

**THE USE OF SUPPLY CHAIN MANAGEMENT TO
REDUCE LOW LABOUR PRODUCTIVITY IN
MALAYSIAN PUBLIC SECTOR CONSTRUCTION
PROJECTS**

LOH YONG SENG

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MALAYSIAN PUBLIC SECTOR CONSTRUCTION
PROJECTS**

by

LOH YONG SENG

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TABLE OF CONTENTS

ACKNOWLEDGEMENT.....	ii
TABLE OF CONTENTS	iii
LIST OF TABLES	ix
LIST OF FIGURES	xi
LIST OF ABBREVIATIONS	xii
LIST OF APPENDICES	xiii
ABSTRAK	xiv
ABSTRACT.....	xvi
CHAPTER 1 INTRODUCTION.....	1
1.1 Research Background.....	1
1.2 Problem Statement	4
1.3 Research Questions	11
1.4 Research Aim & Objectives	11
1.5 Scope of Research	11
1.6 Significance of Research.....	13
1.7 Research Outline	14
CHAPTER 2 CONSTRUCTION LABOUR PRODUCTIVITY	17
2.1 Introduction	17
2.2 Operational Definition of Research.....	17
2.3 The Concept of Project Success in Construction Industry	19
2.4 Project Delay in Construction Industry	21
2.4.1 Cause of Project Delay by Labour Factors	22
2.5 Overview of Malaysian Construction Industry	23

2.5.1	Malaysia Construction Industry Dilemma	25
2.6	Malaysia's Government Plan and Initiatives	28
2.6.1	Public Sector Project	28
2.6.2	10th Malaysia Plan	29
2.6.3	11th Malaysia Plan	30
2.7	Definition of Productivity	31
2.7.1	Definition of Construction Productivity	32
2.7.2	Labour Productivity	34
2.7.3	The Concept of Labour Productivity	36
2.8	Labour Workforce in Malaysia	38
2.8.1	Labour Productivity Issues in Construction Industry	41
2.8.2	Labour Productivity Issues in Malaysia Construction Industry	43
2.9	Factors Affecting Labour Productivity in Construction Industry	44
2.9.1	Past Studies of Factors Based on Countries	46
2.9.2	Past Research Conducted in Malaysia.....	51
2.9.3	Other Past Researches	51
2.9.4	Comparison of Factors that Identified in Past Researches	56
2.9.5	Comparison of Past Research Based on Top Significant Factors	59
2.10	Summary	65
CHAPTER 3 SUPPLY CHAIN MANAGEMENT		66
3.1	Introduction	66
3.2	Definition of Supply Chain Management (SCM)	66
3.3	The Concept of Supply Chain Management	70
3.4	Roles of Supply Chain Management.....	72
3.5	Previous Studies on Utilisation of Supply Chain Management in Construction Industry	73

3.5.1	Relationship Between SCM Success Factors and SCM Performance	74
3.6	Challenges and Opportunities in Implementing Supply Chain Management in Construction Industry.....	76
3.6.1	Construction Supply Chain Management in Malaysia.....	79
3.6.2	Construction Supply Chain Processes in Labour and Project Management.....	81
3.6.3	Barriers to Adopt Supply Chain Management in the Construction Industry	82
3.7	Contemporary Methods and Supply Chain Practices in the Construction Industry	84
3.7.1	Challenges in Contemporary Project Management in Construction Industry	85
3.7.2	Implementation and Resolution Strategies	85
3.8	Utilisation of Supply Chain Management to Improve Labour Productivity	86
3.9	Supply Chain Management as A Way Forward.....	94
3.9.1	Supply Chain Management as a Public Sector Initiative.....	96
3.10	Summary	97
CHAPTER 4 RESEARCH METHODOLOGY.....		98
4.1	Introduction	98
4.2	Research Philosophical	99
4.3	Philosophy of Research Methods.....	101
4.3.1	Qualitative Method.....	102
4.3.2	Quantitative Method.....	104
4.4	Methodology Adopted in This Research.....	106
4.4.1	Research Design	106
4.4.2	Triangulation Mixed Method Research.....	108
4.4.3	Rationale of Research.....	110

4.5	Research Aim	112
4.6	Flow of Research.....	113
4.7	Scope of Research	114
4.8	Research Methods and Instruments.....	117
4.9	Flow of research	121
4.9.1	Achieving Objective 1: a) <i>To identify and rank the main factors of labour productivity issues in 10th Malaysia Plan building project...</i>	122
4.9.2	Achieving Objective 1: b) <i>To group the main factors affecting labour productivity in 10th Malaysia Plan building projects into relevant root causes.</i>	132
4.9.3	Achieving Objective 2: <i>To identify the beneficial SCM tools and develop a validated SCM framework to mitigate labour productivity issues in Malaysia public sector building projects</i>	135
4.10	Sampling Method	137
4.10.1	Snowball Sampling	138
4.10.2	Sampling for Questionnaire	142
4.10.3	Sampling for Interview	145
4.11	Data Analysis	147
4.11.1	Questionnaire	148
4.11.2	Justifying the Use of Self-Grouping	153
4.11.3	Semi-Structured Interview	155
4.12	Research Theoretical Framework.....	158
4.13	Ethical Considerations.....	159
4.14	Summary	160
CHAPTER 5 DATA ANALYSIS AND DISCUSSION - QUANTITATIVE.....		161
5.1	Introduction	161
5.2	Respondents and Their Project Involvement Details	161

5.3	Analysis of Achieving Research Objectives 1	167
5.3.1	Investigating Homogeneity of Responses	168
5.3.2	Checking Consistency in Responses and Proposing New Pair of Factors.....	170
5.3.3	Grouping Main Labour Productivity Factors into Pathogens and Sub Categories of Pathogens.....	195
5.4	Summary	198
CHAPTER 6 DATA ANALYSIS AND DISCUSSION - QUALITATIVE.....		200
6.1	Introduction	200
6.2	Framework Development.....	200
6.2.1	Establishing Main Low Labour Productivity Factors	200
6.2.2	Main Labour Productivity Factor Grouping – into Pathogens and Sub-categories of Pathogens.....	203
6.3	Analysis of Achieving Research Objective 2.....	216
6.3.1	Selecting Suitable Supply Chain Management (SCM) Tools to Overcome each Pathogen and Sub-Categories of Pathogen	216
6.4	Summary	226
CHAPTER 7 DISCUSSION.....		227
7.1	Introduction	227
7.2	Discussion on Achieving Research Objective 1	227
7.2.1	Main Low Labour Productivity Factors (Overall)	227
7.2.2	Main Low Labour Productivity Factors (Factors from Expert Opinions).....	230
7.2.3	Grouping of Main Low Labour Productivity Contributors into Pathogens and Sub-categories of Pathogens.....	247
7.2.4	Main Low Labour Productivity Factor Categorisation	247
7.2.5	Pathogens and Sub-Categories of Pathogens of the Main Low Labour Productivity Factors	251

7.2.6	Impediments to Pathogen Categorization.....	253
7.3	Discussion on Achieving Research Objective 2	255
7.3.1	Establishment of Framework that Utilises Beneficial SCM Tools to Reduce Low Labour Productivity in Malaysia Public Sector Construction Projects	255
7.3.2	Most Beneficial SCM Tools Established for the Framework	257
7.4	Framework that Utilises Beneficial SCM Tools to Reduce Low Labour Productivity in Malaysia Public Sector Building Projects.....	284
7.5	Summary	293
CHAPTER 8 CONCLUSION.....		295
8.1	Introduction	295
8.2	Research Framework Development	295
8.3	Research Key Findings.....	296
8.3.1	Objective 1: <i>To identify the main labour productivity factors in 10th Malaysia Plan building projects and group them into pathogens & sub-pathogens</i>	297
8.3.2	Objective 2: <i>To identify beneficial SCM tools & develop a validated SCM framework to mitigate labour productivity issues in Malaysia public sector building projects</i>	298
8.4	Research Limitations	301
8.5	Research Contributions	303
8.5.1	Contribution to the body of knowledge.....	303
8.5.2	Contribution to the Construction Industry.....	305
8.6	Areas for Further Research	306
REFERENCES.....		308
APPENDICES		

LIST OF TABLES

	Page
Table 3.1	Definitions of Supply Chain Management based on Past Researchers (Modified from: Croom et al., 2000).....67
Table 3.2	Differences of characteristics between traditional management and supply chain management (Modified from: Croom et al., 2000).....69
Table 3.3	Roles of SCM Implementation in the Construction Industry (Adapted from Vrijhoef & Koskela, 2000).....73
Table 3.4	Previous Studies on Relationship Between SCM Success Factors and SCM Performances.....75
Table 3.5	Barriers encountered during every phase of Construction Life Cycle (Adapted from: McKinsey, 2015).....82
Table 4.1	Summary of Research Design107
Table 4.2	Mixed Research Approaches.....107
Table 4.3	Summary of Research Methods121
Table 5.1	Respondents Details According to Their Position level in the Current Organisation.....162
Table 5.2	Respondent Details According to Their Background of Profession.....163
Table 5.3	Respondent Details According to Their Highest Level of Education.....163
Table 5.4	Respondent Details According to Their Experience in Construction.....164
Table 5.5	Respondent Details According to Nature of Contractor Organization.....165
Table 5.6	Respondent Details According to Number of Project that Involved165
Table 5.7	Respondent Details According to Main Type of Project that Involved ...166
Table 5.8	Respondent Details According to the Duration of Project Involved166
Table 5.9	Respondent Perceptions on Average Labour Productivity and Performance at Construction Projects that Involved.....167
Table 5.11	Summary of Factors that Violated Assumption of Homogeneity of Variances According to Different Groups169

Table 5.14	Summary of ANOVA Results for factors with Significant Differences in Mean.....	171
Table 5.15	Summary of Independent Sample T-Test Results and the Proposed New Pair of factors (After Deducting the Culprits).....	174
Table 5.16	Summary of New Pairs of Factors According to Groups (After Deducting the Culprit).....	177
Table 5.17	Summary of Kruskal Wallis Result According to Different Groups.....	179
Table 5.18	Summary of Mann-Whitney U Test Results and the Proposed New Pair of Factors (After Deducting the Culprit – “Facilities Management”).....	179
Table 5.19	Respondents’ Detail for Semi-Structured Interview.....	180
Table 5.20	Pair Sample T-test with Sig. (2-tailed).....	181
Table 5.21	Decision on Factors to be Retained and Deleted Based on Semi-Structured Interview Results.....	196
Table 6.1	Details of Respondents for Semi-Structured Interviews.....	201
Table 6.2	Summary of Interview Comment on Pathogen Self-Grouping.....	202
Table 6.3	Validated Grouping of Main Delay Factors into Pathogens and Sub-Categories of Pathogens.....	206
Table 6.4	Summary of Interview Comments on Pathogen Self-Grouping	208
Table 6.5	Grand Summary of SCM Tool Selection (from Interview)	211
Table 6.6	Details of Respondents for Data Validation on SCM Tool Selection.....	216
Table 6.7	Suggested Tools and Practices by Respondents based on each Pathogen & Sub-categories.....	221
Table 6.8	Initial Framework that Utilizes Beneficial SCM Tools to Reduce Low Labour Productivity Problem in Malaysia Public Sector Construction Industry.....	222
Table 7.3	Final Framework that Utilises Beneficial SCM Tools to Reduce Low Labour Productivity Problem in Malaysia Public Sector Construction Industr5.....	257

LIST OF FIGURES

	Page
Figure 1.1 Labour Productivity Performance of the Main Economic Sectors, 2015-2016 (Adapted from: Malaysia Productivity Corporation, 2017).....	5
Figure 1.2 Labour Productivity Ranking of Selected Economies (Adapted from: Malaysia Productivity Corporation, 2016).....	6
Figure 2.1 Malaysia Labour Force Participation Rate 2011-2015 (Adapted from: Institute of Labour Market Information and Analysis (ILMIA), 2017)....	39
Figure 2.2 Malaysia Labour Force Participation Rate 2010-2023 (Adapted from: CEIC Data, 2021).....	39
Figure 4.1 Snowball Stemma (Adapted from: Noy, 2008).....	141
Figure 4.2 Research Theoretical Framework.....	158
Figure 7.1 Process involved in establishing the final research framework.....	256

LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
BIM	Building Information Modelling
BPR	Business Process Redesign
CFA	Confirmatory Factor Analysis
CIDB	Construction Industry Development Board, Malaysia
CIMP	Construction Industry Master Plan
DSM	Department of Standards Malaysia
EFA	Exploratory Factor Analysis
GDP	Gross Domestic Product
IT	Information Technology
JIT	Just-in-Time
MBAM	Master Builder Association of Malaysia
MCAA	Mechanical Contractors Association of America
PWD	Public Work Department
R&D	Research and Development
RM	Ringgit Malaysia
RMK10	Tenth Malaysia Plan
RMK11	Eleventh Malaysia Plan
SCM	Supply Chain Management
TQM	Total Quality Management

LIST OF APPENDICES

APPENDIX A	Supply Chain management Tools Implemented at Various Level
APPENDIX B	Low Labour Productivity Used for Survey
APPENDIX C	Preliminary Interview Results
APPENDIX D	Questionnaire Survey Form
APPENDIX E	Data Analysis Results - Questionnaire
APPENDIX F	Factor Analysis Results (Self-Grouping Results)
APPENDIX G	Semi-structured Interview Responses
APPENDIX H	List of Publications

**PENGUNAAN PENGURUSAN RANTAIAN BEKALAN UNTUK
MENGURANGKAN KELEMAHAN PRODUKTIVITI BURUH DALAM PROJEK
PEMBINAAN SEKTOR AWAM MALAYSIA**

ABSTRAK

Produktiviti buruh yang rendah dalam sektor pembinaan merupakan isu yang berterusan di Malaysia, terutamanya dalam projek pembinaan sektor awam, disebabkan oleh amalan tradisional yang tidak cekap yang menjadi lumrah dalam industri pembinaan Malaysia selama beberapa dekad. Untuk menangani isu ini, Pengurusan Rantai Bekalan (PRB) telah dicadangkan dengan potensinya dalam meningkatkan produktiviti melalui hubungan yang baik, integrasi, fleksibiliti, inovasi, dan penambahbaikan. Walau bagaimanapun, terdapat jurang pengetahuan yang signifikan mengenai pelaksanaan PRB yang berkesan dalam konteks pembinaan sektor awam Malaysia. Masih terdapat kajian terhad yang secara khusus membincangkan cabaran penggunaan PRB dalam sektor ini. Kajian ini bertujuan untuk mengisi jurang ini dengan meneroka faktor produktiviti buruh yang rendah dalam projek sektor awam Malaysia dan mencadangkan rangka kerja PRB untuk meningkatkan produktiviti buruh. Penggunaan pendekatan campuran kuantitatif dan kualitatif, kajian ini menggunakan soal selidik yang diberi kepada 153 profesional industri yang terlibat dalam projek pembinaan sektor awam Rancangan Malaysia ke-10, bersama dengan lima sesi temu bual separa berstruktur. Analisis statistik, termasuk ANOVA, Kruskal Wallis, T-Tests, dan Mann-Whitney U, dijalankan untuk mengenal pasti penyumbang utama kepada produktiviti buruh dan mengesahkan kelompok faktor untuk rangka kerja kajian akhir. Kajian ini mempersembahkan satu rangka kerja dengan

menyelaraskan alat PRB yang bermanfaat dengan patogen dan sub-kategori patogen kepada faktor produktiviti buruh yang rendah buruh dalam projek sektor awam Malaysia. Secara khusus, dapatan kajian menunjukkan bahawa kemahiran dan pengalaman buruh adalah antara faktor yang paling mustahak, dengan menekankan peranan penting program latihan dan pembangunan bersama dalam meningkatkan produktiviti buruh. Pelaksanaan inisiatif latihan dan pembangunan bersama muncul sebagai satu penyelesaian penting, dalam meningkatkan pelbagai aspek yang tidak cekap dalam projek sektor awam. Dapatan kajian juga menekankan kepentingan peserta projek berkongsi matlamat yang disepakati bersama, yang tidak hanya menetapkan komposisi pasukan yang betul tetapi juga meningkatkan peluang kejayaan projek. Selain itu, kajian ini menunjukkan bahawa penggunaan konsep patogen dapat memudahkan lagi aplikasi PRB. Dengan melihat persekitaran projek dari perspektif sistemik, penyelesaian dapat disesuaikan dengan lebih berkesan dan diselaraskan untuk menangani cabaran-cabaran produktiviti yang mendasarinya. Dapatan kajian menegaskan keperluan yang signifikan bagi kerajaan Malaysia untuk memulakan pelaksanaan PRB yang bertujuan untuk merevolusikan amalan semasa dan berubah daripada kaedah kerja konvensional. Inisiatif tersebut penting untuk mendorong kemajuan dan memberi kuasa kepada kerajaan untuk menjadi pemimpin kepada perubahan transformatif dalam industri pembinaan.

THE USE OF SUPPLY CHAIN MANAGEMENT TO REDUCE LOW LABOUR PRODUCTIVITY IN MALAYSIAN PUBLIC SECTOR CONSTRUCTION PROJECTS

ABSTRACT

Construction low labor productivity is a persistent issue in Malaysia, particularly evident in public sector construction projects, attributed to inefficient traditional practices prevalent in Malaysian construction industry for decades. To address this issue, contemporary practices like Supply Chain Management (SCM) have been advocated for their potential to enhance productivity through improved relationships, integration, flexibility, innovation, and improvement. However, a significant knowledge gap exists regarding the effective implementation of SCM in the Malaysian public sector construction context. There is limited research that specifically addressing the challenges and opportunities for SCM adoption in this sector. This research aims to fill this gap by investigating the causes of low labour productivity in Malaysian public sector projects and proposing a SCM framework to improve labour productivity. Employing a mixed-methods of quantitative and qualitative approaches, the study utilised questionnaire survey administered to 153 industry professionals involved in Tenth Malaysia Plan public sector construction projects, alongside with five sessions of semi-structured interviews. Statistical analysis, including ANOVA, Kruskal Wallis, T-Tests, and Mann-Whitney U, were conducted to identify primary contributors to labor productivity and validate factor groupings for the final research framework. This study presents a framework that align beneficial SCM tools with specific pathogens and sub-categories of pathogens contributing

to low labor productivity in Malaysian public sector projects. Notably, the findings highlight the skill and experience of labour are among the most affected areas, emphasising the pivotal role of joint training and development programs in enhancing labour productivity. The implementation of joint training and development initiatives emerges as a key solution, capable of improving numerous previously inefficient facets within public sector projects. The findings also highlight the importance of project participants sharing a common agreed goal, which able to establishes the right team composition and increases the likelihood of project success. Furthermore, the study suggests that adopting the concept of pathogens can better facilitate the application of SCM. By viewing the project environment from a systemic perspective, solutions can be tailored more effectively to address underlying productivity challenges. These findings underscore the significant need for the Malaysian government to initiate SCM implementations aimed at revolutionising prevailing practices and transitioning away from inefficient conventional working methods. Such initiatives are crucial for driving progress and empowering government to champion transformative changes within the construction industry.

CHAPTER 1

INTRODUCTION

1.1 Research Background

Nowadays, the construction sector in Malaysia is confronted with catastrophic results when trying to complete projects within the time frame, especially public sector projects. Despite the fact that a significant portion of the national budget is spent on public development, several public projects continue to be reported as ‘sick’, which means the physical work progress is delayed from the planned schedule. This results in delays in completion, cost overruns, and failure to satisfy project requirements (CIDB, 2009). In 2011, 235 ‘sick’ projects were detected, while 191 ‘sick’ projects were reported in 2013 (Nurul et al., 2016). For example, a public building project for police housing and headquarters for the Kedah contingent, as well as a family apartment for the Army Mahkota Camp in Kluang, Johor Bahru, and the Port Klang Free Zone (Chief Auditor Report, 2010).

In comparison to other major businesses such as agriculture, manufacturing, and the services, the construction industry is one of the most labour-intensive (Rowlinson and Walker, 1995; Agapiou et al., 1995; Jalal & Shoar, 2019). Time, cost, and quality are the three key components of building projects. These factors are inextricably linked. Labour productivity is critical in building planning efforts and is related to the triple restriction described above (Serdar Ulubeyli et al., 2014). Gilleared (1992) said that the labour cost often occupies between 30% and 50% of the entire cost of a building project. Construction labour plays an important role in construction project costs, and the number of labour hours

required to complete a task is more susceptible to management control than materials or capital. Therefore, the improvement and development of construction labour's productivity should be a main and continuous concern to accomplish project goals and objectives. Construction labour productivity is a significant factor that contributes to the success of the construction project.

The construction sector, when compared with the manufacturing sector, has indicated lower productivity regardless of its significance because construction performance influences all sectors of the economy (Ibrahim et al., 2010). Besides that, improvement and development in labour productivity will provide a huge distribution to the improvement of project outcomes, due to labour playing a significant role and being a performance indicator in determining the success of projects (Mahamid, 2013). Given that construction is a labour-intensive sector, it is reasonable to argue that the labour force is the major factor of productivity.

Productivity on construction sites is critical since it has an effect on the cost, and the time goals (Moselhi & Khan, 2010). Indeed, the number of projects usually exceeds the budget and the time period (Gonzalez et al., 2010; Johansen & Wilson, 2006). Additionally, research has shown that by coordinating and managing activities on the building site, the most critical elements impacting construction efficiency may be improved (Dai et al., 2009; Ailabouni et al., 2009).

Based on Real Estate Housing Developers Association Malaysia (REDHA), (2011), the standard of outcomes, including those related to housing and building, is connected directly to workforce and skill. Many researchers have stated that shortage of labour and workforce productivity will lead to project delays (Abdalla et al., 2002; Yaw et al., 2003; Sadi et al., 2006; Sweis et al., 2007).

Supply Chain Management (SCM) may be characterised as a concept derived from Toyota's supply system for organising and coordinating its suppliers. SCM's primary premise entails the use of technologies such as Just-In-Time (JIT) manufacturing and logistics management. The current definition of SCM is becoming larger and broader but remains mostly dominated by logistics (Vrijhoef & Koskela, 2000). Numerous researchers have recommended SCM, as there are numerous issues in the construction industry, particularly during the construction stage (Egan, 1998; Strategic Forum, 2002; Love et al., 2004).

Construction supply chain management is intrinsically linked to every stage of the construction process, from client requirements through conceptual design, maintenance and construction. It also involves the organisation stakeholders in the construction phase, such as client, contractor, consultant and so on (Xue et al., 2007).

Peter Schnorbach (2005) mentioned that the supply chain management concept is very suitable to adapt in labour management, and also a very applicable concept as organisations continue to find methods for leveraging supply chain to improve project performance, since labour represents 30% to 60% of overall cost for most of the construction projects.

SCM is a very promising method for resolving challenges in the building sector (Mehdi Riazi, 2014). Additionally, the benefits of SCM have been demonstrated for construction performance (Turner, 1993; Stanford et al., 1999; Dubois & Gadde, 2000; Horvath, 2001; Cheng et al., 2010) as well as for effective project management (Love et al., 2004). Implementation of SCM tools has also proven successful in a few applications: for example, British Airport Authority and the Heathrow T5 project. So, it is important to utilise suitable tools in order to support SCM implementation in construction projects.

Besides that, according to Ruben & Lauri (2000), SCM plays a significant role in construction site activities since the target is to reduce the time completion on site activities. In this case, it is important to assure good labour flows and proficient management at site to prevent disturbance to the construction workflow.

Therefore, this research was aimed at identifying the main factors and root causes that contribute to low labour productivity issues. Besides that, a SCM framework will be established and verified via the recommendation of useful SCM solutions for reducing and mitigating labour productivity difficulties in Malaysian public sector building projects.

1.2 Problem Statement

The construction industry plays a vital role in improving the living conditions of residents and bolstering the national economy (Ibrahim et al., 2010; Esa et al., 2020), which including Malaysia as well. Despite its importance, there is a lack of focused research on the issues affecting government construction projects (Pratt, 2000; Abdul Rahman et al., 2006; Sambasivan & Soon, 2007; Esa et al., 2020; Adebawale & Agumba, 2022; Ebrahimi et al., 2022). Doloi (2008) highlights that construction heavily depends on labor effort, making the labour a critical yet challenging productivity factor to manage (Dai et al., 2007; Kazaz & Ulubeyli, 2007; Cao & Ashuri, 2020; Mustafa et al., 2021; Jacobsen et al., 2023). Researchers have identified several labor productivity issues, including manpower shortages and unskilled labor, which can lead to project delays and poor-quality work necessitating rework (Ardity & Mochtar, 2000; Sadi et al., 2006; Sweis et al., 2007; Baskoro et al., 2019; Mustafa et al., 2021; Jacobsen et al., 2023). Public sector construction projects in Malaysia also encounter delays due to these labor productivity challenges and the vacancies left by local employees (Abdul-Aziz & Abdul-Rashid, 2001; OECD, 2013;

Esa et al., 2020). Despite significant public development funding, many projects are labeled as "sick projects" (CIDB, 2009). For instance, 31 out of 417 projects were sick in 2005 (MOF, 2009), with 235 sick projects in 2011 and 191 in 2013 (Nurul et al., 2016). Examples include delays in police housing in Kedah, family flats in Johor Bahru, and the Port Klang Free Zone, mainly due to labor shortages and unskilled labor, especially in Kuantan. Addressing these issues is crucial for improving GDP and productivity.

Moreover, Malaysia's labor productivity remains low compared to other sectors and nations. For instance, Figure 1.1 shows that the construction sector had the lowest productivity level in 2015 and 2016 compared to agriculture, manufacturing, and services (Malaysia Productivity Corporation, 2017). Furthermore, the labor productivity ranking of Malaysia, as shown in Figure 1.2 for 2015 and Figure 1.3 for 2023, has remained stagnant at rank 47, indicating that productivity issues have not been effectively addressed (Institute of Management Development, 2023). Although Malaysia's labor productivity increased by 3.5% in 2016, this performance is still unsatisfactory as it continues to trail behind countries such as Singapore and South Korea.

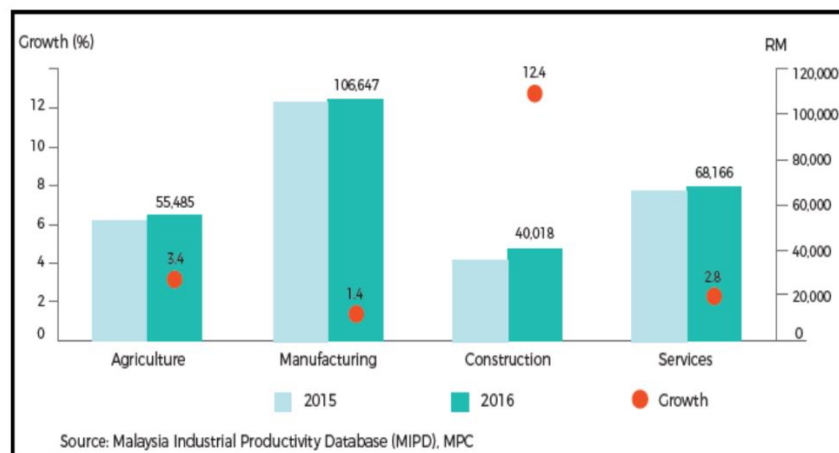


Figure 1.1 Labour Productivity Performance of the Main Economic Sectors, 2015-2016 (Adapted from: Malaysia Productivity Corporation, 2017)

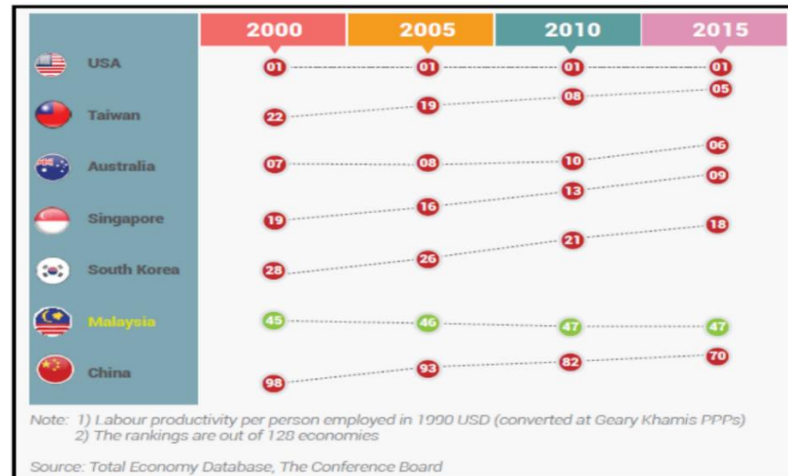


Figure 1.2 Labour Productivity Ranking of Selected Economies (Adapted from: Malaysia Productivity Corporation, 2016)

GLOBAL COMPETITIVENESS RANKING CORRELATES WITH PRODUCTIVITY			
Country	2023 Competitiveness Ranking	Overall Productivity (PPP) Ranking	Overall Productivity (PPP) in US\$, 2022
Ireland	2	3	150,007
Switzerland	3	8	135,642
Singapore	4	1	183,959
South Korea	28	30	93,626
Malaysia	27	47	65,725
Indonesia	34	59	27,963
Philippines	52	61	24,130

Figure 1.3 Global Competitive Productivity Ranking of Selected Countries (Adapted from: Insititute of Management Development, 2023)

The Construction Industry Development Board (CIDB) reported a significant decline in the number of skilled and unskilled general construction workers. The average annual labor productivity growth between 2011 and 2015 was only 1.8%, whereas the 11th Malaysia Plan (RMK-11) aimed for a 3.7% annual growth. Achieving the high-income target of the New Economic Model requires doubling labor productivity growth, which is hindered by the suspension of new foreign worker employment (Ram Chandra, 2016). Additionally, Malaysia experienced slower total workforce growth compared to the

previous year, with total employment increasing by only 0.7% to 14.2 million in 2016 (Aditi, 2017). Consequently, achieving the 3.7% annual growth target becomes more challenging, necessitating effective strategies from the Malaysian government.

Besides, The Construction Industry Transformation Programme (CITP) 2016-2020 focused on improving productivity by addressing the shortage of skilled labor and over-reliance on unskilled foreign workers, while former prime minister Najib Tun Razak emphasized that boosting labor productivity is crucial for achieving the RMK-10 export objective. Labor shortages will significantly impact the construction industry and government-funded projects, like RMK-10 and the Economic Transformation Program (Abu Mansor, 2010). Datuk Ahmad Asri, CIDB chief executive, stated that the labor shortage issue is a national concern affecting all sectors, including construction (Theedgemarkets, 2022). Mordor Intelligence (2023) predicts that the Malaysian construction industry will experience a Compound Annual Growth Rate (CAGR) exceeding 6% from 2023 to 2028.

Additionally, global events like the COVID-19 pandemic in 2019 severely affected the industry's growth, including the construction sector (Chin, 2023). Despite the lifting of the Movement Control Order (MCO), the construction sector has been impacted by project delays due to disrupted material supplies, worker infections with COVID-19, expiring work permits, retention challenges for existing workers, and financial difficulties faced by stakeholders (Kuriakose, 2020; Alaloul et al., 2021). Recognising this, Malaysia must address and mitigate labour issues through long and medium-term planning initiatives. Hence, construction labour productivity issues require thorough appraisal, examination, study, and integration into every country's planning (Ezoji et al., 2019; Kazerooni et al.,

2021; Azmi et al., 2022; Ebrahimi et al., 2022; Abdelgany & Saleh, 2023; Hassan et al., 2023).

While significant attention has been directed towards understanding the challenges within Malaysia's construction industry, particularly in government projects, a critical research gap exists in devising comprehensive solutions to improve labor productivity, a pivotal factor affecting project success. Existing literature highlights various issues plaguing the construction sector, such as poor workmanship, project changes, and labor shortages, underscoring the urgency for targeted interventions. Although previous studies have acknowledged the potential of SCM in enhancing construction performance, research in this domain remains fragmented and insufficiently developed, particularly concerning its application to labor productivity enhancement in the public sector (Briscoe & Dainty, 2005; O'Brian et al., 2009; Saad, Jones, and James, 2002; Niazi & Painting, 2020; Puppo & De Brito, 2021; Azmi et al., 2022). While some studies have outlined SCM initiatives, such as collaborative planning concepts and negotiation models, they have primarily offered theoretical frameworks without delving into the practical implementation of SCM strategies to address labor-related challenges effectively.

Supply Chain Management (SCM) has been recommended by many researchers to address issues in construction industry, especially during the construction phase (Strategic Forum, 2002; Love et al., 2004; Niazi & Painting, 2020; Puppo & De Brito, 2021; Azmi et al., 2022; Zhong et al., 2023). The application of SCM can improve labor productivity in construction projects and is recognized as a beneficial public sector initiative (Dawson, 2002; Saad et al., 2002; London & Chen, 2006; Mulla et al., 2015; Niazi & Painting, 2020; Meng & Boyd, 2021). Past studies have shown the benefits of SCM in various contexts, including integrating project processes, people, and goals (Love et al., 2004; Aboutorab et

al., 2022), collaborative supply chain pre-planning (Tah, 2005; Ying et al., 2020), multi-attribute negotiation models (Xue & Ren, 2009; Kouhizadeh et al., 2021), and web-based systems for improved supply chain integration (Cheng et al., 2010; Zhu & Liu, 2021). Despite these proven benefits, this research has underscored the need for utilising SCM frameworks to mitigate such disruptions effectively.

Despite the recognized importance of SCM in streamlining construction processes, there is a pressing need for research that develop SCM frameworks to improve labor productivity in public sector building projects. Previous studies have provided theoretical frameworks and outlined SCM initiatives, such as collaborative planning and negotiation models, but practical implementation strategies addressing labor-related challenges are lacking. However, the existing literature has been broad in scope, focusing only on subgroup concerns such as contractor-supplier interactions (Vrijhoef & Koskela, 2000), environmental performance (Ofori, 2000), service quality (Hoxley, 2001), and buying behavior (Dubois & Gadde, 2000). Furthermore, past research studies were short and lacked comprehensive frameworks to mitigate labor productivity issues effectively and on SCM adoption specifically, for example: seamless supply chain management approach for construction (Love et al., 2004); collaborative supply chain pre-planning concept based on agents (Tah, 2005); multi-attribute negotiation model across the supply chain (Xue & Ren, 2009); supply chain collaborator supply chain integration via the use of a web-based system (Cheng et al., 2010); SCM framework to overcome delay as result of pre-construction deficiencies (Mehdi Riazi, 2014). Moreover, previous studies in SCM failed to encompass the Malaysian buildings project with proposed frameworks that utilising the full spectrum of SCM tools to tackle labour productivity challenges in construction projects.

Besides that, the COVID-19 pandemic has significantly altered operational conditions and severely disrupted supply chains, particularly within the construction industry, on an unprecedented scale (Ogunnusi et al., 2020; Alsharef et al., 2021; Ivanov, 2022). This disruption has resulted in numerous challenges for construction projects, including suspensions, resource shortages leading to cancellations, widespread supplier shutdowns, and delays in material deliveries (Esa et al., 2020), causing substantial time losses, increased costs, and reduced worker productivity (AGC, 2020; Azmi et al., 2022). However, none of the research conducted aimed at addressing the labour challenges faced by construction industry comprehensively during pandemic session. Even those focusing on COVID-19 specifically lacked a holistic approach (e.g., Karamoozian et al., 2022; Cherian & Arun, 2022; Osunsanmi et al., 2022; Sutterby et al., 2023).

SCM's importance in enhancing construction performance is acknowledged and there is a critical need for in-depth research to develop and implement SCM strategies that address labor productivity issues in the public sector. Therefore, this research aims to fill the gaps by assisting the Malaysian construction industry in overcoming labour productivity challenges via the development of SCM framework that proposes wide-range beneficial SCM tools, specifically linked to improve labour productivity level and contributing to Malaysia's economic development goals for the long terms period.

1.3 Research Questions

Based on the problem statements, the following research questions are defined:

1. What are the main factors that contribute to low labour productivity issues in 10th Malaysia Plan building projects?
2. How can SCM help Malaysian public sector to achieve higher labour productivity in building projects?

1.4 Research Aim & Objectives

By addressing the research objectives, this study hopes to build a framework for using beneficial supply chain management tools to address labour productivity issues in Malaysia's public sector building projects.

The following research objectives are met in order to attain the research aim:

1. To identify the main factors affecting labour productivity in the 10th Malaysia Plan building projects and group them into pathogens & sub-pathogens.
2. To identify beneficial SCM tools and develop a validated SCM framework to mitigate labour productivity issues in Malaysian public sector building projects.

1.5 Scope of Research

This study focuses on the difficulties and variables that contribute to low labour productivity during the construction phase of a project. Additionally, emphasis is placed on building projects undertaken only on the Malaysian Peninsula, as part of the 10th Malaysia Plans (RMK-10), which covered the years 2011 to 2015 for contractor class G7 projects.

This research started in year 2016, which was right after the end of RMK10 (2011-2015). Hence, this was the reason for RMK10 being the central focus of this research so as

to ensure that focus was made on the most recent issues in the industry (i.e., low labour productivity). The focus on the RMK-10 is imperative as it forms the contextual backdrop for this research, aligning with its timeline and policy directives, which makes it essential to understand its goals, strategies, and implications to contextualize findings and recommendations effectively. Besides, labour productivity grew at slow pace 1.1% per annum during RMK-10, from RM84,114 per worker in 2011 to RM89,025 in 2015. Even until now and RMK-12 already initiated, growth across the construction industry continued to slow down following the impact of the COVID-19 pandemic, affecting both value-added and employment within the sector. Malaysia's labour productivity encounter contracting by -5.5 % in 2020, to RM89,025 per person employed. The decline was the first identified since the global financial crisis in 2009, which range within 10 years (Hassan, et al., 2023), and fall under RMK-10. Therefore, RMK-10 is being employed as the main scope of study in the research. Chapter 5, Research Methodology, contains further information on the scope of the research.

Besides, this research focused on building projects due to their relative simplicity and manageability within the research scope. Besides, building projects offer a manageable scope for research, allowing for in-depth analysis without the complexity of larger infrastructure projects, thus facilitating focused investigation and clearer insights (Zainul Abidin, 2010).

The emphasis on contractor Class G7 for this research is warranted due to its significance in Malaysia's construction industry. Contractor Class G7 represents the highest accreditation level with no limit for the project tender capacity, indicating advanced capabilities and substantial contributions to the construction sector, making it

essential to explore their role and implications to help in data collection for this research (Yusof & Aspinwall, 2000).

Besides, this research is focus for the project carried out on Peninsular Malaysia only due to the distinct management and cultural context compared to Sabah and Sarawak (Hamzah & Chen, 2021), necessitating a focused study to understand the specific challenges and opportunities within this region, especially labour productivity issues.

While the created framework may be adapted to many sorts of projects or to different nations, more amendments would be necessary to assure the framework's suitability for use in a variety of circumstances.

1.6 Significance of Research

The construction industry plays an important role in the Malaysia economy. The construction industry, when compared with the manufacturing sector, has indicated lower productivity regardless of its significance because construction performance influences all sectors of the economy (Ibrahim et al., 2010). Besides that, improvement and development in labour productivity will provide a huge distribution to the improvement of project outcomes, due to labour playing a significant role and as a performance indicator in determining the success of projects (Mahamid, 2013).

Productivity is a critical aspect determining the construction industry's overall success (Kazaz and Ulubeyli, 2007). The construction industry's low productivity has a negative impact on the GDP, the industry's reputation, and investor confidence. Numerous construction projects in Malaysia, particularly those in the public sector, are classified as ill projects since they are not finished on time and lead to delays (CIDB, 2009; Nurul, 2016).

The Malaysia government has established the goal of enhancing construction performance via a variety of programs and policies, including the Malaysia Plan and Construction Industry Master Plan, but these have yet to solve the low construction productivity dilemma. Therefore, based on this research, the identification of labour productivity factors and root causes would provide an overview of reasons behind labour productivity issues in Malaysian Public sector projects. From this overview, solutions will be enabled right from the roots of the issues, by utilising the SCM framework.

The research methodology produced in this study will serve as a guide for implementing best practices and SCM technologies more effectively in order to address labour productivity challenges in building projects. With demonstrated advantages and success stories in SCM deployment, it is believed that the framework will aid significantly to increasing labour productivity and project performance.

Additionally, labour productivity might be seen as a global problem. As a result, the framework may be enhanced and adapted to accommodate a variety of types of projects, as well as nations with varying localities. A stronger building sector would result in increased GDP contributions. Additionally, the broader public would gain from this.

1.7 Research Outline

This research examines how supply chain management might assist to minimise concerns with labour productivity in Malaysia public sector building projects. This thesis is divided into seven chapters as follows:

The first chapter introduces the thesis, providing context for the study, problem statements, research questions, and research goals. Additionally, Chapter 1 introduces and

discusses the scope of the study, its relevance, contribution to the body of knowledge, methodology, and thesis framework.

Chapter 2 is the literature reviews about the overview of the Malaysia construction industry. In this chapter, the dilemma and problems that are encountered in Malaysia construction projects will be discussed, such as project delays caused by labour factors. Malaysia government plans and initiatives also will be discussed, acting as key thrusts to improve project performance and labour productivity: for example, 10th and 11th Malaysia Plans. Besides, literature review and previous studies that related to construction labour productivity also mentioned in this chapter. The aspects will cover the labour productivity problems that happen in the construction industry, mainly focussing on Malaysia public sector construction projects, and the factors that cause low labour productivity issues in the construction industry. The past initiatives and methods that were utilised to reduce labour productivity issues are also discussed in this chapter.

Chapter 3 presents a detailed look into supply chain management. This chapter will discuss its definitions, past research, roles and benefits, possibility for implementation, and existing tools that help to mitigate labour productivity issues in the construction industry.

Chapter 4 is about the methodology of this thesis. It covers all the methods that were used in this research. This study utilised a combination of qualitative and quantitative methods to accomplish the study's goals and objectives. Further, definitions about the sampling methods and data analysis approaches are also discussed in this chapter.

Chapter 5 explains the data collection from the respondents through qualitative method (interview session), and quantitative method (questionnaire survey). The data will be presented in graphs, charts and tables form.

Chapter 6 is about the data analysis of this research. Both quantitative and qualitative methods will be explained in detail. Statistical Packages for the Social Sciences (SPSS) will be utilised to analyse the data that was collected by quantitative approach, while content analysis will be used to analyse the data obtained through the qualitative approach.

Chapter 7 is the discussion chapter of this thesis, which explains the findings of the data that was collected from the respondents, either in questionnaire surveys or interview sessions. The data will be ranked and discussed in detail.

Chapter 8 summarises this research study's results, contributions, research limitations, and offers suggestions for further research.

CHAPTER 2

CONSTRUCTION LABOUR PRODUCTIVITY

2.1 Introduction

This chapter delves into the detailed exploring of construction labour productivity issue and provides a rationale for the research approach. It begins by examining the longstanding issues plaguing the construction sector globally, attributing low labour productivity issue with conventional methodologies, and explores the specific context of the Malaysian construction industry, offering an industry overview that includes government development strategies in Malaysia's Plans. The section then delves into low labour productivity factors, exploring different types, their causes, and their impacts across various industry facets, drawing on extensive research findings. It proposes a novel approach to studying labour productivity main factors by applying the concept of "pathogens," previously utilised in other failure-related investigations. Pathogens refer to latent factors that remain unseen until issues arise. The adoption of this approach is elaborated upon and justified, and mentioned the imperative for transformative construction practices through Supply Chain Management as the way forward.

2.2 Operational Definition of Research

Operational definition can be defined as a concept or construct by specifying the operations that must be performed in order to measure or manipulate the concept, as the data collected during research is in terms of observable events (Ary, 1985). Table 2.1 shows the operational definition of the terms and variables used in this research.

No.	Variable	Operational Definition
1	Labour	Labour refers to the human effort, both physical and mental, utilized in the production of goods and services. It encompasses activities performed by workers, including their skills, hours worked, and the nature of their employment (Acemoglu & Autor, 2011))
2	Productivity	Productivity is the measure of the efficiency of production, often expressed as the ratio of output to inputs used in the production process. It can be assessed at various levels, including individual, organizational, and national (Syverson, 2011).
3	Supply Chain Management	Supply Chain Management (SCM) is the coordination and management of the flow of goods, information, and finances as they move from supplier to manufacturer to wholesaler to retailer to consumer. SCM aims to improve efficiency, reduce costs, and enhance customer satisfaction (Ivanov, D., & Dolgui, A. (2020).
4	Pathogen	Pathogen can be described as latent conditions and remain hidden in a system until a blunder or mistake arises. In lay-man term, it could be described as “underlying cause” or “root cause” of a problem (Reason, 1990).
5	Low Labour Productivity	Low labour productivity refers to a situation where the output produced by a worker or a group of workers is below the industry or sector average. It can result from various factors including inadequate training, poor working conditions, inefficient processes, or lack of motivation (McGowan et al., 2017).
6	Construction Phase	The construction phase is a stage in a project lifecycle where the physical building or assembly of infrastructure takes place. It involves activities such as site preparation, foundation laying, structural work, and finishing tasks. This phase is crucial for translating design plans into actual structures (Gould & Joyce, 2020).
7	Factor	A factor is an element or component that contributes to a particular result or situation. In research, factors can be variables that are manipulated or measured to determine their effects on outcomes (Field, 2013).
8	Root Cause	Root causes refer to the fundamental reasons or underlying issues that lead to a particular problem or situation. Identifying root causes is essential for developing effective solutions and preventive measures (Andersen & Fagerhaug, 2006).
9	10 th Malaysia Plan (RMK-10)	The 10th Malaysia Plan (2011-2015) is a strategic blueprint outlining Malaysia's development goals and policy directions. It focuses on transforming the country into a high-income economy through initiatives in economic

		growth, infrastructure development, human capital enhancement, and social inclusion.
10	Project Delay	Project delay refer to extension of time beyond the originally planned period of project.
11	Malaysian Peninsula	Malaysia Peninsula refers to all states in Malaysia except for the states of Sabah and Sarawak which are in West Malaysia. The Malaysian Peninsula consists of twelve (12) states.
12	Malaysian Public Works Department (PWD)	Malaysia Public Works Department is the Malaysian federal government department under the Malaysian Ministry of Works (MOW) and is in charge of construction activities as well as maintenance of public infrastructure.
13	Expert opinion	Expert opinions refers to responds / opinions from the Malaysian experienced construction industry practicing professional.
14	Interview	Interviews are a qualitative research method involving direct, face-to-face, or virtual conversations between a researcher and a respondent. They are used to gather in-depth information, explore attitudes, beliefs, and experiences, and gain insights into complex issues (Brinkmann, 2013).
15	Questionnaire	Questionnaires are research instruments consisting of a series of questions designed to gather information from respondents. They can be used for quantitative or qualitative data collection and are administered in various formats, including paper, online, and face-to-face (Dillman et al., 2014).
16	Research final framework	Research final framework refers to the validated “framework that utilises beneficial SCM tools to reduce low labour productivity in Malaysian public sector building projects.

2.3 The Concept of Project Success in Construction Industry

The construction industry is different from other industries, such as manufacturing and production, which have the same output. Construction projects can be defined as unique due to one project being different from other projects in terms of many aspects, such as economic nature, nationality and civilization (Gray, 1996; Morledge et al., 2009). Construction management is also distinct from other types of management in that it encompasses a diverse workforce capable of completing a job (Oyewobi et al., 2011; Attar et al., 2013).

Project success can be defined as the achievement of predetermined goals and objectives within the constraints of time, budget, and quality. It encompasses meeting stakeholders' expectations and delivering the intended benefits. This comprehensive definition is supported by Baker et al. (1983), Slevin & Pinto (1986), Morris & Hough (1987), and Turner (1993), who underscore the importance of assessing project success based on the triple constraint framework. Additionally, recent research by Li et al. (2019) reaffirms the significance of time, cost, and quality as foundational elements in evaluating project success. Pinto and Slevin (1994), Abdel-Razek (1997), Nyhan et al. (1999), and Cooke-Davies (2002) further emphasize that project success entails achieving optimal efficiency and effectiveness in project execution.

Therefore, project success extends beyond mere completion within allocated resources; it encompasses the delivery of desired outcomes and benefits that align with stakeholder expectations. Continuous evaluation and adaptation throughout the project lifecycle, as advocated by contemporary scholars like Chan et al. (2021), are crucial for navigating complexities and maximizing project success. This concept is strengthened by defining project success in terms of efficiency and effectiveness criteria (Pinto & Slevin, 1994; Abdel-Razek; 1997; Nyhan et al., 1999; Cooke-Davies; 2002).

Three key factors influence building projects: quality, time, and cost. These factors are inextricably linked. Labour productivity is also a major focus of construction planning efforts, and it is inextricably linked to the three restrictions mentioned above (Ulubeyli et al., 2014). Low labour productivity is strongly affected by the presence of change of work, disruptions and work needing to be redone.

2.4 Project Delay in Construction Industry

Construction industry in Malaysia has been developing rapidly from the past decade. Nevertheless, the building sector has struggled with project delays for many years (Ibrahim et al., 2010). Project delay can be defined as non-completion of project work within the specific timeframe as agreed in contract (Aibinu and Jagboro, 2002). Project delay comprises the frequent, costly, complicated and risky issues that happen in construction projects (Alaghbari et al., 2005). Malaysia's construction industry has also suffered delays in projects owing to labour productivity issues, particularly in public sector building.

According to Sambasivan and Soon (2007), 17.3% of Malaysian public sector building projects in 2005 were classified as sick projects, defined as those that were delayed by more than three months or abandoned outright. According to Joshi (2009), 80% of government projects are delayed, while Abdullah et al. (2010) report that 90% of MARA (government organisation) projects are delayed and completed later than expected. Additionally, 235 sick projects were identified in 2011 and 191 sick projects were identified in 2013. (2016) (Nurul et al.). Examples are, a public housing and headquarters project for the Kedah contingent, as well as a family apartment for the Army Mahkota Camp in Kluang, Johor Bahru, and the Port Klang Free Zone (Chief Auditor Report, 2010).

The government 10th Malaysia Plan (RMK-10) and Economic Transformation Program, which include the Mass Rapid Transit (MRT), which required around 130,000 numbers of construction labour, both local and foreign, to execute the projects (CIDB News, 2011). Based on the 7th Malaysian Construction Sector Review and Outlook Seminar (2010), the Ministry of Works, Yang Berhormat Dato' Shaziman Abu Mansor, is adamant about achieving zero delays in the implementation of 10th Malaysia Plan projects. However, several projects remain unfinished as a result of the 10th Malaysia Plan. As a

result, the aim is unreachable, and further measures to address labour productivity difficulties in public building projects must be done. Additionally, the government has established a number of productivity objectives as part of the 11th Malaysia Plan. The 11th Malaysia Plan (RMK-11) defined them explicitly and focused on labour productivity improvement as a critical component of Malaysian economic growth (Sinar, 2016). The former Malaysian Prime Minister YAB Dato' Seri Najib Tun Razak said at the 2nd National Export Council (NEC) meeting that in order to accomplish the RMK-11 export objective, the emphasis should be on increasing labour productivity and developing the necessary human resource skill sets.

2.4.1 Cause of Project Delay by Labour Factors

Labour is the most significant resource in construction projects. Lack of labour in Malaysia will cause the country to depend on workforce from foreign countries, especially from Indonesia and Bangladesh (Berita Harian; Bernama, 2011). Many researchers mentioned that labour is the primary factor that has contributed to project delay (Sadi A. et al., 2006; Sweis et al., 2007). Shortage of labour is the issue encountered by lots of countries all over the world (Bruce and Dulipovici, 2001; Hanim, 2010; Wang, 2010; Mustafa et al., 2021). As mentioned by Trendle (2008), lack of skilled labour can result from the rise in the demand for labour.

According to Kwan Foh Kwai, President of MBAM (Master Builders Association of Malaysia), a key issue in the building business is a shortage of competent labour. He stated that the labour scarcity would have a detrimental effect on the Malaysia Plan and Economic Transformation Program initiatives. According to Mohit Joshi (2009), around 80% of government projects experienced delays, resulting in the problem of inefficiency

in Malaysia building activity. Additionally, Malbex (2009) claimed that around 31 out of 417 Malaysia public projects were identified as sick projects in 2005. Hanim (2010) stated that increased employment fees for foreign labour, due to levy, clinical examination, protection bond, and medical expenses paid by employers, contribute to Malaysia's labour shortage. As a result of the increasing expenses for recruiting foreign labour, Malaysia will face a labour shortage and projects will be delayed.

Additionally, Sweis et al. (2008) and Wang (2010) found that a shortage of labour, including skilled, semi-skilled, and unskilled labour, is the main reason that contributes to delayed and sick building projects. This is further reinforced by Sambasivan and Yau (2007), who conducted research in Malaysia and discovered that labour shortages are the seventh of twenty-eight most common reasons for construction delays. Thus, it is demonstrated that labour shortages are the primary cause of building project delays in Malaysia.

2.5 Overview of Malaysian Construction Industry

Malaysia's construction industry is growing. Generally, building works are financed by Malaysia's national economic activity. Construction project revenues amounted to approximately approximately \$7.21 billion in 2008, \$6.67 billion in 2009, and are predicted to achieve \$9.00 billion by 2015 (Leong, 2010). Malaysia's construction industry has been essential to the country's overall economic development and growth. Over the last two decades, the construction industry has consistently contributed between 3% and 5% of the national gross domestic product (Hamid and Sarshar, 2003). In 1991, with the adoption of "Vision 2020," the industry's growth was accelerated further.

Malaysia's long-term goal is to achieve this vision, with the country aiming to become a developed and industrialised country by 2020.

Malaysia's economy continues to be adaptive and resilient to external shocks, with GDP growing by around 4.2% in 2016 and 4.3% in 2017, as per recent World Bank economic projection. This outlook implies a further slowing of consumer spending and investment growth as global financial growth and commodity prices continue to be subdued, and as households adjust to low employment prospects and economic growth (Malaysia Economic Monitor, 2016)

According to Datuk Abdul Rahman Dahlan, Economic Minister in the Prime Minister's Department (2016), Malaysia has had a period of sustained development driven by accumulation over the last 25 years, from 1990 to 2014. High investment rates, infrastructure expansion, private sector development, and workforce growth have all benefited the economic system significantly. Productivity growth has been notably stable during that period, reflecting the economy's adaptability and expansion into new areas of investment. Malaysia will continue to pursue similar development programs in the future to boost labour productivity.

Although the notion of productivity is critical in building projects, productivity enhancement has been largely ignored for many years (Hammad et al., 2011). As a consequence, labour productivity has been low, resulting in cost overruns and project delays (Attar et al., 2013). The recent Malaysia Economic Monitor is focusing on improving productivity levels. According to the report, boosting productivity will become the major approach for Malaysia's economic and financial success in the future. Apart from increasing total factor productivity, the report identified workforce development via skill