between design management and project success.

2. Methodology

This research adopts deductive approach because it involves development of theory and hypotheses [39]. Thus, it allows anticipation of phenomenon and prediction of outcome. This study begins withextensive literature review on topic of interest namely, i) Issues in Malaysian construction industry, ii) Design management and iii) Project success. Literature review at the early stages of this research seek for issues in Malaysian construction industry and this has resulted in project delay, low quality and cost overrun that are as the most prominent problems. Therefore, focus was given on understanding construction industry problem which relates to delay, cost overrun and quality: these justify problem statement for this study. Information obtained from literature review on design management and project success was gathered to develop theoretical framework and also formulate hypotheses for this study. The theoretical framework is established to guide in identifying the variables for both dependent and independent and their contribution in explaining as to why problem occurs and how they can be solved. The association between each of the variables was further identified in order to formulate hypotheses.

This research is explanatory in nature since the study focuses on identifying the relationship between design management and project success in the context of construction industry. A study by Josephson *et al*., [19] showed that design-caused defects were the biggest category of defects when being measured by cost which are also common problems in construction. As such, there is a probability that deficiency in managing design process (Figure 1) may contribute to design-caused defect which indirectly hindered project success. In contrast, design management practice could be the possible solution to prevent design-caused defect (Figure 1) which possibly contributes to project success. Thus, design management processes and project success measure were selected as variables to develop the theoretical framework.

Fig. 1. Relationship between design management and design-caused defect

3. Literature Review

3.1 Project Success

It can be concluded that project success can be divided into two; i) project management success which includes completion within time, cost quality and stakeholders' satisfaction and ii) product success in terms of users' satisfaction, profitability, and commercial success. In this study, definition of project success will consider these two aspects since both are important andcan benefit user, stakeholders, and project team itself. Furthermore, this is to ensure a holistic approach of defining project success.

Success criteria describe 'what' are the success that should be measured?There are no specific criteria for measuring project success and it is very much related to how an individual, an organization or a Project Manager perceived project success. As an example, a client would want the project to be completed within time and cost given. Therefore, project success criteria in thiscase would be measuring the time and cost upon completion of the project. This might be different to the consultant or project team, by which they may want the end product to have benefitted the end user. Thus, definitely project success criteria for the consultants and project team is measuring the satisfaction of the end user once project has been delivered and used.

There are many different opinions on success criteria. The early scholars tied project success to performance measure, as such, the criteria are normally limited to time, cost, and quality [32]. However, Pinto *et al*., [33] described that success should be measured from the interpersonal relations satisfaction within project team members which they refer to as 'soft' measures. Kometa *et al*., [25] suggest broader success criteria which include safety, construction, and maintenance cost, and users' flexibility. The same suggestion was also brought up by Songer *et al*., [42] whereby success criteria must take into consideration budget, schedule, user's expectation, meeting specification and good workmanship.

3.1.1 Success measure

As mentioned in the definition of project success earlier, success can be viewed from two perspectives: project management success and product success. Therefore, success measure can also be divided into two; i) Measuringproject management success and ii) Measuring product success. Cooke-Davies [12] suggested measure of project success by measuring the performance against overall objective of project while measure of project management success is against the triple constraints. Measuring project success is alsoevolving alongside the evolution of project success

definition as per Table 2.2. The previous scholar who studied project success had accepted the 'soft' sideof success criteria which measure the satisfaction. With this, Slevin *et al*., [34] proposed that project success should have an integration between internal factor and external factor. They describe time, cost, and performanceas internal factors while satisfaction, effectiveness and use as external factors.

Atkinson [8] has proposed two different levels of measuring success: i) Delivery Stage and ii) Post-delivery stage. For delivery stage, Atkinson [8] suggested measuring the process (doing it right) in terms of cost, time, quality, and efficiency. As for delivery stage, he proposed of measuring the systems (getting it right) and the benefits (getting them right). Shrnhur *et al*., [41] similarly divided project success into four dimensions; Project efficiency, impact on customer, business success and preparing for the future. All of these four dimensions are time dependent thus success is measured according to; i) during project execution and right after completion, ii) after project has been delivered to customer, iii) after 1-2 years of sales iv) after 3-5 years of project completion. Sadeh *et al*., [38] also divided project success into four dimensions, but he introduced additional dimension which he termed as 'overall success' that will conclude the whole four success dimensionsearlier. Lim and Zain [27] proposed to measure project success from macro and micro viewpoints. They classified project completion within time, cost, quality, performance, and safety under micro viewpoint. Conversely,macro viewpoint measure completion by time, satisfaction, utility, and operation.

Key Performance Indicators (KPIs) is one of the tools that can be used tomeasure project success. According to Chan *et al*., [10], KPIs will enable measurement of organization performance throughout construction industry. Therefore, any companies or organizations that would want to measure their performance should set KPIs from the beginning. Chan *et al*., [10] had introduced a set of KPIs in order to measure project success that they divided into Objective Measure and Subjective Measure as per Table 1. They differentiated Objective measure as needs of mathematical formulae while subjective measure is more towards getting personal judgement of the stakeholder and can be measured using scale. Summary of success measure from different scholars is listed in Table 1.

3.2 Design Management

The term 'Design Management' was introduced by The Royal Society of Arts, UK way back in 1965 [9]. At that particular moment, design management term is only referred to managing the relationship between design agency and its clients. The definition and understanding of design management has evolved ever since. Design management has been described as an advanced managerial which includes technical practices in the process of designing product and process quality [5]. Sebastian [40] explained in detailed about the inter-relationship between design and management in order to describe design management. He used architecture as an example of design product and described that architecture does not only deal with the physical environment but also depends on social environments in which it fulfils human needs for space and aesthetics. As for management, the environment comprises of the society, the organization and business enterprise. As such, Sebastian [40] deduced that both design and management are inter-related when considered as activity or practice.

Reviewing the literature on the definition of design management may provide deeper understanding of the theoretical concepts of design management. The role of design management has been expanded from merely on managing design to creating value out of the design process. Design is not only limited to product design, but it is able to bring success for the organization and create value to the customer if the process of designing is properly managed. The scope of design management includes strategic management of corporate design functions and design agencies that

consist of design operations, human resource, methods and processes up to the strategic advocacy of design across the organization as a key differentiator and driver of organizational success (DMI). Development of design management theories does not depend solely on design theories, but it is strongly influenced by other theories such as resource management, project management, marketing, and strategy [43]. The integration of different theories has somehow made design management theories more comprehensive as it covers the aspect of management and value creation by applying 'design thinking' into the process. Application of design management will form a successful flow between product creators and the end user who use the product. Because it is only through consistent, clear, and realistic idea in managing design, good and positive products and concepts can be achieved.

Table 1
Comparison of Success Measure(Source: Adopt from Multiple Author)

Shrnhur *et al.*, [41]	Atkinson [8]	Lim and Mohamed [27]	Sadah *et al.*, [38]	Chan *et al.*, [10]	Proposed Success Measure
• Project efficiency – short term measure on time and budget • Impact on customer – performance, functional, specification • Business success – yield & quality, organization performance • Prepare for future – technological infra for future	• Delivery stage – the process: doing it right (cost, time, quality, efficiency) • Post Delivery stage – the system: getting it right (benefits to customer, users, project staff, stakeholders) & the benefits; getting them right (impact to customer & business success	• Micro viewpoint – time, cost, quality, performance, safety • Macro view – satisfaction, utility, operation	• Meeting design goals – functional, technical, schedule, budget • Benefits to end users – operational, satisfaction • Benefits to the developing organisation – profit, market, new technology • Benefits to defence and national infra – contribute to other projects • Overall success – combined measure of project success	• Construction time • Speed of construction • Time variation • Unit cost • Percentage net variation over final cost • Net present value • Quality • Functionality • End-user's satisfaction • Client's satisfaction • Design team's satisfaction • Construction's team satisfaction	• Time • Cost • Quality • Health and safety • Functionality • End-user's, Client's, Design Teams and Construction team satisfaction

In this study, emphasizes will be given to the definition of design management that will focus on creating value towards the customer. This is consistent with the objective of this study that is to identify the relationship between design management and project success.

3.2.1 Design process in construction

Design is very unique as it possesses the meaning of a process of making things or the outcome of the process itself. The activity of designing is user-centered, and most of the time involves problem solving [9]. Therefore, it is important for a designer to perceive design in a wider context, through in-depth understanding of the requirements, and value it may contribute, so that the true potential of design can be exploited. Potter [35] described design as an activity that gives form and order to life

arrangements. According to Borja [31], design process is considered as an identity process for the company, their customers and also their investors.

In construction industry, the activity of designing is normally led by architects in obtaining client's brief, understanding project requirement, and proposing design scheme. However, design process in construction does not only involves architect: input from other professional disciplines such as structural, services, mechanical and electrical engineers is also highly required. Design stage is an interactive and iterative process among project team [18]. Designing a building is a lengthy process, thus a designer is always faced with request of changes as the project progresses. This is a challenge to all designers since they have to satisfy the creative need, being innovative and maintain quality with a great restriction of budget [18].

Gray and Hughes [18] described that a successful product of design process is normally determined by the selection of starting point in solving client's problem. It requires clear definition of the boundaries and overview of the problems before a designer can start designing. For instance, in order to for a designer to design floor layout, the designer must know the number of people working, type of tasks and any other requirement that may need to be translated into the design. Besides, a designer should also understand the constraint that may have the possibility to affect the design product. Thus, it is an advantage if designers can provide alternatives for their designs.

In construction, drawing is deemed as a crucial part in designing. This is due to most of the information needed to proceed with later design stage depends on drawing. During the execution of the project, it revising the drawing due to design change, requirement change or adaptability of design to the construction site is a common practice. Therefore, managing the output of design process is as important as managing the design process. Kalsaas e*t al*., [21] mentioned the importance of understanding the interdependencies between design processes in order to manage them. Hence, it is essential to understand the underlying values that design management have in facilitating construction project.

Construction industry is now experiencing decline in productivity as a result of deficiencies in building design. This might be due to challenges in managing building design phases since it involves managing outputs as drawing and creativity as minds [24]. Furthermore, design management in construction project does not end at designing stage but it should be practiced starting from project inception until post project completion. Design management is simply about managing people and information [16]. It is about managing the flow of information between stakeholders, focus points of the design objective, planning and managing at different stage of construction project. Knotten *et al.*, [24] cited Kestle *et al*.,[23], "Design management is an intricate social situation where value can be a socially constructed phenomenon and decision making to that, end can be inherently unpredictable". Thus, it shows that design management in construction is widely exposed to uncertainties especially in ensuring value of the outcome.

Client plays an important role as decision maker at each project stages and is responsible to who initiate the project by providing comprehensive design brief. A good and experienced client should have clear understanding of their needs for the building, and able to provide detailed brief to the consultants. Upon getting the statement of need, designer should develop concept and design outline, while Project Manager is responsible to determine budgets, time, and cost. The design, budget and set of project information should be forwarded to client for approval. The process will continue with development of schematic design by designer, and budget affirmation by Project Manager. At this stage, the designer must check the necessary basic systems for the building and take into consideration value engineering and buildability. This should provide ultimate design solution, construction method, and comprehensive specification together with detail cost and timeline.

If the Client is satisfied with the scheme, cost and timeline, the process can proceed to engineering consultant detail design. This is where design teams (architects and engineer) develop full production information and segregate work according to work packages. Project Manager may start procurement process once detail information of the building has been obtained. For a complex design, involvement of specialist is required in order to solve any ambiguity or problem found during design stage. Therefore, it is the responsibility of the designer to ensure that all design information needed by the specialist is being attended.

Next, designer, specialist or consultant should provide the necessary information to the contractor to proceed with building construction. During construction period, project team member must ensure that information is constantly available and precise. It is the accountability of the designer to check and inspect project progress against design brief before the project can be handed over to the respective Client. Table 2 describes basic design management process which shows its relationship with project stages. This is in contrast with the existing design management approach as described by [6] through his Total Project Management process. Design management process in the 'Total Project Management process' only applicable during design stage compared to the comprehensive approach proposed by Gray and Hughes [18].

3.2.1 Design management detail process

There is limited literature on design management process in construction available for reference. Therefore, for the purpose of this study, three (3) design management process were referred to which are from; [37], [18] – [17]) - The Design Manager's Handbook. Since design management processes are varied between these three (3) authors, the processes were tabulated for comparison in Table 2. It was found that each of the design management process embraces different project stages. However, there are still some similarities between the processes involved at each project stage.

3.3 Discussion

Based on the literature review, it was literally found that design management could be the possible solution for design-defect caused and might also contributes to project success. Therefore, all information regarding design management which includes definition, process, tools/standards, and its significant together with project success definition, factors, criteria and measure were gathered to justify the aim of this study. Futhermore, this information was further organized and analysed for the development of the theoretical framework.

4. Result and Analysis

This section presents the discussion of theoretical model and hypothesis development of this study. Based on the analysis results of identified theories and empirical evidence of previous studies, the authors combined and conceptualized them to produce the proposed theoretical model of this study. At the end of this stage, the authors found 7 constructs with 6 associations. The following Fig.2 shows a proposed theoretical framework of this study.

4.1 Theoretical Framework Development

The elements of the theoretical framework of this study are divided into 2 parts which include the design management process and the project success measure. There are 41 processes being identified from the review and analysis of previous literature and these 41 processes had been classified into 7 project stages: project initiation, prepartion of design outline, conceptual design, detail design development, procrement, construction and project operation. Table 3 depicts the predetermined design mangement process with respect to design managemen process in construction industry.

Based on literature review being conducted, it was found that design management could be the possible solution for design-defect caused and might also contribute to project success. Therefore, in the development of the theoretical framework, the project success measures are linked with the design management process. Based on the previous literature and analysis, 6 components of success measure had been identified: Objective measure – time and cost and subjective measure- quality, health and safety, functionality and end-user's, client's, design teams and construction team satisfaction. Table 1 depicted the predetermined project success measure with respect to measuring project success in construction industry.

Table 2
Comparison of Design Management Process
(Source: RIBA Plan of Work [37], Gray and Hughes [18] and Eynon [17])

	RIBA Plan of Work 2013	**Collin Gray and Will Hughes [18]** Building Design Management	**John Eynon [17]** The Design Manager's Handbook
Project Stage	**Design Management Process**		
Strategic Definition	▪ Identify Clients Need (Business Case) ▪ Other core project requirements	▪ Formal Start up meeting ▪ Establish programme for decision making	▪ Define + Validate (Client requirement, delivery parameters; time scales, budget limits) ▪ Briefing ▪ Establish Business Case ▪ Value Options ▪ Review and assess feasibility
Preparation and Brief	▪ Develop Project Objectives (Includes quality Objectives, Project outcomes, Sustainability aspirations, project budget and other parameter constraints) ▪ Develop Initial project brief ▪ Conduct feasibility studies	▪ Functional brief ▪ Value Mgmt 1 ▪ Concept Budget (Time/Cost/Quality)	
Concept Design	▪ Prepare concept design (Include outline proposals for structural design, building service systems, outline specifications & Cost information) ▪ Prepare Project Strategies ▪ Issue Final Project Brief	▪ Scheme Design & Firm Budget ▪ Value Engineering 1	

Developed Design	▪ Prepare Developed design (Coordinate updated structural design, building service system, specifications) ▪ Update Project strategies in accordance with Design programme	▪ Detailed Design Management ▪ Facilitate Access to Specialist Trade Contractor information	
		▪ Bidding ▪ Tender Information	▪ Design development + Prototype ▪ Established project parameters ▪ Value Management ▪ Pre-Construction ▪ Tender/Negotiation ▪ Employer's requirements ▪ Contractor's Proposal ▪ Design for delivery (Information needed in accordance to procurement type – D/B, Design-Bid-Build or etc)
Technical Design	▪ Prepare Technical Design (In accordance with Design Responsibility Matrix) ▪ To include architectural, structural and building services, specialist contractor design and specification information	▪ Engineering Design Mgmt. ▪ Value Engineering 2	
Construction	▪ Resolve Design Queries	▪ Construction ▪ Hand Over Training	
Handover and Close Out			▪ Provide information to contractor ▪ Integration + coordination of all stakeholders ▪ Supply chain integration ▪ Deal with compliance issues
In Use	▪ Conduct Post occupancy evaluation		▪ Conduct Post occupancy evaluation

Table 3
Predetermined Design Management process

PROJECT STAGE	PROCESSES
Project Initiation	1. Start-up meeting to identify client's requirement 2. Assessing validity of client's requirement 3. Identify value of design for the project 4. Provide alternative design solution strategies 5. Identify design constraints 6. Establish decision-making structure and respective authority
Preparation of design outline	1. Establish a mutual design objective understanding between Client/Architect/Engineer/Project Team 2. Preparation of detail design brief 3. Appointment of Lead Designer to lead Design Process 4. Seek User's opinion to define functional needs and space relationship 5. Prepare Design Responsibility Matrix 6. Determine requirement of statutory (authorities/planning/other related bodies) 7. Implement systematic data/drawing management process 8. Risk assessment of foreseeable construction health & safety
Conceptual Design	1. Develop design to finalize building's appearance and layout 2. Propose structural design, building service system and material 3. Identify principle supply chain for the project 4. Assess design proposal to meet cost constraints 5. Develop design information schedule 6. Define deliverables of each designer involves in the project 7. Conduct Design team progress meeting 8. Audit conceptual design against priorities in design brief 9. Signing off the chosen scheme by all parties
Detail Design Development	1. Coordination of detail design requirement by Lead Designer 2. Involvement of specialist consultant/contractors in providing advice and knowledge of their system 3. Submit any request of modification to client for approval 4. Ensure sufficient and correct design information (including drawing) is available to the relevant parties 5. Monitor design deliverables as per Design Responsibility Matrix
Procurement	1. Identify scope of work packages (Will there be single or multiple prime contracts?) 2. Resolve design liability issues 3. Identify and specify information required for each work package 4. Shortlist the suitable contractors/suppliers/specialist for each work package 5. Schedule the on-going required information for each of work package to each contractors/suppliers/specialist 6. Evaluate all Tender/RFQ/RFP submission according to design brief
Construction	1. Sharing of information using systematic communication system 2. Implement document control system for issuance of information needed during construction 3. Record all design changes 4. Audit design changes against design brief 5. Resolution of design queries as per defined deliverables agreed during Conceptual Design
Project Operation	1. Conduct Post Occupancy evaluation after a certain period of project completion 2. Evaluate and analyse result of evaluation for lesson learnt

Table 4
Predetermined Design Management process

PROJECT STAGE	PROCESSES
Project Initiation	7. Start-up meeting to identify client's requirement 8. Assessing validity of client's requirement 9. Identify value of design for the project 10. Provide alternative design solution strategies 11. Identify design constraints 12. Establish decision-making structure and respective authority
Preparation of design outline	9. Establish a mutual design objective understanding between Client/Architect/Engineer/Project Team 10. Preparation of detail design brief 11. Appointment of Lead Designer to lead Design Process 12. Seek User's opinion to define functional needs and space relationship 13. Prepare Design Responsibility Matrix 14. Determine requirement of statutory (authorities/planning/other related bodies) 15. Implement systematic data/drawing management process 16. Risk assessment of foreseeable construction health & safety
Conceptual Design	10. Develop design to finalize building's appearance and layout 11. Propose structural design, building service system and material 12. Identify principle supply chain for the project 13. Assess design proposal to meet cost constraints 14. Develop design information schedule 15. Define deliverables of each designer involves in the project 16. Conduct Design team progress meeting 17. Audit conceptual design against priorities in design brief 18. Signing off the chosen scheme by all parties
Detail Design Development	6. Coordination of detail design requirement by Lead Designer 7. Involvement of specialist consultant/contractors in providing advice and knowledge of their system 8. Submit any request of modification to client for approval 9. Ensure sufficient and correct design information (including drawing) is available to the relevant parties 10. Monitor design deliverables as per Design Responsibility Matrix
Procurement	7. Identify scope of work packages (Will there be single or multiple prime contracts?) 8. Resolve design liability issues 9. Identify and specify information required for each work package 10. Shortlist the suitable contractors/suppliers/specialist for each work package 11. Schedule the on-going required information for each of work package to each contractors/suppliers/specialist 12. Evaluate all Tender/RFQ/RFP submission according to design brief
Construction	6. Sharing of information using systematic communication system 7. Implement document control system for issuance of information needed during construction 8. Record all design changes 9. Audit design changes against design brief 10. Resolution of design queries as per defined deliverables agreed during Conceptual Design
Project Operation	3. Conduct Post Occupancy evaluation after a certain period of project completion 4. Evaluate and analyse result of evaluation for lesson learnt

4.2 Hypothesis Development

To articulate the association of design management issues, design management process and project success measure, several propositions can be highlighted through the development of directional hypotheses as stated below. The directional hypotheses are formulated for this study due to identified past studies that show consistent direction. To articulate the association of design management process and project success measure, empirical evidence is used as depicted in Table 1, Table 2, Table 3 and Table 4. According to previous study by Potter [35], there is a relationship between design management and project success. In addition, design management has its own roles in every project phase as describe by Gray and Hughes [18] in their book, 'Design management process map'. Therefore, the null hypotheses are developed. With this, hypotheses are formulated as follows:

Hypothesis 1 (H1a): There is a statistical relationship between Design Management and Project Success. Hypothesis 2 (H2a): There is a statistical relationship between design management during project initiation stage with project success. Hypothesis 3(H3a): There is a statistical relationship between design management during preparation of design outline stage with project success. Hypothesis 4(H4a): There is a statistical relationship between design management during conceptual design stage with project success. Hypothesis 5(H5a): There is a statistical relationship between design management during detail design management stage with project success. Hypothesis 6(H6a): There is a statistical relationship between design management during procurement stage with project success. Hypothesis 7(H7a): There is a statistical relationship between design management during construction stage with project success. Hypothesis 8(H8a): There is a statistical relationship between design management during project operation stage with project success.

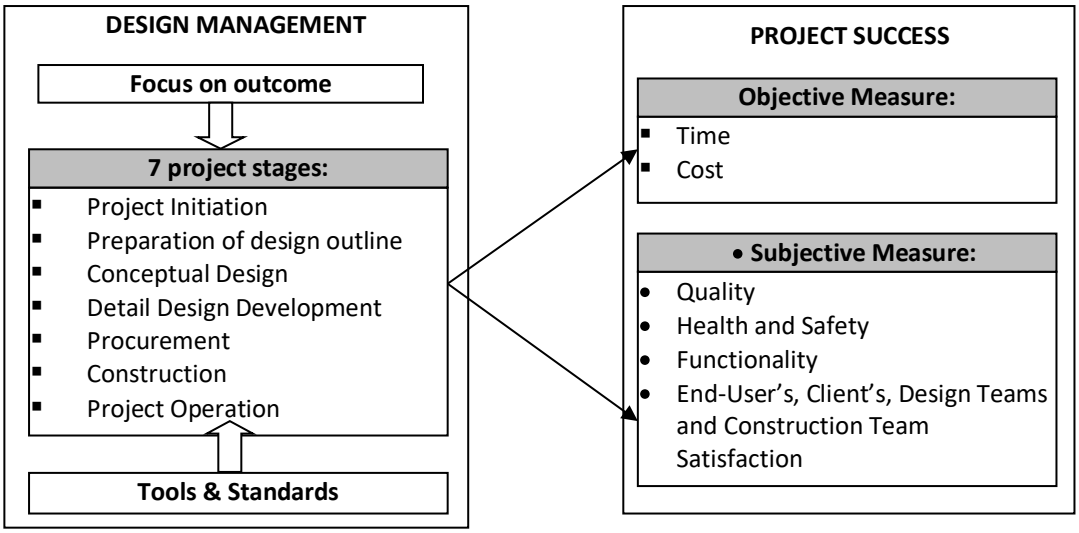

Fig. 2. Proposed Theoretical Framework

5. Conclusions

As a conclusion, many would have argued that design is a creativity task,thus it is unable to be controlled. It is indeed true since we cannot control creativity as it is the mind's activity and also too subjective. There is a misunderstanding towards the interpretation of design management which leads to the thought of design management as managing the way designersthink about their

design. This is indeed untrue, since design management actually provides processes and guideline in managing the external process of designing which involves people, document, data, and drawing. According to previous study, it was found that design management process at design outline, conceptual design, procurement, and construction stage has significant relationship with the subjective measure of project success. Therefore, this study has explored the integration of design management concept in the construction industry with project success. The objective of this study was achieved through the development of theoretical framework for improving the design management process implementation in construction industry.

However, the presented theoretical framework needs to be further developed. Therefore, the author highlighted several recommendations that will be the basis for further study. First, survey strategy is chosen because it is commonly associated with deductive approach and by using quantitative methods for data collection to identify the implementation of designmanagement in Malaysian construction industry to explore pre-determined design management framework in actual practice. Secondly, the same method was chosen to determine the relationship between design management and project success to examine the impact of design management towards project success.

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