DEPARTMENT OF BUILDING

UNIVERSITI TEKNOLOGI MARA

(PERAK)

THE USES OF TECHNICAL MATERIAL SHEET (TMS) FOR THE MAINTENANCE OF A GOVERNMENT OFFICE BUILDING IN PUTRAJAYA

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UNIVERSITI TEKNOLOGI MARA

(PERAK)

20 DECEMBER 2019

It is recommended that the report of this practical training provided

by

Nurul Izzati Binti Shamsul Bahri

2017208748

entitled

The Uses of Technical Material Sheet (TMS) For The Maintenance of a Government Office Building in Putrajaya

be accepted in partial fulfilment of requirement for obtaining the Diploma in Building.

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STUDENT'S DECLARATION

I hereby declare that this report is my own work, except for extract and summaries for which the original references are stated herein, prepared during a practical training session that I underwent at Sunway Construction Sdn Bhd for a duration of 20 weeks starting from 5 August 2019 and ended on 20 December 2019. It is submitted as one of the prerequisite requirements of BGN310 and accepted as a partial fulfillment of the requirements for obtaining the Diploma in Building.

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Name : Nurul Izzati Binti Shamsul Bahri

UiTM ID No : 2017208748

Date : 13 December 2019

ACKNOWLEDGEMENT

First and foremost, I would like to express my most humble gratitude towards Allah for giving me the guidance and strength in order to complete my BGN 310. Praise upon Him, without His support and blessing, I would not have been able to finish my report within the given time.

I am honored and grateful for the opportunity to work for Sunway Construction Sdn Bhd, being Malaysia's most well-known company in the construction field. I would like to extend my appreciation towards my supervisor, Ric Chan Kok Choon, who guided me through every step and gave me helpful advice regarding my case study. I would have been entirely lost without his encouragement and kind support. Next, I am also grateful for my co-workers in the BIM department for helping me when faced with challenges during my time at the site office. Samuel Wong and Ahmad Ridwan who has been a tremendous help in every way. Not to mention, Cassandra Choy Peng and Mohd Azmi who taught me everything I needed to know regarding Technical Material Sheet (TMS) and its process.

Lastly, I would like to say thank you to my family and friends who gave me countless advice, tips and support needed for me to complete this report.

ABSTRACT

Building Information Modelling (BIM) has become an essential part of the construction industry due to its modern methods of managing information during key stages if the project. So, it is no surprise to see BIM being integrated into Facility Management (FM) as an effort to enhance progress and work quality. Therefore, this report will discuss on Technical Material Sheet (TMS) which is the process of collecting and reviewing information from different items based on the category of trade. The case study is conducted at a government office building in Precinct 1, Putrajaya The main objectives of this report includes the process of producing TMS and challenges faced during the production of TMS. Lastly, this report will also explore the recommendations and solutions that can overcome these problems through observations or literature reviews. In summary, BIM plays a powerful role in the construction field that can leave a massive change to the world.

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CHAPTER 1.0

INTRODUCTION

1.1 Background and Scope of Study

Building Modelling Information (BIM) is the sophisticated process of creating and managing information on a construction project across the project's lifecycle and key stages. Moreover, BIM does not only stop at the completion of a building but strives to increase the level of sustainability of a building and its facilities by adopting efficient planning management, tools and methods. In other terms, *BIM can be viewed as a virtual process that encompasses all aspects, disciplines, and systems of a facility within a single, virtual model, allowing all team members (owners, architects, engineers, contractors, subcontractors and suppliers) to collaborate more accurately and efficiently than traditional processes. As the model is being created, team members are constantly refining and adjusting their portions according to project specifications and design changes to ensure the model is as accurate as possible before the project physically breaks ground.* (Carmona and Irwin, 2007).

Nowadays, BIM is being implemented around the world by several modern countries due to its effectiveness and benefits such as the increase in the elimination of human errors and loss of time through automatic quantification and software. BIM can enhance the planning process, design and quality of construction projects. The benefits of BIM to construction players cover many aspects, which include design, budget, communication, documentation, and scheduling. BIM is especially necessary for large scale projects that involve complicated engineering, architectural design, high-risk factors and large costs. In the western part of the world, BIM is considered obligatory when it comes to planning large projects of any kind.

One of the elements collaborating with BIM is Facilities Management (FM) which they are closely integrated. *Facilities Management defined as 'an integrated approach to maintaining, improving and adapting the buildings of an organisation in order to create an environment that strongly supports the primary objectives of that organisation'* (Barrett & Baldry, 2003: xiii). For example, the installation process of high-tech security systems to an office building which will guarantee the safety of

valuable property. Yet, every element installed within the building such as mechanical items, furniture, paint, and pipes, must be recorded and documented for the client's future use. The scope of my study focuses on the documentation process of Facility Management (FM) where information regarding these items from different category of trade are collected, cross-examined, endorsed and organized. This documentation process is known as Technical Material Sheet (TMS). By using the right methods and tools for TMS, many opportunities and advantages can be gained within the construction industry. The manipulation and collection of this information are essential in order to safeguard user information, ease maintenance work once the building is complete and increase the efficiency of the building itself.

In this case, the present construction industry in Malaysia has been implementing TMS over recent years as an effort to increase the sustainability of a building while simultaneously securing relevant documents, specifications and drawings for future references by the clients themselves. Currently, a government office building which consists of ten separate blocks titled Parcel F in Precinct 1, Putrajaya, is using TMS to improve the building's quality. Initially, TDMS is seen as the final stages of Building Information Modelling (BIM). TMS contributes to the processes of BIM in regard to improve planning, design and construction of complex projects.

However, TMS, like any other system, is not immune to problems that can greatly affect the productivity and efficiency of the company, resulting in an extended time of a project, loss of cost, wastage, and so on. These problems stem from the lack of planning, insufficient communication and applying the wrong methods to the system. Thus, companies must be quick to find solutions to them rather than allowing the mistakes to be repeated in the near future.

In summary, this report contains the aims to further examine the procedures of TMS and its advantages that it can bring to a project or organization. Furthermore, this report will also focus on the problems the system faces and suggestions to overcome the problem.

1.2 Objectives

The objectives of this report are as follows:

- To analyse the procedures of the Technical Data Management System (TMS) of the construction of a government office building.
- To investigate the problems faced when applying TMS to the project of a government office building.
- To recommend solutions for the problems found in TMS methods and practices

1.3 Method of Study

During the period of my practical training, numerous methods of research were done in order for me to compile and evaluate data for my chosen topic. Firstly, observations were made during my working hours at the office site of the project. Notes, flowcharts and diagrams were made to better understand TMS and its process in general. Most of the written notes are done in the practical training logbook with printed pictures of the work done. Meanwhile, rough sketches of flowcharts and diagrams are written in a personal notebook for my own personal reference and use.

Secondly, interviews are also important to collect relevant data of my topic from people who are experienced in this area. Unstructured interviews were conducted with my supervisor who has been involved in managing TMS for over half a year with working experience of various departments from past projects. Not to mention my colleagues who are involved in TMS, were very helpful in answering my questions and allowing me to understand the system even further. Furthermore, most of the structured interviews were conducted with the coordinator of the Building Information Modelling (BIM) department for this project, who has been working in the BIM department for more than five years with many projects under his supervision. Normally, questions are prepared beforehand in order for the interview to proceed smoothly with straight-to-the-point answers. He has given me many great bits of advice with occasional comments to my written notes which helped me to improve my research. Lastly, document reviews were also used frequently for data research. Documents such as approval letters for materials, shop drawings, cut sheets and catalogues were important for me to better understand the procedures

CHAPTER 2.0

COMPANY BACKGROUND

2.1 Introduction of Company

Since 1981, Sunway Construction has been responsible for the construction of Malaysia's globally recognised landmarks and structures which symbolises national significance. Some of these landmarks include Legoland Malaysia, KLCC Convention Centre, the Kajang – SILK Highway and the nation's first elevated Bus Rapid Transit (BRT) Sunway Line. Today, SunCon is capable of acting as a leader in notable projects with their world-class expertise for civil engineering, building, geotechnical solutions, mechanical and electrical solutions, industrial building systems, machinery and logistics. They provide services which include building construction, infrastructure services, mechanical, electrical and plumbing engineering (MEP), precast manufacturing, façade management and Virtual Design Construction (VDC). Sunway Construction believes in building landmark projects through passion and determination which makes them seen as a reliable construction group.

In addition, Sunway Construction is one of the few construction companies in Malaysia to venture internationally with collaborative projects in Singapore, India, the Middle East and the Caribbean, earning them awards for outstanding achievements in the construction field.

SUNWAY®
CONSTRUCTION

Figure 2.1.1: Sunway Construction Sdn Bhd Logo

2.2 Company Profile

Sunway Construction Group Berhad (SunCon), is one of Malaysia's largest construction group that provides a complete range of integrated design and high-quality construction services which includes building, infrastructure mechanical, electrical and plumbing (MEP) services, etc. SunCon has a track record that spans over 38 years that are capable of tailoring fully integrated and cost-effective solutions for the clients, delivering effective end-to-end solutions as well as control over timely delivery and quality.

The company started off humbly in the year 1981 where they took their first project of resurfacing the carpark and road for a shop lot complex in Bukit Damansara. Soon, the company took more complicated and advanced projects as the company grew such as the widely known shopping mall, Sunway Pyramid Shopping and Convention Centre, the Ministry of Finance Building in Putrajaya, the LRT Package B, Kelana Jaya Extension Line and many more. Some of their projects reach to international grounds which gained numerous awards for their determination in creating sustainable and eco-friendly buildings.

SunCon's reputation is evident in their list of outstanding achievement and awards received over their years of service to this nation. Receiving the Asia Sustainability Reporting Awards 2018 – Winner of Asia's Best Sustainability Report in Annual Report, IFAWPCA 2018 Builders Award – Building Construction Category: KL Convention Centre – Silver Medal, The International Road Federation's Global Road Achievement Awards (GRAA) – Urban Planning and Mobility Award – BRT Sunway Line and the so on.

2.3 Vision and Mission

Sunway Construction's vision is **to be the leading regional construction and engineering group.** With a vision of becoming the region's leading pure-play construction group, they are constantly innovated to deliver value, build synergistic and sustainable relationships and achieve the highest standards of quality, safety and excellence.

Sunway Construction's mission which goes as follows. **"Innovating to deliver value underpins our relentless efforts to drive positive and sustainable change in the way we work and operate to create values for all our stakeholders."** Achieving the highest standards in quality, environmental, safety and health, remains SunCon's founding value. The company makes individual and collective efforts in aiming higher to achieve strategic business goals with a commitment to excellence.

2.4 Organization Chart

Tan Sri Dato' Seri Dr Jeffrey Cheah, the founder and chairman of Sunway Group leading Malaysia's formidable conglomerate with 12 business divisions spanning 50 locations worldwide including Sunway Construction Sdn Bhd. In the construction company's constant pursuit for success, it is supported by the board of directors that form the structure of the organisation today.

Tan Sri Dato' Seri Dr. Jeffrey Cheah

Founder and Chairman of Sunway Group
Figure 2.4.1

Board of Directors for Sunway Construction

Dato' Ir Goh Chye Koon

Independent Non-Executive Chairman
Figure 2.4.2

Mr Chung Soo Kiong

Managing Director
Figure 2.4.3

Datuk Kwan Foh Kwai

Advisor
Figure 2.4.4

Dato' Siow Kim Lun

Independent Non-Executive Director
Figure 2.4.5

Dato' Dr Ir Johari Bin Basri

Senior Independent Non-Executive Director
Figure 2.4.6

Dato' Chew Chee Kin

Non-Independent Non-Executive Director
Figure 2.4.7

Evan Cheah Yean Shin

Non-Independent Non-Executive Director
Figure 2.4.8

Dr Sarinder Kumar

Independent Non-Executive Director
Figure 2.4.9

Chart 2.4.1: Organisation chart and board of directors for Sunway Construction Sdn Bhd

Meanwhile, the construction of a government office building, Parcel F has their own organization chart with skilled and hardworking people in different departments working together in order to meet the completion of the project. Chart 2.4.1 shows the technical organization chart of project Parcel F.

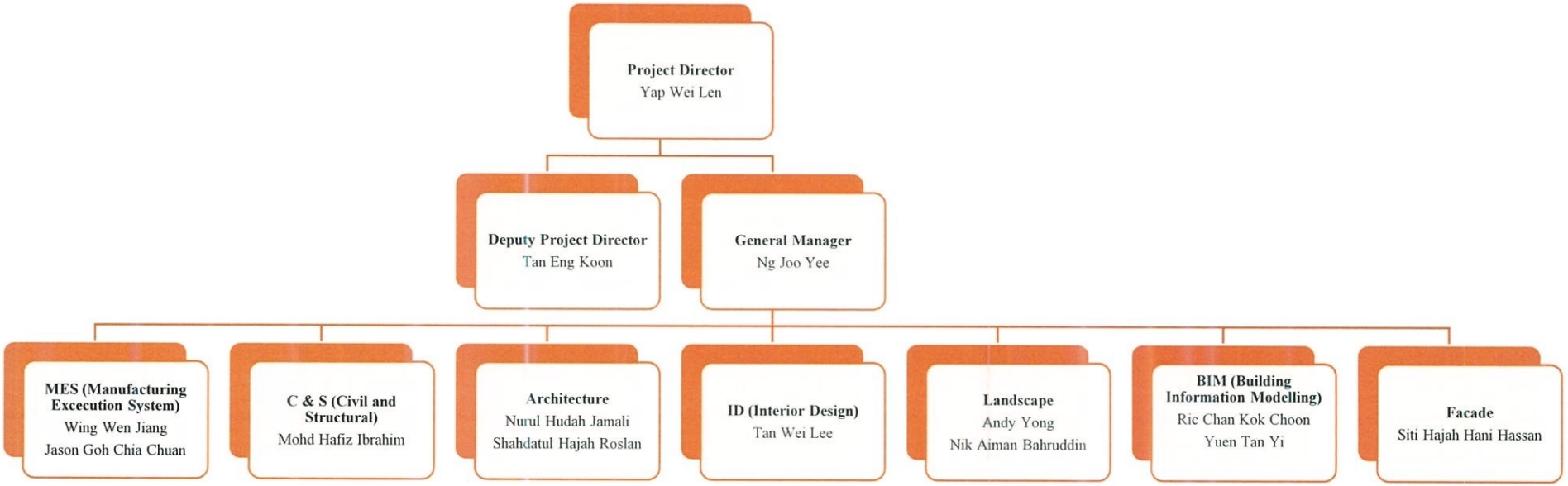
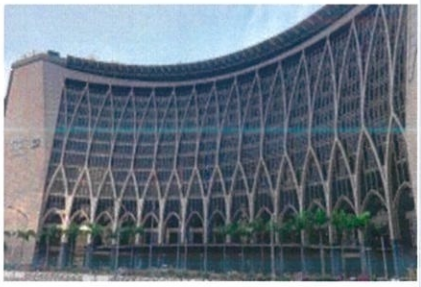


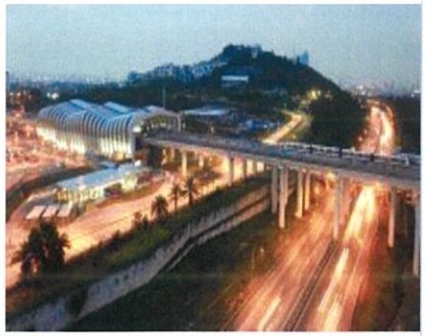
Chart 2.4.1: Technical Organisation Chart for Project Parcel F

2.5 List of Completed Projects

Sunway Construction has been involved in revolutionary projects that have shaped Malaysia's landmarks throughout history. Table 2.5.1 below shows the list of projects undertaken by the company.

Table 2.5.1: List of projects by Sunway Construction Sdn Bhd

No	Name of Project	Picture	Year Completed	Estimated Cost
1	Sunway Pyramid Shopping and Convention Centre in Bandar Sunway, Petaling Jaya		1996	RM209 million
2	Ministry of Finance Building, Government Building in Putrajaya		2002	RM139 million

3	Kajang-SILK Highway		2004	RM1.05 billion
4	Al-Reem Island Development, Abu Dhabi		2006	AED1.33 billion
5	Bus Rapid Transit – BRT Sunway Line		2003	RM452 million
6	LRT Package B, Kelana Jaya Line Extension		2011	RM569 million

	TNB HQ Campus, Bangsar, Kuala Lumpur		2019	RM768 million

CHAPTER 1.0

INTRODUCTION

3.1 Introduction to Case Study

The project which was assigned during the period of my practical training is the construction of a government office building with the given name Parcel F in Lebuh Perdana Timur, Presint 1, 62000 Putrajaya, Wilayah Persekutuan Putrajaya. It consists of ten blocks, recently on its final stages of construction and is handed over to the client on the 26th November 2019. The large-scale design and construction of the blocks range from 4 to 13 storeys high, spread and arranged over a land area of 34 acres in the Federal Government Administrative Center of Putrajaya. The government office building houses over 5800 government employees and provides carpark space over 2800 bays. Its project value is estimated around RM 1.49 billion with a gross floor area of 417000-meter square. The project is under the public sector with the client being Putrajaya Bina Sdn Bhd and Sunway Construction Sdn Bhd playing the role as the main contractor.

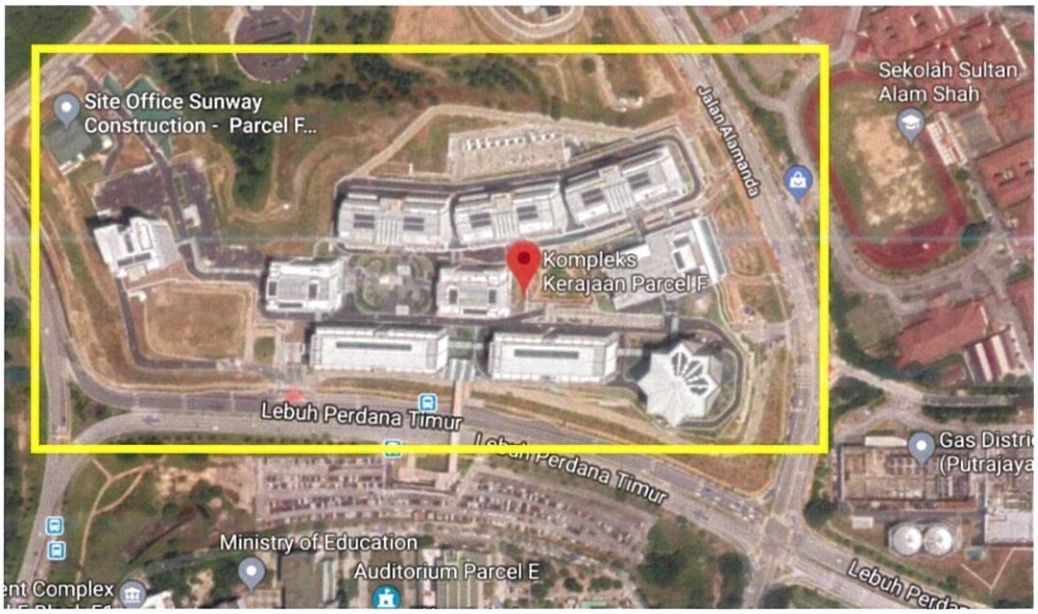


Figure 3.1.1: Satellite image of Parcel F

Figure 3.1.2: 3D Model of Parcel F showing respective departments for each block

Figure 3.1.3: Completed construction of Block F05

Figure 3.1.4: Completed construction of Block F11

Figure 3.1.5: Completed construction of Block F11

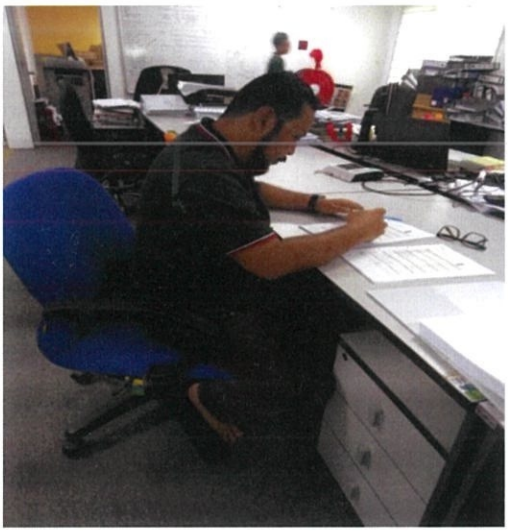
3.2 Process of Technical Material Sheet (TMS)

Technical Material Sheet (TMS) is the process of handling and compilation of data for a set of items under certain categories such as Mechanical, Electrical, Architecture and Interior Design and Furniture. These items are registered under TMS which will include relevant data for the client's reference or future use. Data of these items such as technical specifications, warranty code, model number, finishes, manufacturers, block numbers, etc. Firstly, a template is created which will contain all the relevant data of that particular item. This template is used and standardize for all categories of trade. Furthermore, it will include spaces for certain parties to provide their signatures which will verify these items. These single files are referred to as 'cut sheets'. Figure 3.2.1 shows an example of a cut sheet for item number 7.02 Door under the Interior Design and Furniture (IDF) category.

In order to fill in the cut sheets with the correct data and cross-examine them to avoid errors, catalogues, drawings and schedules are retrieved from other departments or using Electronic Document Management System (EDMS) software where multiple documents are stored. These catalogues and drawings are prepared by other departments and are submitted to the client's representative for approval. Once an item receives an approval letter by the client's representative, the catalogues and drawings are used by the TMS department. Figure 3.2.3 shows a drawing detail of an office chair for IDF. At this point, these steps are referred to as the production stage where the cut sheets are filled in, organized, examined and printed out. This process is achieved by using BIM software and methods such as TMS template generators and 360 photo software viewers.

Next, the endorsement process given by different parties is the most important stage. In-house consultants hired by Sunway Construction Sdn Bhd will review and give comments on the printed cut sheets. If errors are found in the details of these items such as wrong model numbers, incorrect manufacturers or different pictures from the actual site, then amendments are done to the cut sheets before handing it over to the in-house consultants.

These in-house consultants come from different companies depending on the category of trade. For example, consulting engineers from Li-Zainal Sdn Bhd and Jentrik Sdn Bhd are hired by Sunway Construction Sdn Bhd, working for the mechanical and electrical department. The signing process is done repeatedly until no more mistakes or comments are found. Figure 3.2.4 shows Encik Zahrul Amin from Al-Ciptra Design Associates Sdn Bhd signing cut sheets for blocks F02 and F03 under IDF.



Picture 3.2.1: In-house consultant, Encik Zahrul Amin signing cut sheets for IDF

Picture 3.2.2: External consultant, Puan Saidatul signing cut sheets for IDF

SUNWAY CONSTRUCTION

7.02
F03

FM CUTSHEET

INVENTORY NAME: SINGLE LEAF 1 HR FIRE RATED DOOR
INVENTORY CATEGORY: 1 HR FIRE RATED DOOR
ASSET CODE:

NO.	ITEM	DETAILS
A	**Dimension**	
1	Standard Width	1000mm
2	Standard Depth	NA
3	Standard Height	2400mm
4	Standard Weight	NA
5	Standard Area	NA
6	Diameter	NA
7	Thickness	NA
B	**Technical Specification**	
1	Manufacturer	Dormakaba Malaysia Sdn Bhd (954310-D)
2	Model Number	IDRS-1
3	Description	Single Leaf 1 HR Fire Rated Door
4	Materials	Timber, Metal
5	Finishes	White Meranti Veneer Clad Finished in Sel. Stain Finish
6	Upholstery	NA
7	Years Life Expectancy	5 years DLP
C	**Warranty Code**	
1	Supplier/Main Cont	Dormakaba Malaysia Sdn Bhd (954310-D)
2	Warranty	5 years DLP
3	Warranty Code	NA
4	Date of Manufacture (if applicable)	CPC date
5	Meter Units (km, hours, m^3, Btu/hr, kWH, kW and etc.)	NA
6	Purchase Date	CPC date
7	Serial Number (if applicable)	NA
8	Standard Operating Procedures (Operation and Maintenance Manual)	As per O&M Manual
D	**Vendor**	
1	Contact	Dormakaba Malaysia Sdn Bhd (954310-D) No. 31 Jalan 15/23, Taman Perindustrian Tiong Nam, Seksyen 15, 40200 Shah Alam, Selangor Darul Ehsan, Malaysia Tel : Fax :

PREPARED BY	VERIFIED BY
Name:	**Name:**
Company:	**Company:**
Date:	**Date:**

CHECKED BY	APPROVED BY
Name:	**Name:**
Company:	**Company:**
Date:	**Date:**

Figure 3.2.3: Example of cut sheet template for item 7.02 Doors under IDF

SUNWAY CONSTRUCTION

3.01
F01

FM CUTSHEET

INVENTORY NAME: OFFICE CHAIR - C2 TYPE B
INVENTORY CATEGORY: OFFICE CHAIR
ASSET CODE:

NO.	ITEM	DETAILS
A	Dimension	
1	Standard Width	530 mm
2	Standard Depth	460 mm
3	Standard Height	1230 - 1300 mm
4	Standard Weight	NA
5	Standard Area	NA
6	Seat Height	430 - 500 mm
7	Thickness	NA
B	Technical Specification	
1	Manufacturer	Merryfair Chair System Sdn Bhd
2	Model Number	S629 YC C80 NC_FL (ARES II)
3	Description	C2- High Back Office Chair (Type B)
4	Base	As per As-Built Drawing
5	Gas lift	As per As-Built Drawing
6	Upholstery (Colour)	Leather (Feredica 3313) - Light Brown
7	Years Life Expectancy	5 years DLP
C	Warranty Code	
1	Supplier/Main Cont	Etnik Anggun Sdn Bhd
2	Warranty	5 years DLP
3	Warranty Code	NA
4	Date of Manufacture (if applicable)	CPC date
5	Meter Units (km, hours, m^3, Btu/hr, kWH, kW and etc.)	NA
6	Purchase Date	CPC date
7	Serial Number (if applicable)	NA
8	Standard Operating Procedures (Operation and Maintenance Manual)	As per O&M Manual
D	Vendor	
1	Contact	Etnik Anggun Sdn Bhd No. 82-84, Jalan 2/23A, Jalan Genting Kelang, 53300 Setapak, Kuala Lumpur. Tel: Fax:

PREPARED BY	VERIFIED BY
Name: Ric Chan Kok Choon	Name: Rohaizan Mohammad
Company: Head of Section - BIM, Sunway Construction Sdn Bhd (27175-V)	Company: Director, Fizz Associates (M) Sdn Bhd (642430-M)
Date:	Date:

CHECKED BY	APPROVED BY
ARKITEK MAA SDN BHD	Parcel F Putrajaya Bina S B Zaidy
Name: HAMIZ MURSYIDI SUHAIMI	Name:
Company: Project I.D. PARCEL F, PUTRAJAYA	Company:
Date:	Date: 14/10/19

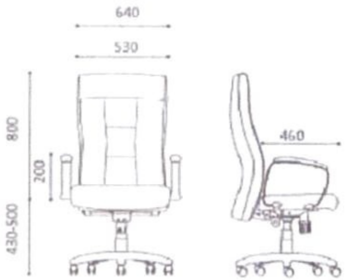
Figure 3.2.4: Fully endorsed cut sheet for TMS IDF

Ref. Code	Lot	: PARCEL F - BLOK F1 / PACKAGE 2
C2 (TYPE B)	Department	: SURUHANJAYA PERKHIDMATAN AWAM BLOK F1
	Area	: BILIK MESYUARAT TURUS (VU3) (CHAIRMAN)

MANUFACTURER / SOURCE		MERRYFAIR CHAIR SYSTEM SDN. BHD.	
DESCRIPTION		High Back Office Chair	
MODEL		S629A YC C80 NC_FL (ARES II)	
LEGEND	ITEM	DESCRIPTION	
	SIZE	Overall Height (mm) : 1230 - 1300 Overall Width (mm) : 530	Seat Height (mm) : 430 - 500 Seat Depth (mm) : 460
	FOAM	50mm thickness for seat in moulded polyurethane (PU) foam and 38mm sponge thickness for backrest.	
A	BASE	700mm Five-prong base of die-cast aluminium in chrome finish. (NC Base)	
B	MECHANISM	Synchron mechanism with multiple locking positions. Height Adjustable and reclining function. (YC Mechanism)	
C	GAS LIFT	Phenumatic height adjustable. 100mm stroke with minimum up thrust force of 350 Newton Meet requirement of ANSI/BIFMA X5.1-2011 Standard	
	FRAME	Backrest Padding employ dual-layer, dual-density foams. Shell are injection-moulded in black polypropylene.	
D	CASTOR	50mm diameter hooded dual-wheel castors in black polyamide (Nylon). Meet requirement of ANSI/BIFMA X5.1-2011 Standard	
E	ARMREST	Fixed armrest in chrome finish with leather padded. (C80)	
F	UPHOLSTERY	Seat Colour : LEATHER - FEREDICA 3313 (LIGHT BROWN)	Backrest Colour : LEATHER - FEREDICA 3313 (LIGHT BROWN)
G	BACK SHELL	Back shell - 4mm thickness frame covered with 6mm sponge in leather finished.	

BLOCK F1

OFFICE CHAIR TYPICAL DETAIL - 01A of 21



BILIK MESYUARAT TURUS (CHAIRMAN)

UPHOLSTERY : **PART :**

SEAT & BACK REST : LEATHER : FEDERICA 3313 (LIGHT BROWN)

ALUMINIUM BASE - NC : COLOUR : CHROME

ARMREST C80 : COLOUR : CHROME ARM WITH LEATHER PADDED - FEREDICA 3313 (LIGHT BROWN)

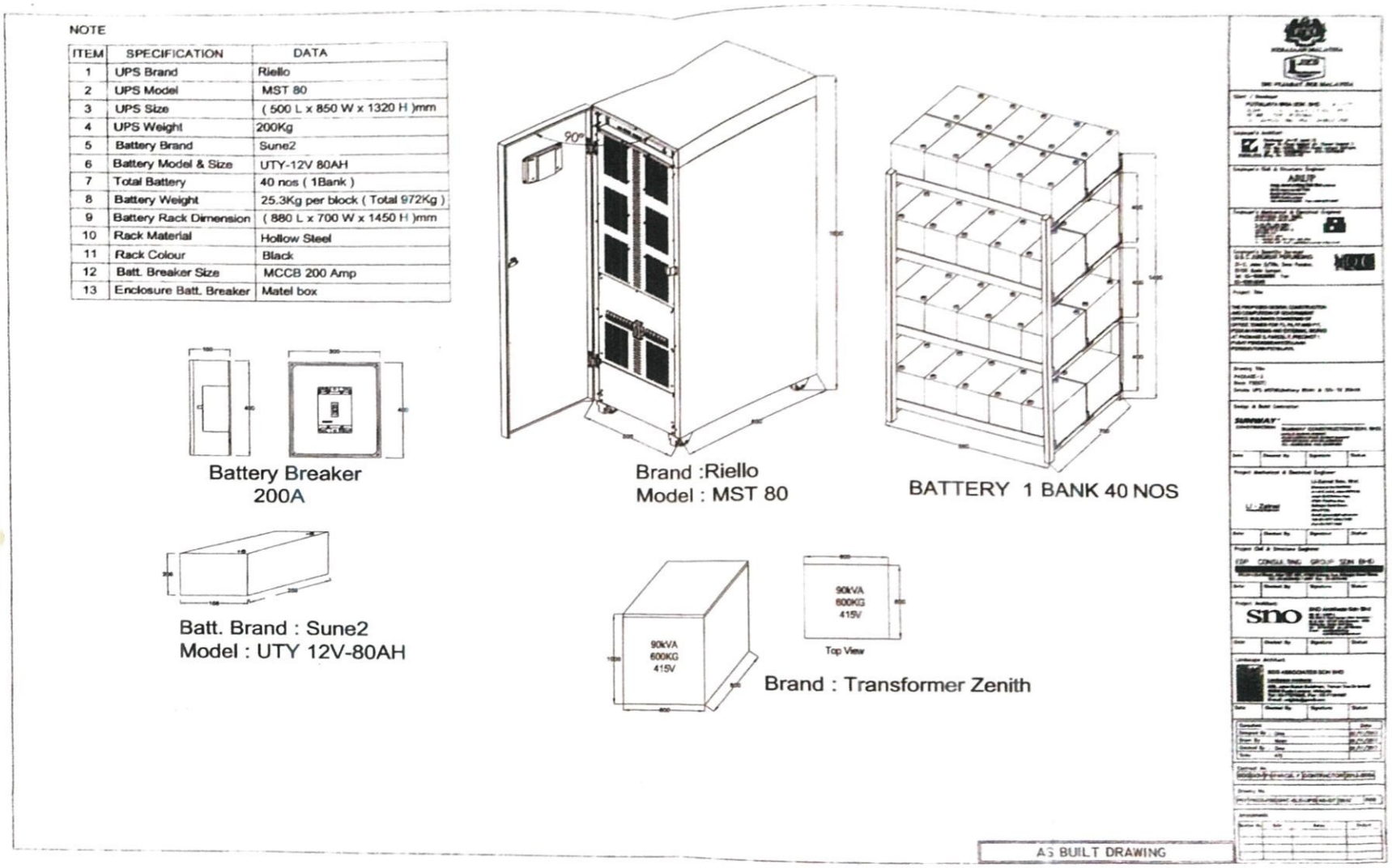
PARCEL F PUTRAJAYA

A
B
C
D

ARKITEK MAA SDN BHD

Project I.D.
PARCEL F, PUTRAJAYA

Figure 3.2.5: Detail Drawing of Office Chair



Picture 3.2.6: Example drawing of Uninterrupted Power Supply (UPS)

SUNEZ

-UTY SERIES-

Maintenance-Free Rechargeable VRLA Battery

UTY 12V-120AH

Features

- Maintenance-free operation
- Compact design
- Stable quality and high reliability
- 10 years design time (at 25°C)

Application

- Telecommunication system
- Alarm and security system
- Backup power for testing and measuring instruments
- UPS
- Emergency lighting
- Fire alarm and security systems
- Auto control system
- Electronic apparatus and equipment
- Communication power supply
- DC power supply

Specifications

Nominal Voltage	12V (6 cells)	Operating Temp.Range	Discharge: -15 - 50°C (5 - 122°F)
Nominal Capacity	128AH (20hr, 1.80V/cell, 25 °C/76°F)		Charge : 0 - 40°C (32 - 104°F)
	120AH (10hr, 1.80V/cell, 25C/77°F)		Storage : -15 - 40°C (5 - 104°F)
	102AH (5hr, 1.75V/cell, 25 °C/77°F)	Nominal Operating Temp.Range	25 ± 3°C (77 ± 5°F)
	72AH (1hr, 1.60V/cell, 25 °C/77°F)	Cycle Use	14.2~14.4V (25°C/77°F) Temp.Coefficient -30mV/°C
Dimension	Length 407 ± 2mm		Initial Charging Current Less than 36A
	Width 174 ± 2mm	Standby Use	13.5~13.8V (25°C/77°F) Temp.Coefficient -20mV/°C
	Container Height 209 ± 2mm		No limit on Initial Charging Current
	Total Height(with Terminal) 238 ± 2mm	Capacity affected by Temperature	40°C (104°F) 103%
Approx Weight	Approx 35.8Kg		25°C (77°F) 100%
Terminal	T3 or F5		0°C (32°F) 86%
Container Material	ABS	Self Discharge	Sunez UTY series batteries may be stored for up to 6 months
Max. Discharge Current	1200A (5S)		at 25°C (77°F) and then a freshening charge is required.
Internal Resistance	Approx 4.8mΩ		For higher temperatures the time interval will be shorter.

Constant Current Discharge (Amperes at 25°C/77°F)

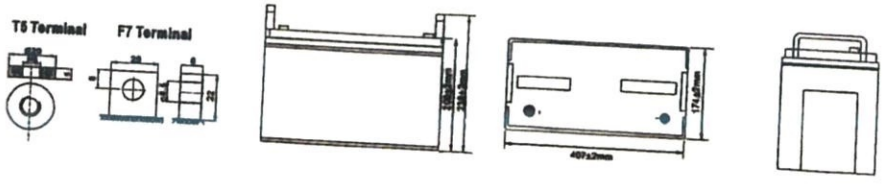
F.V/Time	5min	10min	15min	30min	45min	1h	2h	3h	5h	10h	20h
1.80V/cell	\	208.4	168.3	91.4	61.1	66.7	38.4	29.6	20.3	12.3	6.47
1.75V/cell	\	228.7	182.5	96.3	84.2	68.8	40.5	30.3	20.8	12.5	6.57
1.70V/cell	\	242.1	197.2	98.5	86.9	70.8	41.6	31.0	21.2	12.7	6.63
1.65V/cell	\	258.2	208.4	103.9	90.5	73.6	42.8	31.9	21.6	12.8	6.73
1.60V/cell	\	275.9	217.9	106.5	93.9	76.1	44.0	32.4	22.0	12.9	6.79

Constant Power Discharge (Watts per cell at 25°C/77°F)

F.V/Time	5min	10min	15min	30min	45min	1h	2h	3h	5h	10h	20h
1.80V/cell	\	378.2	319.4	196.5	154.1	129.9	75.8	57.4	40.2	24.4	12.75
1.75V/cell	\	406.3	336.4	205.0	160.5	132.9	77.8	58.6	40.8	24.7	12.94
1.70V/cell	\	426.8	362.8	210.0	165.7	134.7	78.7	59.7	41.3	24.9	13.07
1.65V/cell	\	446.5	365.8	212.0	170.5	138.2	81.4	60.8	42.1	25.1	13.20
1.60V/cell	\	464.6	381.6	214.0	175.0	143.5	83.0	62.0	42.7	25.3	13.33

Note: The above characteristics data are average values obtained within three charge/discharge cycles, not the minimum values.

Dimensions unitimm[inches]



ctory Address:Nanlian Village Industry Area,LongGang District,Shenzhen,China

CE

Figure 3.2.7: Catalogue of Uninterrupted Power Supply (UPS)

Once the endorsement process from in-house consultants is completed, the cut sheets are then signed by external consultants. External consultants are consultants hired by the client, acting as their own personal advisors under a specific category of trades. For instance, Interior Design consultants from Arkitek MAA Sdn Bhd is hired by Putrajaya Bina Sdn Bhd (PBSB), taking the responsibility of endorsing drawings and documents under IDF. In other words, both client and contractor will have their own respective consultants in order to review and verify the proposed drawings or documents. If errors are found by the external consultants during the process of signing, amendments are made to the commented cut sheets and are handed back to the in-house consultants for re-signing. This process proves to be the most difficult stage due to frequent re-signings from consultants.

After that, the endorsed cut sheets are sent to the client's representative for the final verification. Figure 3.2.2 shows a cut sheet of an item with all four signatures from different parties. The next stage is renaming the softcopy files using an agreed file name which would have to be easy to understand. The renaming of these softcopy files is important in order to ease the mapping process done by the BIM department. Lastly, the fully endorsed cut sheets are scanned along with the catalogue or drawings attached below the sheet. Chart 3.2.1 shows a flowchart of the complete process for Technical Material Sheet (TMS).

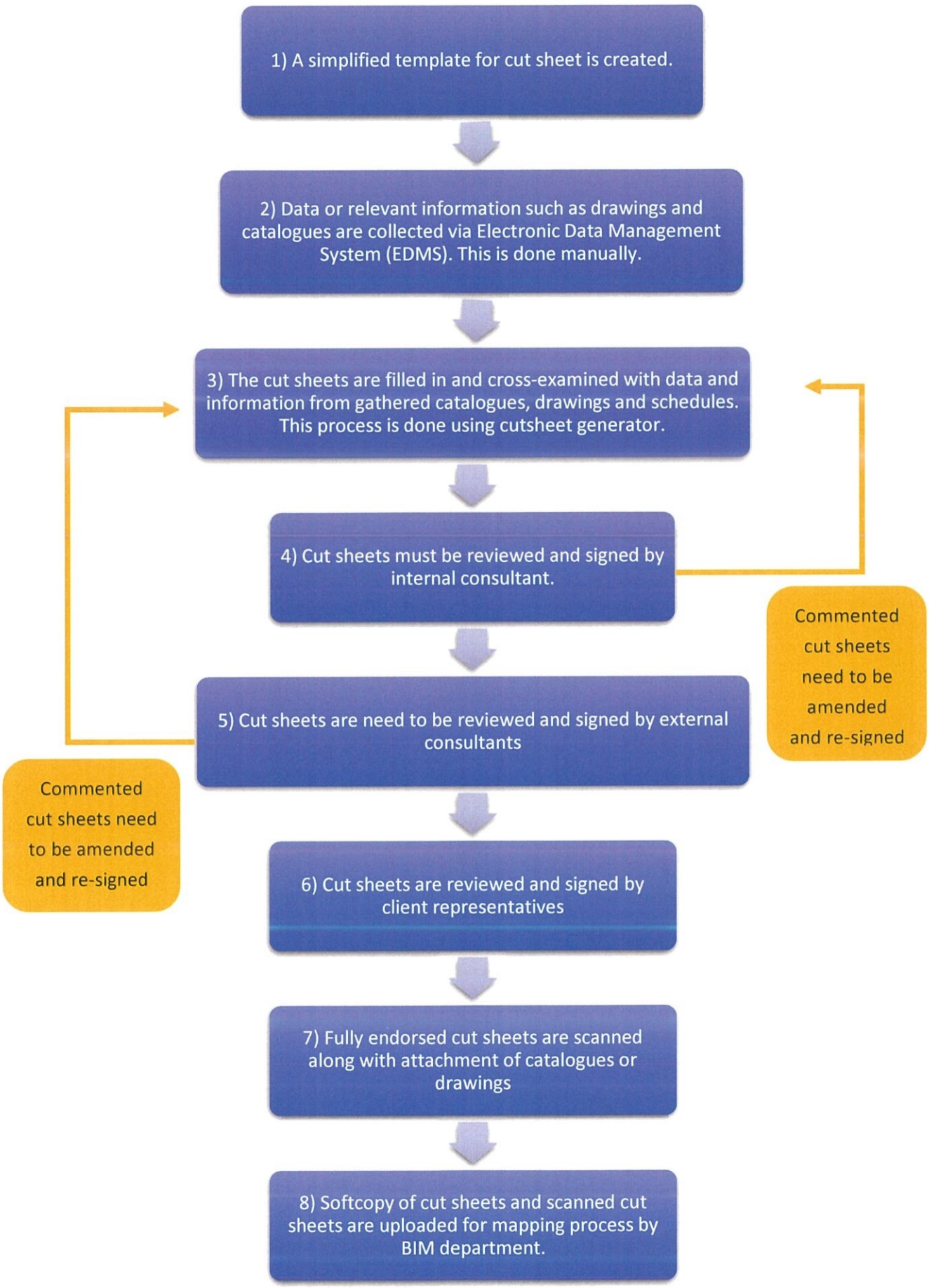


Chart 3.2.1: Flowchart of TMS process and production

3.3 Problems Faced in TMS Process

Since the implementation of BIM into Facility Management, any user can create a cut sheet with the registered TMS item which can be shared, disseminated, stored and acted upon via the Internet, servers, database and accessible software. BIM creates a more modern approach to certain jobs. Yet, the traditional method of document management is still very much relevant in this day and age. The current situation in the construction industry adopts both the modern and conventional methods of handling documents due to it being a more practical and easier way of management, expressed plainly by Bo-Christer Björk.

"A slightly more sophisticated method is that documents are produced digitally and transferred digitally as email attachments. In terms of document management, this offers hardly any improvement over the current situation since finding a document in another person's computer may be even more difficult than on his shelves." (Björk, 2003)

In summary, he explains that even with the advancement of technology in document management, it is not enough to lessen the manual labour or errors created. Despite its obvious advantages, Technical Material Sheet (TMS) continuously face many problems during the production and final signing stages which lead to adverse effects impacting the whole process. This section of the report will be discussing the challenges faced in TMS as well as the negative ways it impacts the workflow and efficiency of the process.

1) Poor file management
    - The most concerning problems faced during the TMS process is poor file management. Hardcopy versions of the TMS cut sheets were not organized accordingly which resulted in confusions, missing files and time consumption. These cut sheet folders are placed on desks without notes indicating its current status. Figure 3.3.1 shows the TMS folders unorganized on several desks.
    - Moreover, softcopy files of cut sheets are stored away without a standardized format or in a manner which will make the files easier to retrieve.

- Each worker has his/her own way of organizing, managing and storing their softcopy or hardcopy files which causes hindrance to other workers when handing over TMS jobs to a different worker.
- The poor management system of these files will ultimately cause softcopy files to go missing, the latest files eventually getting mixed with older files and causing difficulties in retrieving back older catalogues and approval letters.

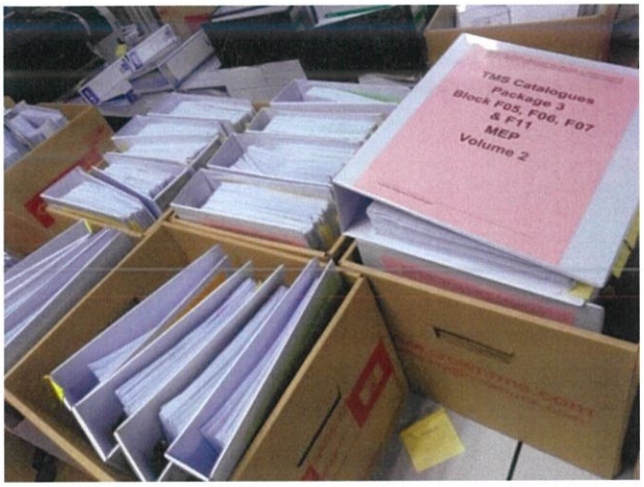


Figure 3.3.1: Unorganized folders of cut sheest

2) Insufficient human resources
   - Project Parcel F is a large-scale project with many blocks, floors and assets that will require a large number of human labours to produce the cut sheets for each item at a steady speed.
   - However, the BIM department for this project lacked sufficient human resource working on TMS. Without enough workers, large amounts of work are placed under a single person, causing an extended period of time for the tasks to finish.
   - Furthermore, the replacement of workers being done in the BIM department caused more problems since the new workers were inexperienced with the process of TMS and required more time.

3) Lack of cooperation from internal and external consultants

- Communication and cooperation is key to a successful flow of progress for any task. However, the lack of cooperation between consultants and TMS workers is the most visible problem faced in TMS.
- The main issues which I have observed are that consultants fail to communicate directly with TMS workers. This situation is evident when consultants do not explain thoroughly regarding his/her comments made to the reviewed cut sheets. Thus, more time will be wasted on amending and re-printing. It also causes many complications when TMS workers must amend the wrong cut sheets with little information given to them.
- Moreover, some consultants demand more items to be added into the TMS list rather than complying with the original item list. This causes a serious delay of submissions for the final signing from the client.

4) Ineffective methods and process for TMS
   - The process of TMS is straightforward and simple. Yet, the methods that are being used is not effective and has been proven time-consuming.
   - Once a cut sheet has errors to its data, the process of re-signing is needed which means internal and external consultants must be called back to the office site. In some circumstances, TMS workers must go to the consultant's office to get the cut sheets reviewed and signed if the consultants are unable to visit at the site office.
   - Many small errors can be overlooked, causing more cut sheets to be amended and reprinted. Thus, this requires more time due to re-printing and signatures that must be obtained from internal and external consultants.

3.4 Recommendations and solutions for TMS

1) Adopt good file management practices
    - In order to avoid missing softcopy or hardcopy files from going missing, a good folder structure is essential to maintain a well-organized system. For example, separate files into a different folder based on the document's current status such as 'Working', 'Archive' and 'Final'. This method helps users to navigate through the various folders easily.
    - Any type of method being used must be followed by the whole team. Once the whole team uses a standardized method of storing files, it will be easier to share files among other co-workers
    - Naming the files is also an important method. Keeping the file name simple, straightforward and short, will help to avoid confusions and duplicate files. Moreover, adding dates can keep the files updated of current status.

2) Hire more human resources for TMS
    - The workload for TMS can be overwhelming, especially for a large-scale project with many blocks, floors and items. Thus, recruiting more people to equally divide the work can prove to be necessary in order to avoid delayed submissions or human errors. Regular workers with little experience can also be useful for manual labour work such as scanning and sorting which is a straightforward job.
    - By increasing human labour, high levels of efficiency and quality of the TMS can be maintained throughout the whole process.

3) Good planning and finding effective methods
    - The methodologies of TMS can be tedious and slow. So, finding other means that can speed up the process is encouraged. For example, creating personal tables which indicate the current status of work and the upcoming task can help workers to stay focus on a job while still being reminded of less important jobs. Figure 3.3.1 shows an example of an overall summary of TMS Interior Design and Furniture which shows the stages of signing

process that needs to be completed within a week. This method especially helps when a deadline for TMS submissions is near.

- Creating a master list is also an advantage when keeping track of registered items for TMS in order to avoid cut sheets from being left out which can cause major drawbacks from the progress. Picture 3.3.2 shows an example of a master list created for Interior Design and Furniture (IDF).

SUNWAY CONSTRUCTION

The Proposed Design Contruction and Completion of Government Office Buildings Consisting of Office Towers, Podium Parking, and External Works at Parcel F, Precint 1, Pusat Pentadbiran Kerajaan Persekutuaan, Putrajaya (Parcel F)
Tittle: Master List of TMS IDF Block F11

No.	File Name	Description	Remark
	3.01 System Chair		
1	IDF 3.01 F11 Office Chair - C9	OFFICE CHAIR - C9	
2	IDF 3.01 F11 Office Chair C3 (TYPE A) JP JUSA ABC	OFFICE CHAIR - C3 (TYPE A)	
3	IDF 3.01 F11 Office Chair C3 (TYPE B) JP Bilik Mesyuarat JUSA ABC	OFFICE CHAIR - C3 (TYPE B)	
4	IDF 3.01 F11 Office Chair C3a	OFFICE CHAIR - C3a	
5	IDF 3.01 F11 Office Chair C4 JP Bilik Gred 54 & Bilik Gred 48-52	OFFICE CHAIR - C4	
6	IDF 3.01 F11 Office Chair C4a (TYPE A) JP PA JUSA ABC	OFFICE CHAIR - C4a (TYPE A)	
7	IDF 3.01 F11 Office Chair C4a (TYPE B) JP Ruang Tamu Menunggu Typical	OFFICE CHAIR - C4a (TYPE B)	
8	IDF 3.01 F11 Office Chair C4a (TYPE C) JP Ruang Pejabat	OFFICE CHAIR - C4a (TYPE C)	
9	IDF 3.01 F11 Office Chair C4a (TYPE D) JP Maintainance Office	OFFICE CHAIR - C4a (TYPE D)	
10	IDF 3.01 F11 Office Chair C5 JP Bilik Mesyuarat Bahagian & Sektor	OFFICE CHAIR - C5	
11	IDF 3.01 F11 Office Chair C5a (TYPE A) JP Bilik Cetakan Umum & Bilik Komputer	OFFICE CHAIR - C5a (TYPE A)	
12	IDF 3.01 F11 Office Chair C5a (TYPE B) JP Podium 1 & Maintainance Office	OFFICE CHAIR - C5a (TYPE B)	

Figure 3.3.2: Master list of TMS items for IDF

TMS PART 02 OF IDF (OVERALL SUMMARY) **AS OF: 30 SEPTEMBER 2019**

BLOCK	SIGNED/ REVIEWED BY EXTERNAL	AMMENDING CUTSHEETS	RE-SIGNED BY INTERNAL	RE-SIGNED BY EXTERNAL	REMARKS
F1					Ammending sheets before passing to external (missing pictures)
F2	COMPLETED (26/9/19)				
F3	COMPLETED (26/9/19)				
F5	COMPLETED (25/9/10)	COMPLETED	COMPLETED (26/9/19)		
F6	COMPLETED (25/9/10)	COMPLETED			Puan Fazdlinda currently holding ammended sheets to be signed
F7	COMPLETED (25/9/10)	COMPLETED			Puan Fazdlinda currently holding ammended sheets to be signed
F8	COMPLETED (27/9/10)				
F9	COMPLETED (26/9/19)	COMPLETED			
F10	COMPLETED (27/9/10)				
F11	COMPLETED (25/9/10)	COMPLETED			Puan Fazdlinda currently holding ammended sheets to be signed

Figure 3.3.3: Table of overall summary progress for TMS

4) Create good communication with team members and consultants

- Successful outcomes of a group task stem from good communication among co-workers and consultants. It is especially important in an environment which requires teamwork and dedication.
- Good communication with consultants must be maintained by asking them frequent questions and getting to know them in a friendly manner. Cut sheets with wrong data can be cleared quickly when the consultants are willing to explain the errors and give helpful information. Moreover, building a good relationship with consultants avoids the risk of creating conflict.
- Based on a research paper by RICS Cobra in London titled *"Assessment of Construction Project Managers Communication Skills in Project Success"*, there are many communication skills that regular employees and project managers must practice in the workplace such as conflict management, team building, decision-making, problem-solving, holding meetings, negotiating, etc.

CHAPTER 4.0

CONCLUSION

2.1 Conclusion

There is no doubt that Building Information Modelling (BIM) plays a massive role in the construction industry across the world and the integration of BIM into Facility Management (FM) has changed the ways of conventional data and document handling. Nevertheless, many construction companies in Malaysia refuse to adopt BIM into their projects despite the benefits. Some of these factors include the absence of BIM policy and compulsion. Since the adoption of BIM in Malaysia, there had been no standard guideline being launched from Malaysian government due to poor education regarding BIM in the construction industry. Other factors such as poor holistic readiness, software integration competition strategy and reluctant to change among contractors and stakeholders. Thus, the construction industry in Malaysia should make BIM as a staple trend in order to improve the future of the country.

In terms of the case study conducted in government building Parcel F in Precinct 1, Putrajaya, the methods used were relatively new in the BIM department. The production of Technical Material Sheet (TMS) using BIM methods has never been applied to any other project in Sunway Construction Sdn Bhd. By using new tools and software such as RioTech, a software which helps TMS workers to view the site without having to go there in person.

TMS certainly helps to maintain the sustainability, refurbishment and maintenance of a building which is a long term benefit for both contractors and its occupants. It avoids the hassle of extracting an item's data using a mapping system provided by BIM while also safeguarding the information for the client's future use. In summary, the integration of BIM into TMS is a step forward towards a more modern way of document and information management in a project and will hopefully be adopted by the construction company as a whole.

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