ATENEO DE MANILA UNIVERSITY
GRADUATE SCHOOL OF BUSINESS
ATENEO STUDENT BUSINESS REVIEW VOL.8 NO.2

TECHNE 11

MANAGING THROUGH NUMBERS

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Message from the Dean

How the business world met, and continues to meet, the challenges brought by the pandemic has become a rich source of learning for faculty and students in the Ateneo Graduate School of Business. This special double issue of Techne, published by the Department of Operations and Information Technology, showcases eleven such stories filled with insights into the application of math and science to address different challenges in the still-ongoing public health crisis.

In this way, Techne continues a strong tradition of research derived from practice, and developed by faculty and students as an organic result of their classes. This issue also shows the diversity of these applications, from health care to consumer goods manufacturing to logistics to sustainability projects.

To the faculty and students who conducted and wrote up the research that made this special double issue of Techne possible, my sincere congratulations and thanks on behalf of the community.

To readers, I am sure that you will gain an appreciation for their work and the research objective that Techne represents: the view of the world of business and management from the lens of a scientist-practitioner.

Jowett Cecilio F. Magsaysay, MBA, PhD
Dean
Ateneo Graduate School of Business

Message from the

Operations and IT Department Head

Congratulations to our Management Science and Operations Management MBA students for their excellent articles featured in our Techne 10 & 11 journals.

Techne 10 is expectedly all about what most people in the world read and talk about – the Covid 19 pandemic. I am truly amazed that our students are able to contribute through their projects in our country's fight against this formidable virus.

Included in this edition are a testing facility, an isolation center, an improved vaccination procedure mobile phone application, and even articles touching on a shuttle service to bring employees to work as well as a quick service restaurant.

As always, our goal is to equip our managers and professionals the basic information they would need to remain relevant and competitive in this business world, no matter how challenging or difficult.

Techne 11, on the other hand, dwells on operations type of problems. The reader gets a glimpse of how a paper recycling plant, a wastewater treatment facility, and several manufacturing firms can use management science techniques to improve their businesses and contribute to nation building.

I do believe our readers will enjoy and learn from reading these articles for information and practical use.

As always, I congratulate and thank the members of our Department of Operations and IT (DOIT) faculty for their untiring efforts in guiding and molding our students to be Men and Women for Others by formulating practical and timely projects.

Ad Majorem Dei Gloriam.

Ralph A. Ante, MBA
Head, Department of Operations and IT
Ateneo Graduate School of Business

Message from the Editor

We have put together another double issue of Techne. Since it was developed during the COVID-19 pandemic, it was deemed fitting to dedicate one whole issue (Techne 10) to creating systems and apps that address challenges brought by this health crisis.

Thus, we are excited to bring you the following innovations:

- Building a testing facility for COVID-19 diagnosis
- Installing shuttle system for moving groups of employees from home to office
- Building an optimal COVID-19 isolation center
- Developing an app that will manage the integrated vaccination process
- Designing quick-serve restaurant automation to be operated through AI

On the other hand, we cannot digress much from our original purpose of providing math-based solutions for operations-type problems. Thus for Techne 11, we have applied Operations Management and Quantitative Method tools to analyze the issues faced by:

- A paper recycling outfit
- A company delivering aerospace galleys
- A wastewater treatment facility
- A lift truck supplier
- A home appliance manufacturer

We hope you will find equal fulfillment in drawing insights from these examples.

Ed Legaspi
Editor
Techne: Managing through Numbers
Ateneo Graduate School of Business

The Wastepaper Recycler

Charity Baldemor
Rochelle de la Cruz
Francis Jerome de Lara
Cristine Galang
Jomar Pineda
Jasmin Suarez

FIBERCYCLE INC. (FI), a company pseudonym, is currently the leading paper manufacturer across the Philippines, providing the newsprint requirements of major local newspapers, both broadsheets and tabloids. It is also a chief supplier for local converters marketing school pads, notebooks, and office paper supplies. It manufactures its products by utilizing 100% recycled raw materials.

FI established its presence and ensured the development of other businesses to support its core enterprise, as shown in Figure 1.

FI is currently constrained by the availability of their most critical supply item, wastepaper, which vitally comprises 60% of their raw material costs. Local suppliers in the Philippines are no longer able to fulfill the required volume of the Firm to manufacture the projected quantities of finished goods to provide to customers.

Left unresolved, this exposes them to potential:

1. Revenue losses,
2. Market share deterioration,
3. Customer dissatisfaction,
4. Underutilization of (a) assets, (b) sunk capital costs (production equipment, transportation, warehouses, factories, etc.), and (c) Operating Expenses (utilities, salaries, etc.),
5. Job losses for personnel.

Given the substantial impact of this situation, FI needs to identify international supplier(s) of wastepaper to fill the volume gap that current local suppliers cannot meet in a way that:

1. Utilizes as many systematic, methodological, and sound Supply Chain Management frameworks, tools, and concepts as possible.
2. Conforms to the Corporate Policy of having three suppliers, at least, for their most critical supply items.
3. Suitably balances the various risks/costs vs. benefits/gains related to this decision.

In doing so, their standing as the country's leading player in the industry is sustained.

Limitations of the Study and Methodology

The paper is based on information from FI and other reputable sources. The study was conducted in 2019 and did not include data and

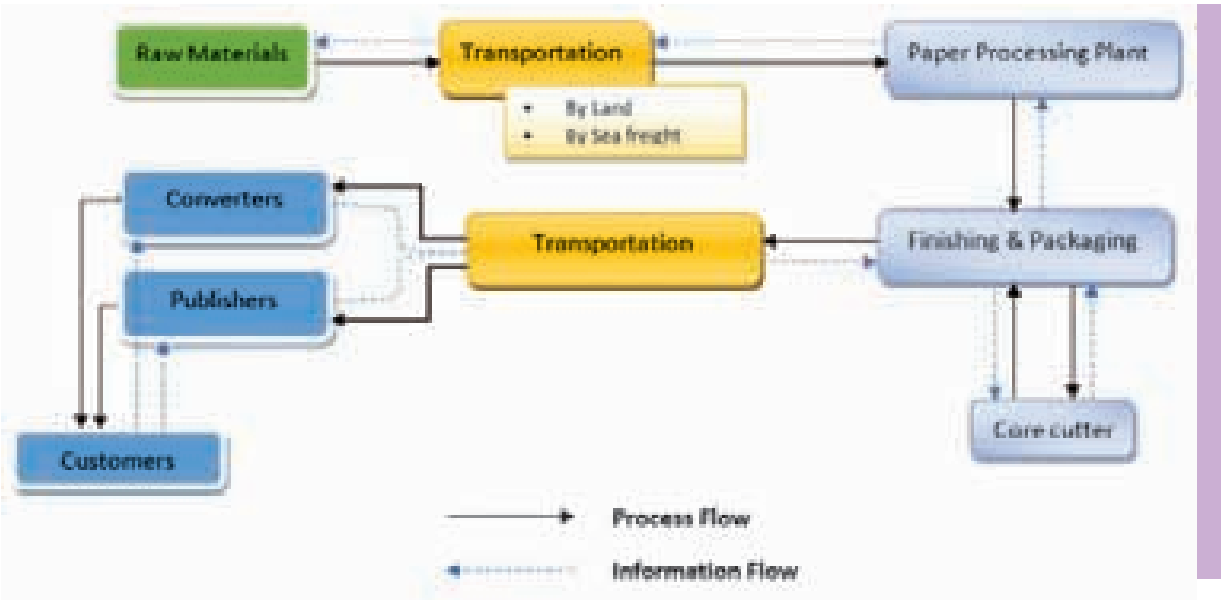


Figure 1. Process/Information Flow

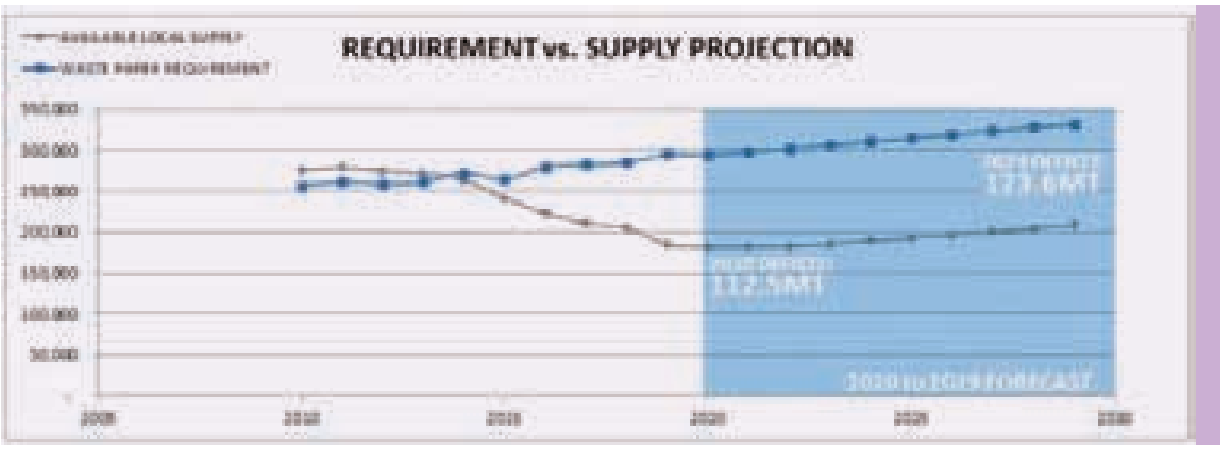


Figure 2. Requirement vs. Supply Projection

circumstances beyond that timeframe.

The following Supply Chain Management Frameworks were utilized in the analyses:

1. The Supplier Perception Model (SPM) was used as the primary tool to evaluate each possible vendor's capability and motivation to identify international wastepaper suppliers for FI. For Capability, six appraisal criteria that were agreed upon with FI were assessed. (See Table 2). For Motivation, two components, also discussed with the Firm, were gauged:
   a. *Level of Attractiveness* – Was evaluated using the Supplier's Performance Evaluation (SPE) tool. This demonstrates how attractive FI is as a client to each possible supplier as a determinant of how viable the relationship will be for both parties.
   b. *Value of Business* – Linear Regression was used to forecast the 10-year supply gap in comparing FI requirement vs. Excess Capacity in Appendix 6
2. The POCKET Framework was used to evaluate external factors (Political/Legal/Socio-Cultural, Outbound Logistics, Competition, Key Inputs to the Supply Market, Economic/Infrastructure, and Technology) and ensure these are appropriately incorporated in the analyses as well.

Analysis

Forecasting (Linear Regression)

Linear regression is used to forecast the 10-year requirement (2020 - 2029) of wastepaper. The forecasted value is compared to the projected available local supply (in metric tons or MT) of wastepaper. The difference between the two is the supply gap of the needed raw material.

The scatter plot in Figure 2 shows that starting 2014, the available local supply of wastepaper was not enough to meet FI's requirement for paper production. Using linear regression, the authors forecasted that FI must import 112.5MT of wastepaper in 2020. Should FI decide to have a long-term agreement (e.g., ten years) with the selected foreign supplier, it must have the ability to supply as much as 123.6MT of wastepaper to the Company. Appendix 2 and Appendix 3 show the full details behind the computations and analyses.

Suppliers' Performance Evaluation (SPE)

To close the supply gaps from 2014 to 2019 (See Appendix 3), FI sourced wastepaper supply

from one seller from Japan, Indonesia, Australia, Canada, and the Netherlands. A Suppliers' Performance Evaluation (SPE) was prepared[4] to assess key interaction dimensions these foreign suppliers have had with FI over the years. The SPE is divided into three major categories: Quality, Delivery, and Business Agreement. These are further subdivided into more granular elements. Lastly, the corresponding percentage allocations are based on FI's strategic priorities.

Table 1. Summary of Findings

	Supplier	Rating
1	Netherlands	Outstanding
2	Japan	Above Satisfactory
3	Indonesia	Above Satisfactory
4	Canada	Satisfactory
5	Australia	Needs Improvement

On Quality (45%):

» Conformance to Specifications – Quality of wastepaper, 100% of the time.

» Issue Resolution – Timeliness and effectiveness of settling any quality issues.

» Impact on Operational Performance– How quality of supply affects FI's overall operational performance.

» Responsiveness – How promptly and how adequately suppliers respond to FI's queries.

On Delivery (35%):

» Delivery on Time– Timeliness of delivery.

» Incoterms– Flexibility of agreeing to FI's requested Incoterms, which vary in response to various external and internal reasons (e.g., currency fluctuations, political climates, changes in volume, etc.)

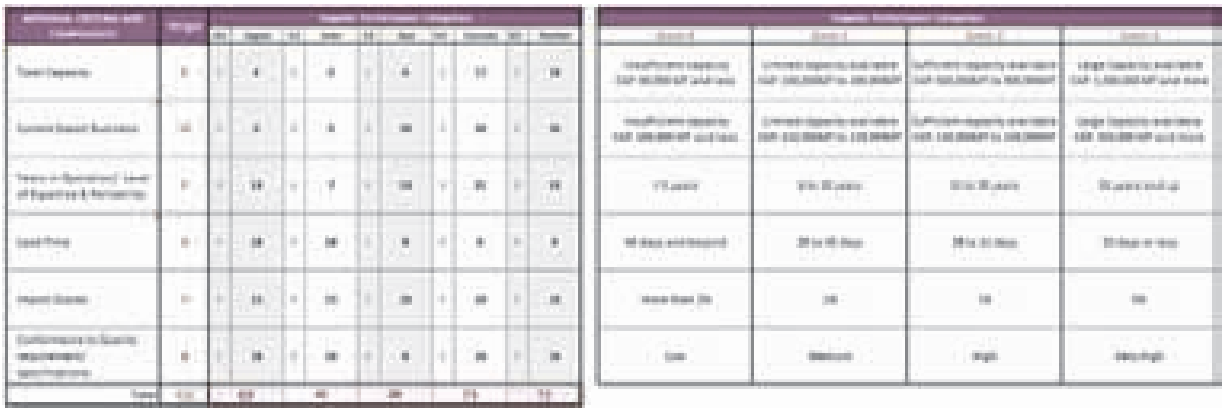
On Business Agreement (20%):

» Environmental Compliance– 100% of delivered supply is waste material.

» Payment Terms– Flexibility of agreeing to FI's requested payment terms, which can change due to factors like Changes in nature of relationship with the Supplier, Working Capital availability, etc.

» Inventory Management– Availability of supply in cases of ad-hoc or spot requests.[5]

Table 2. Supplier Perception Model – Capability Criteria



4 The writers of this paper revised FI's existing SPE to align more closely with best practice guidelines in Supply Chain Management.

5 Impromptu requests like these are an accepted occurrence across the industry.

Results:

Based on these factors, the summary of findings is presented in Table 1.

Supplier Perception Model (SPM)

The authors used the Supplier Perception Model (SPM) to narrow down the number of suppliers further. Using this tool, suppliers were assessed in terms of Capability in handling FI's requirements and Motivation in developing potential partnerships, and/or providing continuous supply over the long run.

On Capability, six criteria were used to evaluate the capability of each foreign supplier to meet FI's requirements. Each criterion was given a respective weight corresponding to FI's strategic priorities. The three heaviest weights were given to:

1. Current Business Export - FI aims to limit its wastepaper suppliers to two to three countries, at least, that can cater to their forecasted ten-year deficit.
2. Conformance to Quality Requirements/ Specifications (congruent to SPE-Quality) – Reflects the Company's commitment to excellence.
3. Lead Time (congruent to SPE-Delivery) - Reflects the Company's commitment to efficiency.

Therefore, in terms of Capability to meet FI's needs, the evaluation presented in Table 2 shows Canada, The Netherlands, and Japan leading the pack amongst the potential foreign suppliers. Canada and Netherlands - first and second place, respectively - have the largest available quantity for business exports (in MT). Despite being one of the lowest in terms of quantity for business export, Japan has an edge in terms of lead time due to its proximity to the Philippines.

On Motivation, this portion of the model is divided into Level of Attractiveness and Value of the Business. Each provides a distinct, critical perspective in assessing the supplier's motivation in doing business and developing relationships with FI.

1. The authors based level of Attractiveness (See Appendix 6 for details) on the Suppliers Performance Evaluation (SPE). Referring to Appendix 4, 'Outstanding' is rated H, 'Above Satisfactory' is rated M, and so on. The rationale behind using SPE to assess FI's attractiveness to foreign suppliers is the assumption that if the said overseas providers scored high in SPE, they have historically established an excellent relationship with FI.
2. Value of Business (See Appendix 7 for details) is computed by dividing excess capacity for export by the total requirement of FI forecasted over ten years. Japan, Indonesia, and Australia have less quantity (in MT) for export than FI's forecasted demand, resulting in a more than 100% ratio. This puts these countries in the highest tier with the implication that FI, if it decides to partner with them, can get all their wastepaper supply. Thus, the value of FI to their business is high.

Thus, for Motivation, Japan, Indonesia, and The Netherlands topped the list. The Motivation Chart illustrates this (see Appendix 8) which integrates the two motivational aspects discussed.

While Capability is crucial in selection, Motivation is a similarly imperative consideration. It demonstrates the supplier's commitment to meet - if not, exceed - FI's needs. It also indicates the degree of effort a supplier is willing to invest in building and reinforcing the business relationship. In choosing a supplier that FI can strategically partner with for its most crucial resource need, it is best to use proven, systematic, scientific tools. This will determine the right balance between the two characteristics. The SPM analysis in Figure 3 shows that the supplier from Japan and The Netherlands are both leading in Capability and Motivation.

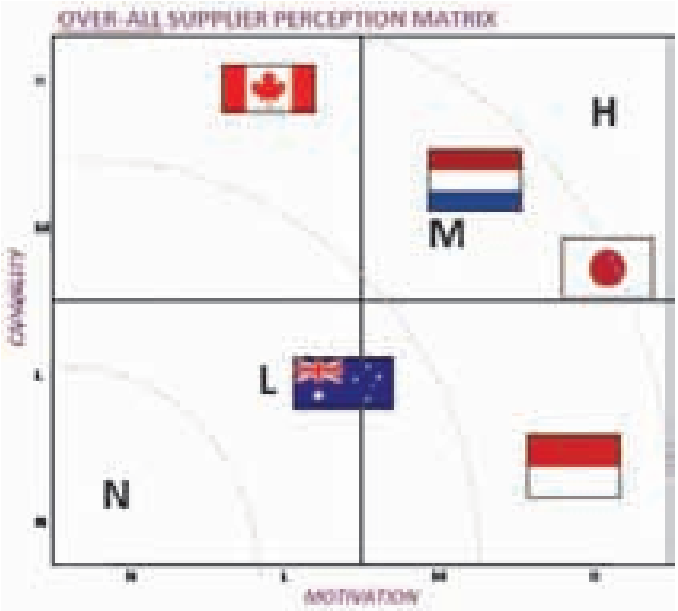


Figure 3. Overall Supplier Perception Matrix

Political/Legal/Socio-cultural, Outbound Logistics, Competition, Key Inputs to the Supply Market, Economic/Infrastructure factors, Technology factors (POCKET) Evaluation

Beyond SPE and SPM, other contextual dimensions need to be assessed to determine the final list of recommended suppliers for FI. Since FI is forced to find international suppliers, the geographic dimensions are critical. The POCKET framework is ideal for outlining these diverse but equally impactful considerations.

In summary, the two primary suppliers that topped this analysis are from Canada and Indonesia (for full details, see Appendix 9). Figure 4 highlights the key reasons Indonesia's supplier was the more attractive of the two.

Recommendation

Incorporating Company Policy, Suppliers' Performance Evaluation (SPE) results, Supplier Perception Model (SPM) output, and POCKET analysis, the authors recommend for FI the supplier mix presented in Table 3 [6].

Japan has the highest allocation (40%) since it has been a reliable supplier with consistent quality compliance. It also has the highest motivation and capacity factors among the five foreign supplier options and probably would be top in terms of supplier commitment. Providing good quality wastepaper consistently results in high production efficiencies and improved operating performance, greatly benefiting the paper manufacturing operations. Japan suppliers may also be likely to give excellent and value-added service, as it considers FI as its core business. It has good motivation to keep the business running smoothly and will unlikely attempt to exploit it unfairly. A fixed contract business relationship is recommended with this supplier as securing the volume and quality, and mitigating cost variations are important.

The Netherlands has the second-highest allocation of 35%. This supplier may consider FI to have small business value now. However, over time, there is a positive future business potential which can result in a win-win situation for both companies. While motivation is medium, this source has the highest capability, which is very attractive for FI to consider as its long-time partner. With limited local wastepaper availability causing price war among local paper manufacturing firms, the need to establish alternative sources from foreign countries is imperative. Given the opportunity, the Netherlands may find the demand from the

6 Though pricing was considered in Appendix 5, this is only a secondary factor in the wastepaper industry because market selling prices for wastepaper are globally "standardized" and are not significantly changed due to geographical location or distance. On the other hand, shipping costs are factored into the analyses through the SPM framework (import duties) and SPE tool (incoterms).

Figure 4. Reasons for Attractiveness

Table 3. Recommended Supplier Mix

Supplier	Sum	Relationship	Mitigation Strategies	Remarks
Japan ($1)	40%	Fixed Contract	Using Fixed Contract necessitates excellent negotiation skills to lock in a price that is viable over the agreement duration.	Since Japan quality is consistent and reliable, a fixed volume per month on an annual basis can be arranged with pricing set every quarter to allow for market fluctuations.
The Netherlands ($5)	35%	Regular Trading	Outstanding procurement skills needed in planning. Employ preemptive coordination methods with Sales and Production teams.	Regular monthly allocation with agreed quality and quantities. Can later transition to fixed contract with potential volume increase.
Indonesia ($3)	25%	Regular Trading	Keep initial allocation low as contingency against risks. Leverage for ad-hoc purchases.	Regular monthly allocation with agreements on quality and quantities.

Philippines attractive with the growing population and increasing percentage in paper products consumption per capita. It is recommended that 35% of FI's imported wastepaper volume be allocated to the Netherlands supplier. It can start with regular monthly ordering and can later move to fixed contracting for regularity of volume and reduce volatility in price. To mitigate the risk in ocean freight costs, FI can also arrange a monthly container space allocation to a specific shipping line calling from Amsterdam port to any Philippine ports. This way, FI can somehow control the cost while securing its much-needed raw materials.

Indonesia will take up 25% of the imported wastepaper allocation. It is an important source that must be established as it has good advantages, especially its proximity to the Philippines with a shorter shipping lead time. It might have lower capability than Japan and the Netherlands, but it has comparative motivation with the supplier in Japan. There is potential that this supplier will improve its capacity and operations in the future. Allocating the majority of the imported wastepaper supply from sources near the Philippines will also help with the inventory management of FI, with its relatively shorter lead time. This allows for sudden changes in sales and market demand and lesser risk of shipment delays which can abrupt the production and ultimately penalize the Company.

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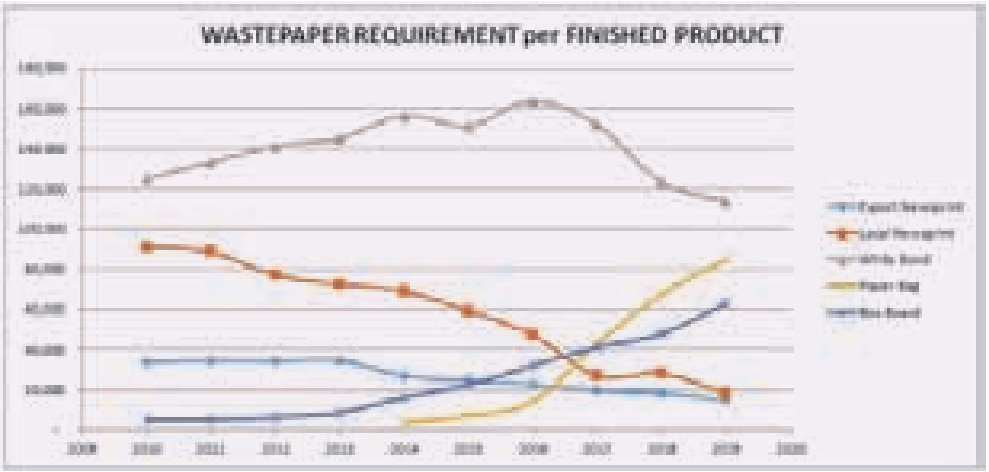
Appendices

Appendix 1. Wastepaper Requirement Per Finished Product

WASTEPAPER REQUIREMENT (in MT)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Export Newsprint	32,017	34,775	34,359	34,872	26,838	24,268	22,402	19,635	18,204	14,850
Local Newsprint	91,269	88,593	77,008	72,855	68,070	59,279	47,078	36,817	26,097	18,264
White Bond	129,248	133,294	141,181	143,268	136,409	131,691	143,741	151,608	125,241	113,570
Paper Bag	-	-	-	-	3,618	6,964	14,836	42,963	67,476	64,325
Box Board	5,014	5,172	6,155	8,345	16,133	22,453	35,381	45,203	41,790	62,948



Appendix 2. Linear Regression Result: Paper Usage vs. Wastepaper Requirement (2010 To 2019)

MS Excel Result:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.94703929
R Square	0.89688342
Adjusted R Square	0.88399385
Standard Error	4475.48247
Observations	10

ANOVA

	df	SS	MS	F	Significance F
Regression	1	1393725407	1393725407	69.5820942	3.22791E-05
Residual	8	160239547	20029943.4		
Total	9	1553964954			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	25382.938	29535.66391	0.85939961	0.41512834	-42726.4251	93492.3011	-42726.425	93492.3011
Paper Consumption per Capita	0.18795786	0.022552623	8.34158823	3.2279E-05	0.135997541	0.23991818	0.13599754	0.23991818

RESIDUAL OUTPUT

Observation	Predicted Y	Residuals
1	252954.104	2406.495688
2	257080.362	4745.576427
3	261202.71	-2445.951348
4	265321.393	-4161.037912
5	269435.678	2517.122552
6	273545.565	-8837.552583
7	277652.031	1666.734128
8	281753.365	539.0418194
9	285851.523	-931.2027525
10	289946.016	4500.775982

Scatter Plot:

Model Analysis:

a. R^2 ≥ 0.75
   0.90 ≥ 0.75
   Therefore: **GOOD MODEL**

b. -0.5 < r^2 < 0.75 (use AnOVa)
   Sig F ≤ 0.05
   NOTE: *Not Applicable*

c. Use T-Test: abs(tsat) > 2
   8.34 ≥ 2
   Therefore: **Paper Consumption is RELEVANT**

Linear Regression Model:

y=a+bx

y=25382.94+0.188 x *Paper Consumption*

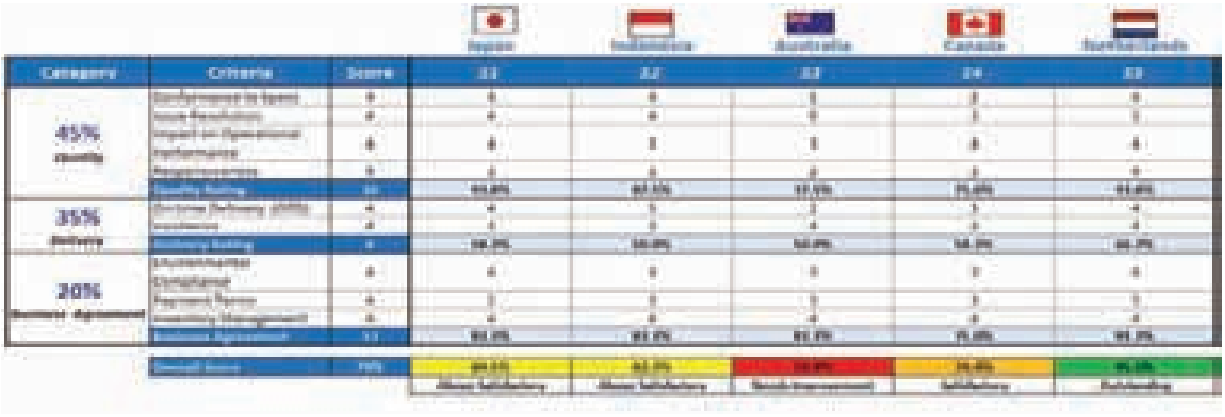
Appendix 3. Forecasted Values

YEAR	AVAILABLE LOCAL SUPPLY (MT)	PHILIPPINE POPULATION	PAPER USAGE (MT)	WASTE PAPER REQUIREMENT (MT)	EXCESS (DEFICIT)
2010	275,789	93,135,100	1,210,756	255,361	20,429
2011	278,648	94,823,800	1,232,709	261,826	16,822
2012	274,854	96,510,900	1,254,642	258,757	16,098
2013	271,871	98,196,500	1,276,555	261,160	10,710
2014	263,601	99,880,300	1,298,444	271,953	(8,352)
2015	241,414	101,562,300	1,320,310	264,708	(23,294)
2016	223,056	103,242,900	1,342,158	279,319	(56,262)
2017	211,363	104,921,400	1,363,978	282,292	(70,929)
2018	205,099	106,598,600	1,385,782	284,920	(79,821)
2019	185,258	108,274,300	1,407,566	294,447	(109,188)
2020	181,450	109,898,415	1,428,679	293,914	(112,464)
2021	182,104	111,546,891	1,450,110	297,942	(115,838)
2022	182,718	113,220,094	1,471,861	302,031	(119,313)
2023	185,674	114,918,395	1,493,939	306,181	(120,506)
2024	189,284	116,642,171	1,516,348	310,393	(121,109)
2025	192,953	118,391,804	1,539,091	314,668	(121,714)
2026	196,684	120,167,681	1,562,180	319,007	(122,323)
2027	200,721	121,970,196	1,585,613	323,411	(122,690)
2028	204,701	123,799,749	1,609,397	327,882	(123,181)
2029	208,899	125,656,745	1,633,538	332,419	(123,520)

Items:

- Available Local Supply [4]
- Philippine Population[5]
- Paper Usage [6]
- Wastepaper Requirement[7]
- Excess (Deficit) [8]

Appendix 4. Supplier's Performance Evaluation



Category	Criteria	Score	Japan	Indonesia	Australia	Canada	Netherlands
45% Quality	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Quality Rating	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
35% Delivery	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Delivery Rating	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20% Business Agreement	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Business Agreement	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Overall Score	[illegible]	[illegible] Above Satisfactory	[illegible] Above Satisfactory	[illegible] Needs Improvement	[illegible] Satisfactory	[illegible] Outstanding

PERFORMANCE	SCORE	MEANING
O - Outstanding	95 - 100	Supplier Performance is considered "Outstanding" when they exceed FI's performance expectations.
AS - Above Satisfactory	80 - 94.9	Supplier Performance is considered "Very Satisfactory" when they meet FI's performance expectations.
S - Satisfactory	75 - 79.9	Supplier Performance is considered "Satisfactory" when they meet FI's performance expectations.
N - Needs Improvement	Below 75	Supplier Performance is considered "Needs Improvement" when their performance is below FI's performance expectations. Also, Supplier Performance received a "Needs Improvement" rating when the rate of Score in Quality or the rate of Score in Delivery is below 75.

4 FI projection of available local supply based from the Philippine recovery rate of 49.9% (RISI World Pulp and Recovered Paper Forecast)

5 TABLE 1.9 Projected Population by Age Group and by Sex: 2010 to 2020 Medium Assumption; Philippine Statistics Authority Yearbook (2010 to 2020). To project population from 2021 to 2029, annual growth of 1.5% is assumed.

6 Based on CFP's data, paper consumption per capita is 13kg. This column is computed by multiplying 13kg/capita to the projected population then converting kg to MT (metric tons).

7 Waste paper requirements from 2010 to 2019 are actual data of FI. Waste paper requirements from 2020 to 2029 are forecasted values using linear regression. (See Appendix 2 for analysis).

8 Difference of Available Local Supply and Wastepaper requirement

Appendix 5. Supplier's Performance Evaluation

SUPPLIER	ORIGIN	ANNUAL CAPACITY (MT)	CURRENT EXPORT VOLUME (MT)	YEARS IN OPERATION	LEAD TIME (Days) (INCL. SHIPPING)	IMPORT DUTIES	REMARKS
S1	Japan	120,000	55,000	15	21	0%	Price is typically higher due to competition and proximity to China. This supplier confirmed that they can still support our demand for paper raw material up to 40% increase based on the current consumption. They are also willing to add machines and hire more manpower if the demand will continue to increase in the next few years
S2	Indonesia	80,000	25,000	8	14	0%	Price is typically higher due to competition in the Indonesian market. Shortest lead time
S3	Australia	250,000	180,000	20	35	7%	Competitive price but usually encounters quality concerns
S4	Canada	500,000	350,000	25	49	1%	Relatively lower price due to higher collection rate/capacity but government has no clear regulation on waster exports
S5	Netherlands	1,200,000	850,000	20	60 days	1%	Material itself is cheap but price volatility is caused by moving ocean freight rates. Even with volatile ocean freight though, CNF price is still lower than other Asian sources. Vessles pass thru transshipment points (causing even longer leadtime)

Appendix 6. Supplier's Perception Model (SPM) – Motivation – Level of Attractiveness

FIBER CYCLE INC.'s REQUIREMENT vs. SUPPLIER's EXCESS CAPACITY (for export)

FI REQ: 124,000

SUPPLIER	ORIGIN	ANNUAL CAPACITY (MT)	CURRENT EXPORT VOL (MT)	VOLUME SUPPLIED TO TIPCO (MT)	EXCESS CAPACITY FOR EXPORT (MT)	FI REQ vs. EXCESS CAPACITY (%)	RATING (H,M,L)
S1	Japan	120,000	55,000	8,000	57,000	218%	H
S2	Indonesia	80,000	25,000	1,000	54,000	230%	H
S3	Australia	250,000	180,000	20,000	50,000	248%	H
S4	Canada	500,000	350,000	12,000	138,000	90%	M
S5	Netherlands	1,200,000	850,000	12,000	338,000	37%	L

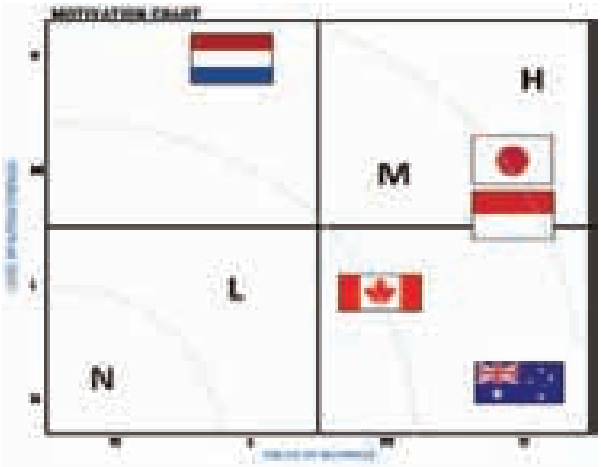
CRITERIA:
H = 92% and up
M = 50 to 90%
L = 30% to 49%
N = 29% and less

Appendix 7. Supplier's Perception Model (SPM) – Motivation – Value of Business

ATTACTIVENESS OF FI TO SUPPLIERS BASED REFERRING To PAST BUSINESS TRANSACTIONS (SPE)

SUPPLIER	ORIGIN	PERFORMANCE	RATING
S1	Japan	Above Satisfactory	M
S2	Indonesia	Above Satisfactory	M
S3	Australia	Needs Improvement	N
S4	Canada	Satisfactory	L
S5	Netherlands	Outstanding	H

Appendix 8. Supplier's Perception Model (SPM) – Motivation – Motivation Chart



Appendix 9. Political/Legal/Socio-Cultural, Outbound Logistics, Competition, Key Inputs to The Supply Market, Economic/Infrastructure Factors, Technology Factors (Pocket) Evaluation

	Japan (S1)	Indonesia (S2)	Australia (S3)	Canada (S4)	The Netherlands (S5)
Political, Legal, Socio-cultural	• Very stable politics. • Hard-working, quality-focused. • Usual work week is 8am-6pm (M-F) → 5 extra hours productivity/wk. • English is not always top-priority.	• Extensive trade histories between many Philippine and Indonesian entities. • Similar cultures → Easier to conduct business. • Lack of legal certainty and clarity of rules.	• Transparency and accountability are standard practices. • Native English speakers. • Time zone is not too far despite being a different continent. • Workday starts before the Philippines → Get work done earlier. • 395 days to enforce a contract → Long. Risky.	• Less robust waste export regulations. → Less feasible economic and environmental sustainability. • Native English speakers. • In 2018, Canada was 6th on the Forbes' Best Countries for Business list (US = 17th). → Due to trade freedom, investor protection, low corruption, minimal red tape and low corporate tax rates.	• European Union's Best Country for Business. • English is commonly spoken. • Global outlook → Encourages foreign partnerships. • Culture of openness and tolerance for others.
Outbound Logistics	• 2nd closest to the Philippines → Shorter delivery time, lower costs. • Efficient logistics processes in all ports.	• Closest proximity → Better response to the impromptu purchases.	• Not too far from the Philippines. • Importing and exporting is bureaucratic → Six documents for export and seven for import → 9 days to export and 8 to import.	• Farthest from the Philippines → Needs the most lead time for orders. • Challenging to coordinate due to time zone gaps → Risk in efficiency loss for FIBERCYCLE INC. which starts working earlier.	• Longer lead time and cost variations on freight rates. • Proven international hub for Europe.
Competition	• China's consumption volume/supply requirement is massive; and consequently, they command market price. The increasingly restrictive environmental policies in China have led to the relocation of many paper manufacturing plants to Vietnam. • China and Vietnam are top competitors for securing Japan, Netherlands and Indonesia wastepaper suppliers.				

	Japan (S1)	Indonesia (S2)	Australia (S3)	Canada (S4)	The Netherlands (S5)
Key Inputs to Supply Market	• Paper consumption per capita is higher compared to other Asian countries at 242kg • There are still several Newspaper and book printing presses, as well as paper converters • Since Japan has a lot of manufacturing plants and is a significant exporter, most of the packaging materials are brought out of the country • Waste incineration in the country is allowed, so there are still a lot of plastics usage	• Paper consumption per capita is 32.6kg per capita so there is still future for paper industry in this country • Book production is still significant especially for specialty paper • Several assembly plants are investing in the country. These plants require parts from different regions that are carton boxes. • This results in more packaging materials coming into the country which will add up to the wastepaper supply packaged in.	• Paper consumption per capita is stable at 223kg per head • Paper consumption is decreasing, particularly Newspaper • Supermarkets are using brown packaging grades, but most consumers reuse their own grocery bags	• Paper consumption per capita is 250kg • Most processes and transactions are paperless • While waste segregation from the source is practiced. Materials recovery facilities combines all wastepaper contaminating the cleaner wastepaper, that can still be recycled, with curbside waste	• The Netherlands still produces significant number of wastepaper supply with 295kg per capita consumption • Most of the wastepaper supply comes from packaging grades
Technology	• Semi-automatic waste sorting. → Partial reliance on manpower → Susceptible to labor cost fluctuations and workforce dispute issues. • Other aspects of operations are technologically advanced and highly automated.	• Semi-automatic waste sorting. → Partial reliance on manpower → Susceptible to labor cost fluctuations and workforce dispute issues. • Country tends to be more manual in daily operations and business processes.	• Involved in cutting-edge research → Contributes over 4% of world research publications in 2017 despite having only 0.3% of the world's population.	• Thriving tech ecosystem → entrepreneurs, significant access to capital and international scope. → ex. Shopify and Slack →Start-ups in Canada →Now global leaders in their industries.	• Sophisticated and highly automated waste segregation facilities. → Auto-detection of metals and wires. → Low operational expenses = Low price. • One of the most prolific countries when it comes to electronic commerce and communications.


We turn these wastes...


to these final products
PRINTING AND WRITING PAPERS
NOTEBOOKS
NEWSPRINTS
PAPER BAGS
PACKAGING BOXES

Pilipinas Aerospace – Galley Operations

Melven Dimapilis
Ma. Raquel Mahinay
Georgie Moral
Rey Pagtabunan

Pilipinas Aerospace - Galley Operations is the sole supplier of galleys and trolley compartments for the A320, A330, and A380 aircraft. The galleys feature harmonized cabin aesthetics and high reliability. The galley design fully integrates into the aircraft, resulting in weight-efficient solutions.

Statement of the Problem

As the Covid-19 pandemic continues worldwide, many global aerospace companies are feeling the impact during this uncertain time. The Pilipinas Aerospace business and operations in the Philippines are not exempt. The two major business units—the galleys and advanced lavatories operations—experienced disruption, especially in producing and delivering finished products to its customers. The outbound logistics complexities and changes due to the pandemic resulted in delays in delivering interior products to customers. Refer to Table 1. The 58 days transit lead time pre-pandemic is no longer doable as the actual transit lead time has increased to 72 days, an additional 14 days from the previous transit time. This means that Pilipinas Aerospace will not be able to meet when the customer needs the parts. For example, from October 18, the committed date of delivery was moved to November 1. This delay in delivery will impact the company financially.

Table 1. Pilipinas Aerospace Order Book

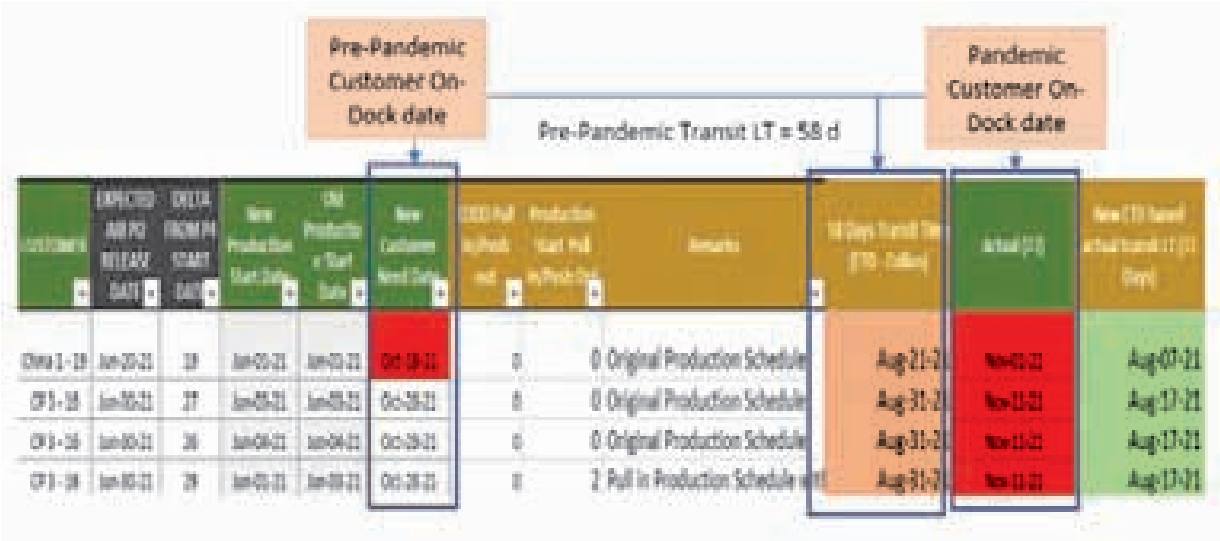


Table 2. Late Delivery Penalty

Expected Penalty (In K$) ($16K per day of delay)					
Production Change	JUL	AUG	SEP	OCT	Grand Total
Pull in Production Schedule within 7 Days	11	9	5	9	34
Pull in the Production Schedule 2 to 4 Weeks	21	14	3	5	43
Pulled in Galleys	32	23	8	14	77
Late Delivery Penalty ($16K per Day) 7 days delay	$ 3,584	$ 2,576	$ 896	$ 1,568	$ 8,624

Table 3. Air Shipment Costing

Galley	Min (in k$)	Max (in K$)	Average Cost in K$
Small	$ 8.0	$ 10.0	$ 9.0
Medium	$ 10.0	$ 14.0	$ 12.0
Large	$ 12.0	$ 16.0	$ 14.0
Average	$ 10.0	$ 13.3	$ 11.7

Table 4. Shipment Delta: Air vs, Sea

Additional Freight Cost (in K$) From Sea Shipment to Air Shipment					
Production Change	JUL	AUG	SEP	OCT	Grand Total
Pull in Production Schedule within 7 Days	11	9	5	9	34
Pull in the Production Schedule 2 to 4 Weeks	21	14	3	5	43
Pulled in Galleys	32	23	8	14	77
Average Air Shipment Cost per Galley	$ 11.7	$ 11.7	$ 11.7	$ 11.7	$ 11.7
Average sea shipment cost per galley (10K per container) for 5 galleys	$ 2	$ 2	$ 2	$ 2	$ 2
Freight Cost Delta from Sea to Air	$ 9.67	$ 9.67	$ 9.67	$ 9.67	$ 9.67
Total Freight Cost Risk	$ 309.3	$ 222.3	$ 77.3	$ 135.3	$ 744.3

Financial Risk Due to Delivery Delays

The agreed incoterms of Pilipinas Aerospace with its customers are Door to Door (DDP) which means all the risks are with the company. Missing the On-Dock-Date of the customer will cost the company a $16K penalty for every missed delivery day. Seventy-seven galleys must be shipped until October, as shown on the left table. Refer to Table 2. If all these 77 galleys are delayed, Pilipinas Aerospace will pay an estimated $8.6 million as a penalty based on the contract agreement.

One way to mitigate the risk of paying an $8.6 million penalty due to delayed shipment is to ship the finished goods by air. However, this is not advisable as it increases the shipment cost five times from its current shipping cost, though still lower than the penalty cost.

The standard shipment is by sea. The shipment cost is $10k per container. One container contains five galleys which result in $2k per galley. A shipment can be expedited by air with the three types of galleys produced by Pilipinas Aerospace (Small, Medium, and Large). Table 3 shows costs for different types of shipments. The average Air Shipment cost per galley is $11.7K.

As shown in Table 4, delayed shipment caused by the additional 14-day transit time may trigger the need for an air shipment. The company may have to shoulder a massive amount if no actions are done to mitigate the issue.

Objectives

With the understanding that the subsequent shipments will be delayed because of the additional 14-day transit time, an estimated $8.6 million penalty cost will be applied to the 77

galleys scheduled to be received by the customer in October. The objective of this study aims to:

1. Provide strategies for mitigating the risk of delayed shipment to customers.
2. Avoid costs due to delayed shipment and additional costs due to expedited air shipments.

Understanding the Process

Transit Lead Time: Pre-Pandemic and Pandemic Time

During the pre-pandemic period, the transit lead time from Pilipinas Aerospace dock to the customer's dock is 58 days on average. However, during the pandemic period, as shown in Figure 1, the transit lead time from Pilipinas Aerospace dock to the customer's dock has increased by 14 days, resulting in a total of 72 days on average

Analysis of the Gap

Table 5 shows the increase in days for all areas in the logistics activities, resulting in an additional 14 days from the total transit time.

Solutions to the Problem

Solution 1: Pull-In Production

One alternative way Pilipinas Aerospace can mitigate delayed shipment caused by the longer transit time is to pull in the production of galleys. As shown in Figure 2, it needs to advance production equivalent to 14 days of output to offset the 14-day transit lead time extension. The number of galleys required for pull-in is shown in Table 6.

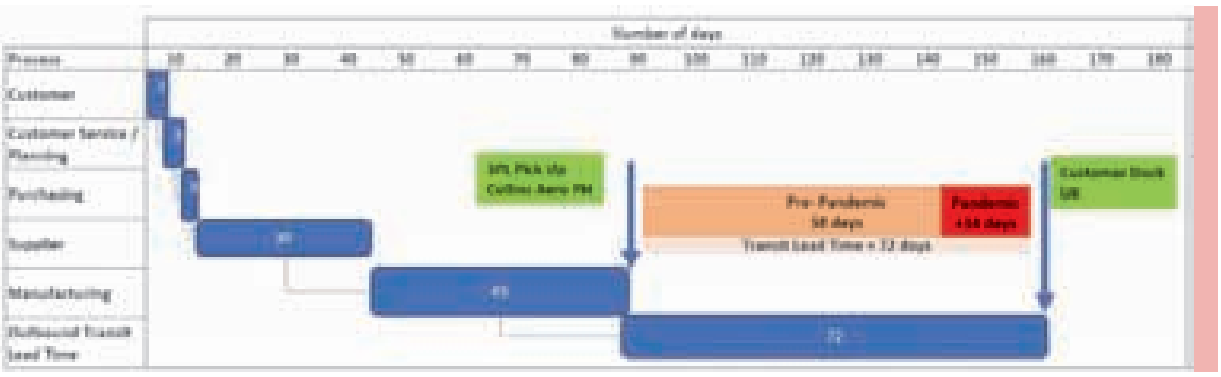


Figure 1. Total Transit Lead Time from Pilipinas Aerospace to Customer Dock

Table 5. Transit Time Breakdown in Days from Port of Origin to Destination

3PL Pick-Up to Manila Port to Singapore	Departure of structure from Singapore Port/Yantian	Sailing Singapore to UK Port	UK Port to Customer Dock	Total Transit Time
5	7	40	6	58
9	10	40	13	72
Target: 5 days max; Actual: 8.92 days in ave.)	Target: 7 days max; Actual: 9.28 days in ave.)	No Change	Target: 6 days max; Actual: 13 days in ave	Increase in Transit time from 58 to 72 Days

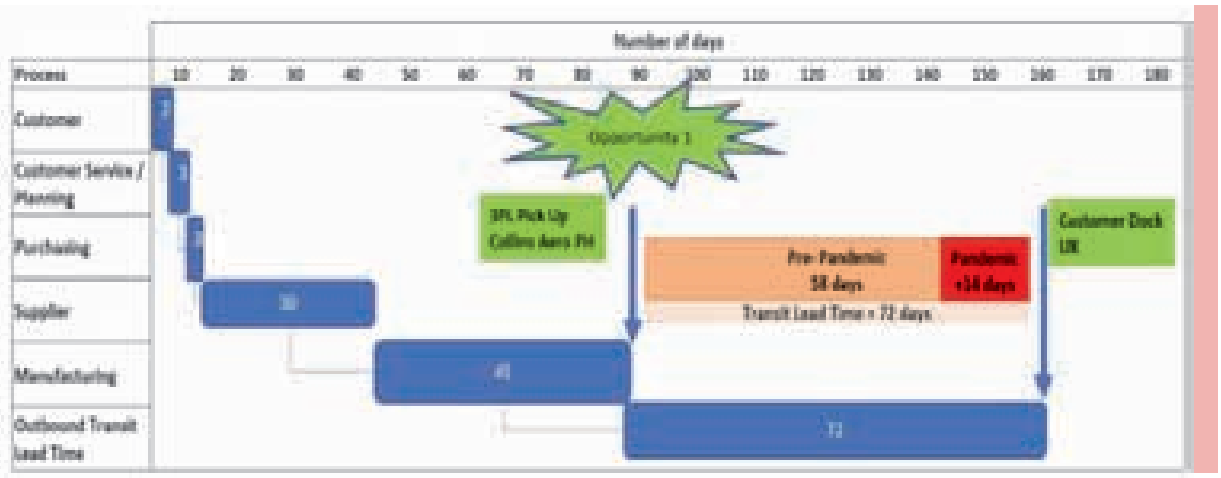


Figure 2. Opportunity on Production Pull-in

Table 6. Numbers of Galleys for Pull-in

PRODUCTION RATE AND SCHEDULE					
Production Change	JUL	AUG	SEP	OCT	Grand Total
Original Production Schedule	16	2	14		32
Pull-in Production Schedule within 7 Days	11	9	5	9	34
Pull in the Production Schedule 2 to 4 Weeks	21	14	3	5	43
Re-schedule to Later Date		10	15	24	49
Grand Total	48	35	37	38	158
Number of Pulled in Galleys	32	23	8	14	77

Galley Production Capacity

Manufacturing can pull in an additional number of galleys for production, as shown in the Galley production Capacity (Table 7). There will still be excess capacity left after the pull-in quantity is comprehended.

Solution 2: Supply Chain Solution (Parts Pull-In)

Tables 8-10 show the production and raw materials analysis, showing the impact of pull-in on production schedule and materials availability.

Analysis

The standard build and pull-in build can be supported by different commodity groups except for Commodity Group B materials. Based on the plotted production schedule, Group B commodity can only support July and August build, and parts shortage will be experienced starting around the 2nd week of September. The parts breakdown of Commodity Group B is presented in Table 11.

Galley Assembly Parts Supply Positioning

Kraljic[4] Chart (Figure 3) shows the classification of parts used in galley assembly. The Chart also shows the classification of selected parts under Commodity Group B, which are determined to have a shortage to support the pull-in build. These parts will be prioritized for pull-in through the

4 The Kraljic Chart is like the Supply Positioning Model in function except for the coordinates and is sometimes used interchangeably.

different supply chain strategies discussed below.

Supply Chain Strategies

After a detailed review of the parts and components under commodity B, The Pareto Chart (Figure 4) shows how the parts can be pulled in to support the advanced production of galleys. The chart shows that 1,992 parts, or 65% of the projected shortage, can be solved by the "Make or Buy" strategy, while the remaining 35% can be addressed by doing pull-in negotiations and local sourcing. The group decided to dive deep into the "Make or Buy" strategy to address the urgent need for raw materials and supplier development for long term strategy.

The Make or Buy (MoB) Strategy (Short Term Action)

Parts identified under the Make or Buy Strategy can be made by repurposing materials that involve simple operations such as cutting to different sizes and marking that conforms to structural requirements, materials specification, product specification, and painting requirements based on the customer's specifications. Figures 5 and 6 are examples of the parts that will undergo MoB.

The MoB process flow (Figure 7) and the resulting timeline (Figure 8) show that 25 hours are needed to complete 150 lines of materials. 14 days are required to complete the 1, 992 lines of materials using the Make or Buy Strategy.

Conclusion

Tables 12 and 13 show that implementing these supply chain strategies will give a 95% success rate with a total cost avoidance of $705.65K. Out of the 77 galleys that will pull in due to the increase in outbound transit lead time, four galleys will not be supported by materials in October. Two options need to be done to avoid a huge penalty on the late shipment as its short-term action to mitigate the risk of delayed shipments.

Option 1 – Negotiate with the customer to move the Customer On-Dock Date (CODD). The equivalent late penalty for these four galleys is $448K ($16K daily penalty x 7 days delay x 4 galleys). If A350 accepts the CODD, the next option is to ship the galleys via air.

Table 7. Galleys Daily Capacity

	July	Aug	Sept	Oct
Galley Monthly Requirement	48	35	37	38
No of days / month	20	20	20	20
Galley Req't Per Day	2.4	1.8	1.9	1.9
Pre-Pandemic Capacity	5.0	5.0	5.0	5.0
Current Production Capacity	4	4	4	4
Current Monthly Capacity	80	80	80	80
Excess Capacity	1.6	2.3	2.2	2.1

Table 8. Number of Galleys for Pull-in

Build Schedule	July	Aug	Sept	Oct	Total
Original production build	16	12	29	24	81
Pull-in build	32	23	8	14	77
Total	48	35	37	38	158

Table 9. Raw Materials Grouped Based on Commodity

Commodity	Required Per Gally	Orginal Prod Build	Pull In Build	Total Req'd	On-hand Inventory + PO + Substitute	Delta	Remarks
		81 Galleys	77 Galleys				
Commodity Group A	50	4050	3850	7900	9662	1,762	Enough parts supply
Commodity Group B	44	3564	3388	6952	3864	-3,088	Need to Pull In
Commodity Group C	10	810	770	1580	1860	280	Enough parts supply
Commodity Group D	9	729	693	1422	2783	1,361	Enough parts supply
Commodity Group E	7	567	539	1106	1428	322	Enough parts supply
Commodity Group F	7	567	539	1106	1310	204	Enough parts supply
Commodity Group G	2	162	154	316	573	257	Enough parts supply

Table 10. Commodity Group B Number of Galleys for Pull-in

	July	Aug	Sept	Oct
Galley Build (Normal + Pull In)	48	35	37	38
Commodity Group B Req't	2112	1540	1628	1672
BOH	3864	1,752	212	0
EOH	1,752	212	-1,416	-1,672
Cumm Neg Delta			-1,416	-3,088
Delta Equivalent Days	0	0	17	20

Option 2 – Ship the four galleys via Air shipment, which will incur an additional cost of $38.7K ($9.67K Average cost difference of shipping galleys via Air instead of Sea x 4 galleys). This is still better than the $448K penalty with the customer.

Recommendations

The Supplier Development Strategy

Supplier development is the process that Pilipinas Aerospace can adopt by working with certain suppliers on a one-to-one basis to improve their performance for their and the supplier's benefit. This process is closely associated with supplier relationship management and partnering. The goal of supplier development is to have an agile or flexible source of raw materials to support the business, especially in those crucial times. Some of the objectives of supplier development include:

» Improving supplier performance
» Reducing costs
» Resolving serious quality issues
» Developing new routes to supply
» Improving business alignment between the supplier and the Pilipinas Aerospace
» Developing a product or service
» Generating competition for a high-priced product or service and dominating the marketplace

The group recommends venturing into supplier development as its long-term action plan for its business continuity program. The following are the approaches to supplier development that Pilipinas Aerospace can apply.

1. *Supplier Value Management (SVM)*
   In particular, value analysis is a key part of supplier development. Value analysis can be used to reduce the cost of a product or service without diminishing the operational value. Wikipedia describes SVM as "the discipline

of strategically planning for, and managing, all interactions with third-party organizations that supply goods and/or services to an organization to maximize the value of those interactions. In practice, SVM entails creating closer, more collaborative relationships with key suppliers to uncover and realize new value and reduce risk of failure."

This approach means defining processes, segmenting suppliers, assessments and qualifications of suppliers, risk assessments, creating KPIs or scorecards to monitor performance, compliance, and building strategic partnerships. It helps build relationships with your supplier and make them feel that we are helping them improve for their benefit.

2. Value Engineering

   Value engineering is a systematic, organized approach to providing necessary functions in a project at the lowest cost. Value engineering promotes substituting materials and methods with less expensive alternatives without sacrificing functionality. It is focused solely on the functions of various components and materials rather than their physical attributes. Pilipinas Aerospace can benefit from this approach by working with its local suppliers by analyzing the materials they make or provide substitutes.

Table 11. Material Breakdown of Commodity Group B

Commodity Group B	# of Parts	Remarks
Doublers and Blocks	1506	Requires shorter delivery lead time; can be sourced in 7 to 14 days
Plastic Parts	340	Plastic parts has shorter lead time, ca be pulled in within 2 weeks Pelmet and ducts requires long delivery lead time With second source supplier
Complex Metal Parts	510	Work Deck Skin are complex and customize parts Can be prioritized production at local supplier Can be sourced to second local supplier
Electrical Parts	408	Harness and Cables Colins has harness operations Can be planned in the production; IOT required
Other Leverage Parts (Kick Strips, Extrusions, Etc)	274	Requires shorter delivery lead time; can be sourced in 7 to 14 days

Figure 3. Kraljic Chart

Figure 4. Pareto of Pull-in Strategy of the Raw Materials

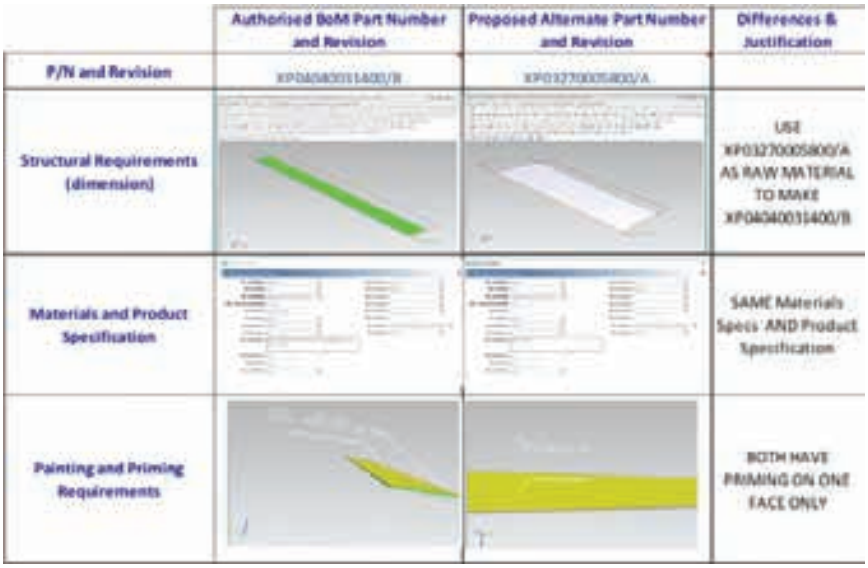


Figure 5. Ann example OF Raw Material with repainting requirement

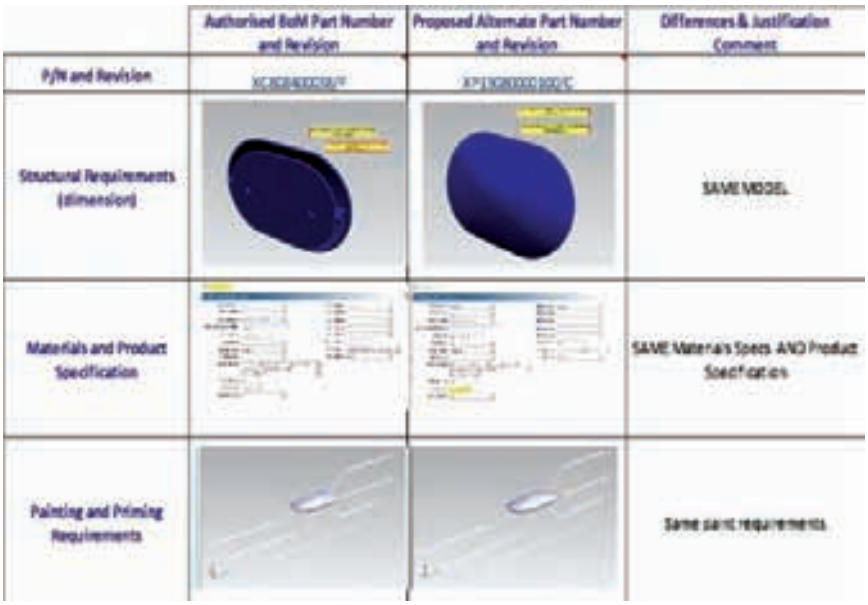
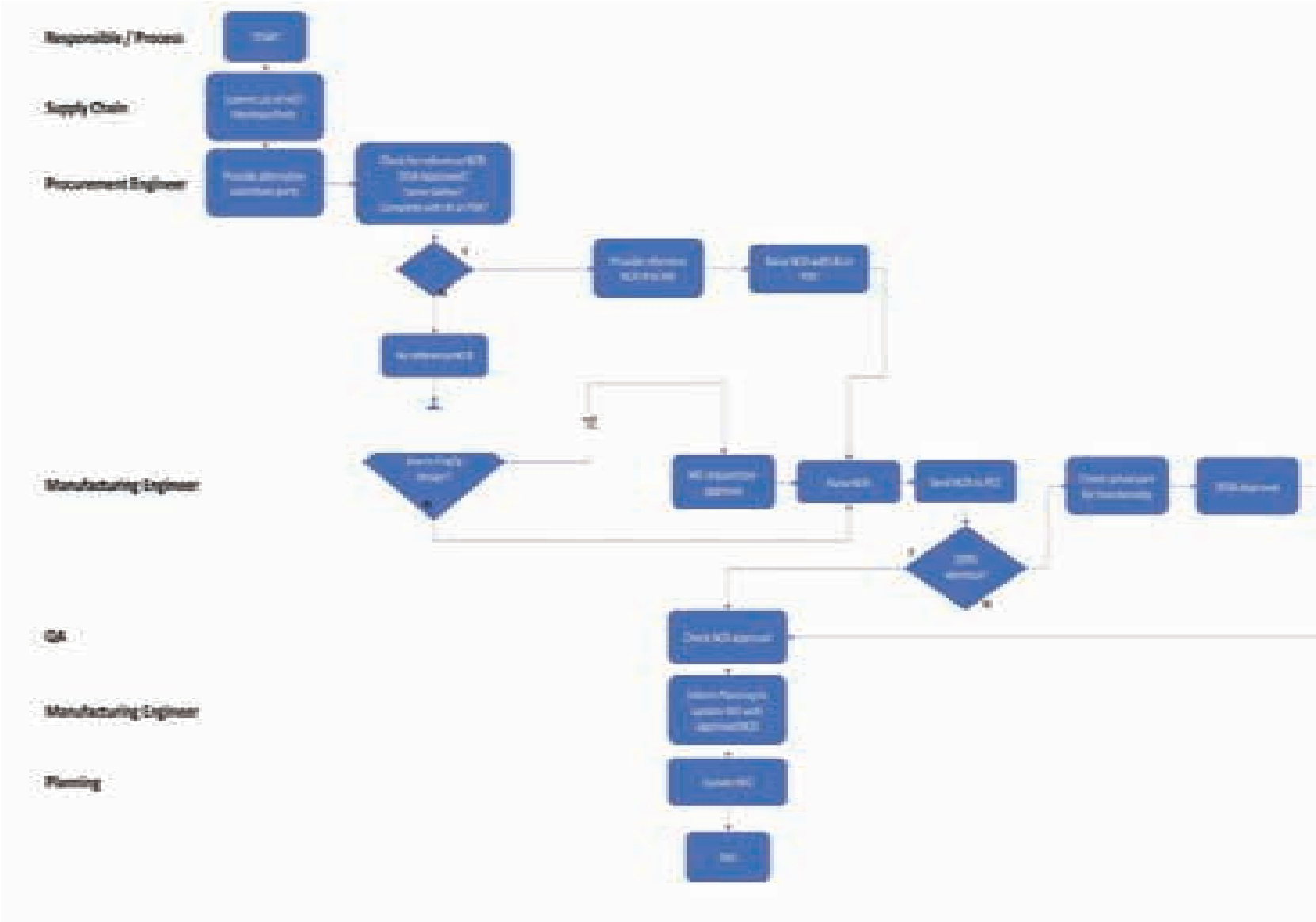


Figure 6. An example of Raw Material for Remarking

Figure 7. Make or Buy Process Flow



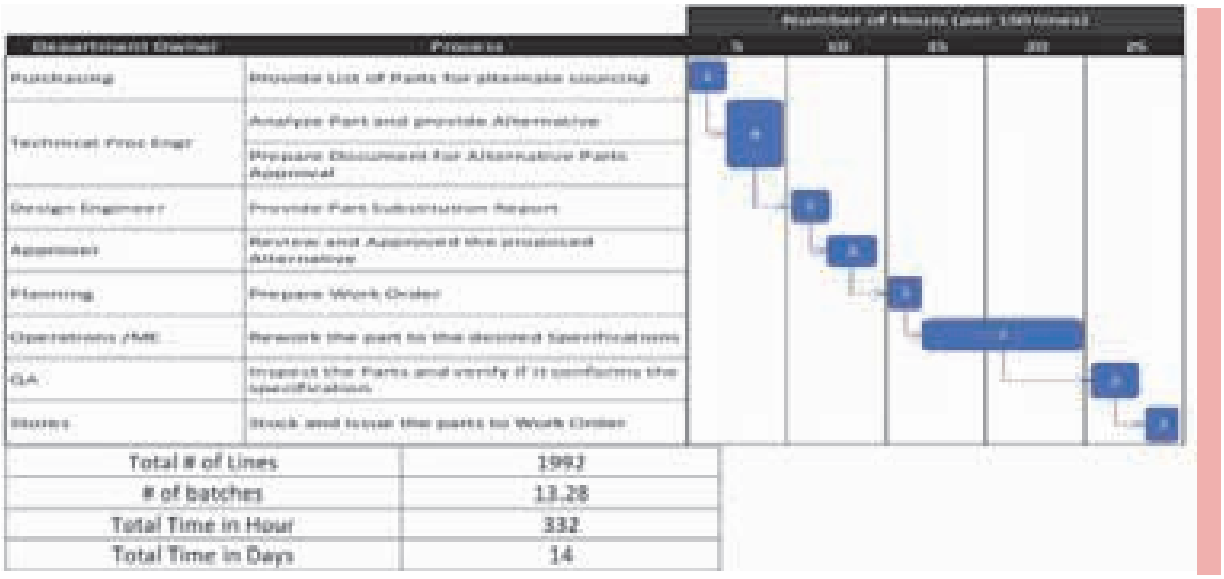


Figure 8. Total Number of Man-hours Needed to Complete the Pull-in Strategy

Table 12. Measurement of Success Rate of the Pull-in Strategy

Changes Description	JUL	AUG	SEP	OCT	Total Amount in K USD
Pulled In Galleys (Plan)	32	23	8	14	77
Supported by Materials	32	23	8	10	73
No of Galleys Without Materials	0	0	0	(4)	(4)
Success Rate	100%	100%	100%	71%	95%

**Reason of not meeting the plan - Supplier of Work Deck Assembly can only produce 6 pcs in 30 days. Supplier can only produce 18 pcs until September 30. This will be 4 pcs short for October plan

Table 13. Cost Avoidance Breakdown of Late Delivery

Changes	Changes Description	JUL	AUG	SEP	OCT	Total Amount in K USD
Late Delivery Penalty for 77 galleys	Expected Penalty (in K$) ($10K per day of delay)	$ 3,584	$ 2,576	$ 896	$ 1,568	$ 8,624
Freight Cost Difference	Additional Freight Cost (in K$) From Sea Shipment to Air Shipment	$ 309	$ 222	$ 77	$ 335	$ 944
Additional Charges	Total Amount that Collins will pay due to unavailability of materials to meet the demand	$ -	$ -	$ -	$ 38.7	$ 38.7

Wastewater Treatment Optimization
People, Planet, Profit: Aligned?

Camille Ante
Soana Mari Fuentes
Jennifer Jardin
Emilio Lim
Renante Palparan

The Covid–19 pandemic, without a doubt, gave us a new normal. Markets shifted, and the dynamics of supply and demand were, in a way, disturbed. In a word: unprecedented. Now, Covid–19 has found its place in society, and humanity has once more proven what it has always been capable of: adaptation. Despite the economic downturns that disrupted all four corners of the world, there was also a bright side to the Covid–19 pandemic: the time regained with family and loved ones, the smog-free skies, and refreshed waters. It was the kind of winding down that Mother Nature may have prayed for and finally hit home.

We see evidence of the notable effects of the pandemic in present economic conditions all over the world. In the way demand has fluctuated and new products and services have emerged, business rules have also become seemingly uncharted once more, and organizations have reverted to adjusting their reigns and taking things slowly all over again. The global economy, as we know it, is never as it was before, and with technology at its most relevant, the electronics trade has become one of the industries significantly affected by the Covid–19 pandemic.

The Euromonitor International for the consumer electronics industry conducted a study that spanned research data on industry growth, product demand, and market trends as of May 31, 2021. Key findings indicate that the electronics industry is poised for positive growth in 2021 after a massive decline in 2020, with smartphones leading the recovery and wearable devices coming in second. Marginal increases in growth came from those markets where the acceptance of vaccination rollouts was high, indicative of growing optimism in the present.

With the economy bouncing back to activity, the dependence on mobile technology persistently surges. Consumers are becoming more and more tech-savvy and inseparable from their smart devices since online engagement became germane at the time of lockdown. This spurs the industry players to rethink ways to grow revenue streams with new enhancements and cost–attractive products that will appeal to a broader market, giving the industry its much-needed rebound.

In light of all this, the Philippines boasts of being home to electronic companies that practice the best–known manufacturing methods. Year-to-date data as of May 2021 shows that the total value of the Philippines' electronic exports reached USD 17.99 billion, a recovering number from the country's 2020 performance of USD 29.35 billion, reaching Hong Kong, USA, China, Singapore, and Japan. Despite the 38.70% decline in terms of year-on-year industry performance in 2020, the electronics manufacturing industry—with 73% generated from semiconductors and 27% coming from electronics, still has the highest % impact on the country's Gross Domestic Product (GDP) and remains to be a great contributor to the Philippine economy.

According to the Semiconductor and Electronics Industries in the Philippines, Inc. (SEIPI), if the electronics industry ceases to produce output, purchase inputs, and distribute its products, the country's GDP will drop by 28%. Every peso increase in export sales generates at least 0.12 cents of additional indirect taxes in the economy and 0.11 to 0.25 cents of additional household income. And for every billion-peso increase in investments, an additional 620 to 1,408 quality jobs are created.

The Philippines is a developing country. And just like every other developing nation, water pollution is among its primary concerns. Water is a critical resource, and the lack of access to clean and safe water while navigating the country's health crisis has been an added challenge. Leonardo Da Vinci once said, "Water is the driving force of all nature." Now, more than ever, access to safe water is critical to the health of

all Filipino families. According to Water.org, nearly 5 million people in the Philippines rely on unsafe and unsustainable water resources, and another 9 million people lack access to improved sanitation. While our leaders and regulators are not estranged from these facts and pressing issues, finding the right balance between the environment, industrialization, and the welfare of the people makes the classic Utilitarian principle 'the greatest good for the greatest number' an unremitting dilemma.

CALABARZON (Cavite, Laguna, Batangas, Rizal, and Quezon) is home to most electronics manufacturers in the country. In the Philippines' prime years of industrial growth, the Office of the President enacted the Wastes Control Act of 1990 (RA 6969) and the Clean Water Act of 2004 (RA 9275) and thereafter organized the Laguna Lake Development Authority (LLDA). The goal was to have administrative supervision over CALABARZON and a few areas in Metro Manila regarding environmental management and control, preservation of the quality of human life and ecological systems, and the prevention of undue ecological disturbances, deterioration, and pollution.

Factories such as those located in Economic Zones are therefore kept on their toes in conforming to water quality guidelines and general effluent standards (DENR Administrative Order No. 2016-08) concerning the discharge of treated waste by-products into the municipal sewerage system. And yet, notwithstanding the laws protecting our water resources, industries continue to violate laws while required to have their primary sewage treatment facilities. In 2015, the LLDA filed charges against 163 companies (out of 5,882 companies monitored) for water pollution. That same year, two establishments (a fast-food restaurant and a salon) were issued cease-and-desist orders for violating the effluent standards for wastewater discharge.

The business of protecting our water resources and being able to give back to the environment for everything we take from it is everybody's job; it's on our shoulders. We owe it to our children and the generations to come. As the electronics manufacturing industry is set for a 7% growth goal for the year due to an expected market comeback, we chose an electronics manufacturing company to be the object of our paper. Here, we want to share how an optimistic industry player can embody this shared accountability by optimizing the level of products it manufactures to achieve zero overflows in its wastewater treatment facility and, in the process, achieve alignment in its triple bottom line of People—in the way it looks out for its stakeholders, Planet—in the way it stands by its environmental initiatives, and Profit—in the way it contributes to society by creating employment, innovating products, and paying taxes.

The Company

The organization that we have chosen is GHQ Semiconductors Inc., a semiconductor and electronics manufacturing company. Its presence in the Philippines began more than three decades ago in one of the PEZA-controlled industrial complexes in the Philippines, occupying almost ten hectares of land. At present, it gives jobs to about 5,000 Filipinos. The company's value proposition centers on quality and contributes to human culture advancement. It provides high-quality semiconductors, monolithic integrated circuits, transistors or diodes, and resistors.

Semiconductors are essential to our way of life in these digital times. Without them, our mobile phones, laptops, and cars couldn't function. It is also a thirsty business, with water fundamental to its manufacture. A semiconductor is a miniaturized electronic circuit containing a multitude of transistors. After each of several dozen layers of semiconductors are added to the silicon wafer,

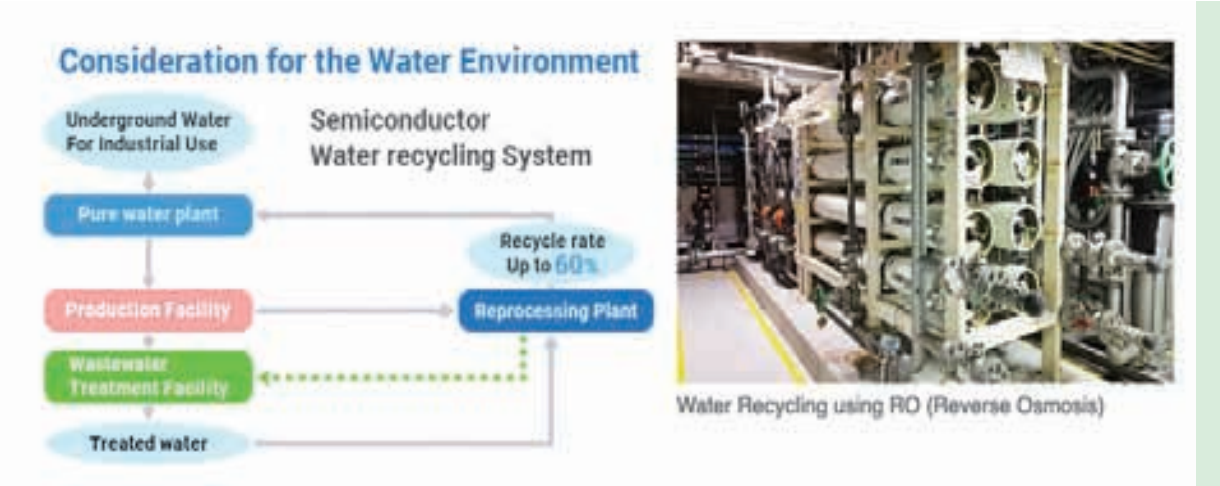


Figure 1. Environmental Conservation Measures through Water Recycling

it must be rinsed, requiring massive amounts of water. A great deal of this water is Ultra Pure Water (UPW), water that is thousands of times purer than drinking water.

Considering the environment, the company has been aggressively conducting activities that can create corporate social value leading to the solution of social issues that will help the organization attain its sustainable development goals. Its 4–point development and technology strategy covers:

1. Pursuing lower energy consumption to address the social issue of increased energy consumption due to population growth.
2. Pursuing smaller products to address the social issue of limited natural resources.
3. Pursuing security and safety that seeks to address the social issue of road accidents.
4. Thoroughly pursuing high quality and high efficiency to address global warming issues.

Each production line involves an electroplating process that produces acid and alkaline wastewater. These go to an in-house wastewater treatment facility, where they are processed to be suitable for discharge. The treated waste by-product ends up in the municipal sewerage system, which is regularly and randomly monitored by the Laguna Lake Development Authority (LLDA).

Figure 1 shows the environmental conservation measures through water recycling. Figure 2 presents the initiatives in business activities to achieve 2020 environmental targets.

The Problem

The wastewater treatment facility of GHQ Semiconductors Inc. is able to process 456 m3 of wastewater per day. This capacity has been sufficient to process the daily discharge from the factory's production lines for quite some time. But for the past five (5) years, the growth in the company's production levels has driven the company's daily wastewater to 540 m3 per day, with the risk of an overflow looming at the neutralization tank forming a composite wastewater pool. Composite wastewater from this tank is then passed onto the slightest technical issue. As a safety measure, the company built an effluent sump tank that serves as equalization and treatment facility where it undergoes a series of processes before the water is finally released to the municipal sewerage system by not more than the facility's capacity.

The treatment plant's capacity is a constraint. The challenge for the company is to be able to identify the level of daily production for each product line

	Policy	2020 Targets	Targets in Fiscal Year 2019	Results in Fiscal Year 2019
3. Reduction of environmental impact	Reduce the amount of materials discharged to the air and water, and strive to preserve the Global environment.	(1)Reduce the amount of handling volume of PRTR substances (per production unit) by 10% from the actual results of FY2010.	Maintain the amount of handling volume of PRTR substances (per production unit) in FY2019 as the results of FY2018.	**The amount of handling volume of PRTR substances (per production unit) were reduced by 3.8% from the actual results of FY2018.**
		(2) Reduce VOC emission by 40% from the actual results of FY2000.	Reduce VOC emission by 0.5% in FY2019 from currently predicted value according to the quantity of production of FY2019.	**VOC emissions was reduced by 25.0% from currently predicted value according to the quantity of production of FY2019.**

Figure 2. Initiatives in Business Activities to achieve 2020 Environmental Targets

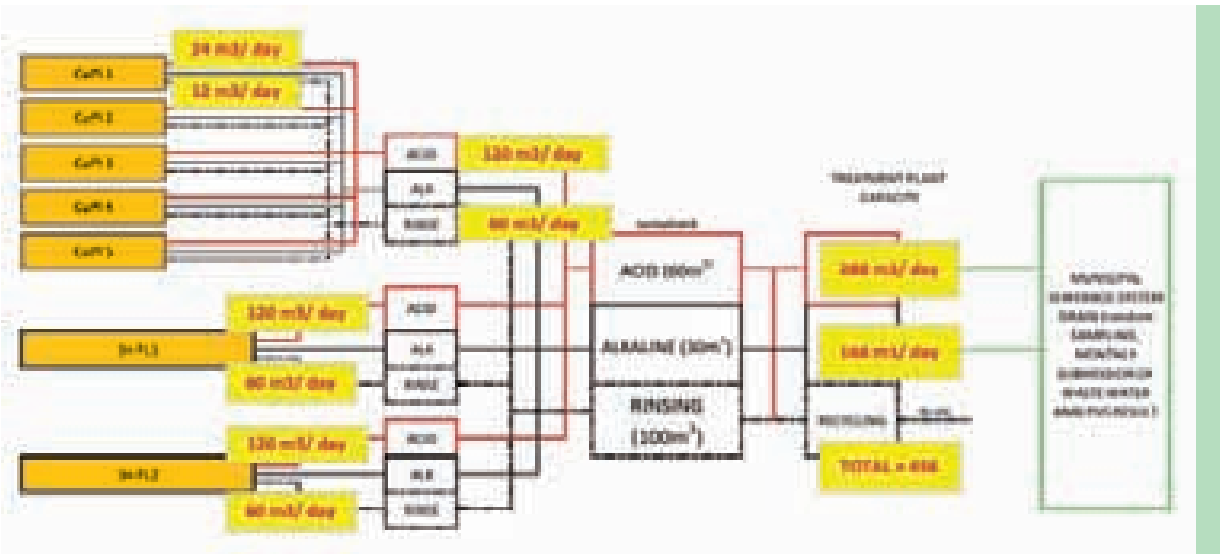


Figure 3. Wastewater Treatment System Schematic Diagram

that will result in a zero possibility of overflow or discharge of untreated wastewater or effluents into the public sewerage while generating positive contribution margins.

Once the company has identified the optimal solution, analyzing the efficacy of increasing the treatment capacity by expanding the existing WWT (Wastewater Treatment) facility becomes essential. Additionally, if the likelihood of increased capacity is a good option for GHQ Semiconductors Inc., identifying the optimal way to manage the project could be more value-adding to the organization.

Models to be Used

Linear Programming (LP) Model

We employed Linear Programming to optimize profit by calculating the best production output as the decision variables are constrained by the volume of discharge of acid and alkaline effluents and the capacity of the wastewater treatment facility.

Monte Carlo Simulation

Coming from the results of the LP model, we investigated the financial impact of boosting production vis-a-vis the investment in expanding the water treatment facility through 1-year and 5-year simulation models.

PERT CPM Method

Using PERT CPM, we plotted the development of a larger wastewater treatment facility in the fastest and most economical way.

Data Sources

Figure 3 shows the schematic diagram of the company's Wastewater Treatment facility: It has

PLATING LINE	PRODUCT TYPE	MAXIMUM CAPACITY (Kpcs/day)	DEMAND (Kpcs/day)	UNIT COST (Kpcs)	MARGINAL PROFIT (Kpcs)	DISCHARGE (m^3/ Kpcs)
CuPL1	Product S1	550	138	$4.25	$2.12	0.07
CuPL2	Product S2	550	138	$2.88	$1.30	0.07
CuPL3	Product B1	900	225	$4.17	$2.00	0.04
CuPL4	Product B2	900	275	$7.85	$4.95	0.04
CuPL5	Product B3	900	225	$10.48	$6.60	0.04
SnPL1	Product M	113537	56769	$6.22	$2.74	0.005
SnPL2	Product R	49092	24546	$7.70	$3.46	0.005

Figure 4. Data from the Production Control Department

seven production lines: five copper plating lines and two tin plating lines. Its current treatment facility produces an average of 540 m3 of wastewater daily, but its current treatment plant capacity is 456 m3 per day. Figure 4 presents the data from the company's production control department that will be used in the application of quantitative models.

Application of the Models

Linear Programming (LP) Model

The objective of using this model is to determine the optimal level of production, which will maximize the profit that, at the same time, will align with the company's wastewater treatment capacity. The ultimate goal is to have zero overflows to the environment.

Max Profit (daily) = 2.12C1 + 1.30C2 + 2C3 + 4.95C4 + 6.6C5 + 2.74S1 + 3.46S2

Decision Variables

C1 = No. of Product S1 in Kpcs passing through Copper Plating Line 1

C2 = No. of Product S2 in Kpcs passing through Copper Plating Line 2

C3 = No. of Product B1 in Kpcs passing through Copper Plating Line 3

C4 = No. of Product B2 in Kpcs passing through Copper Plating Line 4

C5 = No. of Product B3 in Kpcs passing through Copper Plating Line 5

S1 = No. of Product M in Kpcs passing through Tin Plating Line 1

S2 = No. of Product R in Kpcs passing through Tin Plating Line 2

Constraints

Acid/Alkaline Discharge must be less than or equal to 456 m3/day - for a zero overflow.

0.07C1 + 0.07C2 + 0.04C3 + 0.04C4 + 0.04 C5 + 0.005S1 + 0.005S2 <= 456

Demand per Plating Line

C1 >= 129

C2 >= 125

C3 >= 221

C4 >= 88

C5 >= 100

S1 >= 44,983

S2 >= 20,128

Maximum Capacity per Plating Line

C1 <= 550

C2 <= 550

C3 <= 900

C4 <= 900

C5 <= 900

S1 <= 113,537

S2 <= 49,092

Non-negativity Constraints

C1, C2, C3, C4, C5, S1, S2 >=0

By utilizing Excel Solver, the optimal solution (see Figure 5) shows that the current treatment plant facility can earn a maximum profit of $261,440.47 per day.

Based on the LP sensitivity report (Figure 6), the treatment capacity is a binding constraint, and the shadow price is $692 per day up to an allowable increase of 48 cubic meters/day—equivalent to about a 10.5% increase in current capacity. We will not be able to use the shadow price because we need at least an 18% increase in treatment capacity for the current demand. We recommend increasing treatment capacity by 20%; therefore, we need to re-run Solver to determine the incremental profit. The results are shown in Figure 7.

With the increase of 20% in treatment capacity, the maximum profit is $318,398.16 per day—an additional $56,958 in daily profit or $20,798,558 in yearly profit. Assuming the company wants to recover the expansion capital expense in a year, the company shouldn't spend more than $20,798,558 for the expansion.

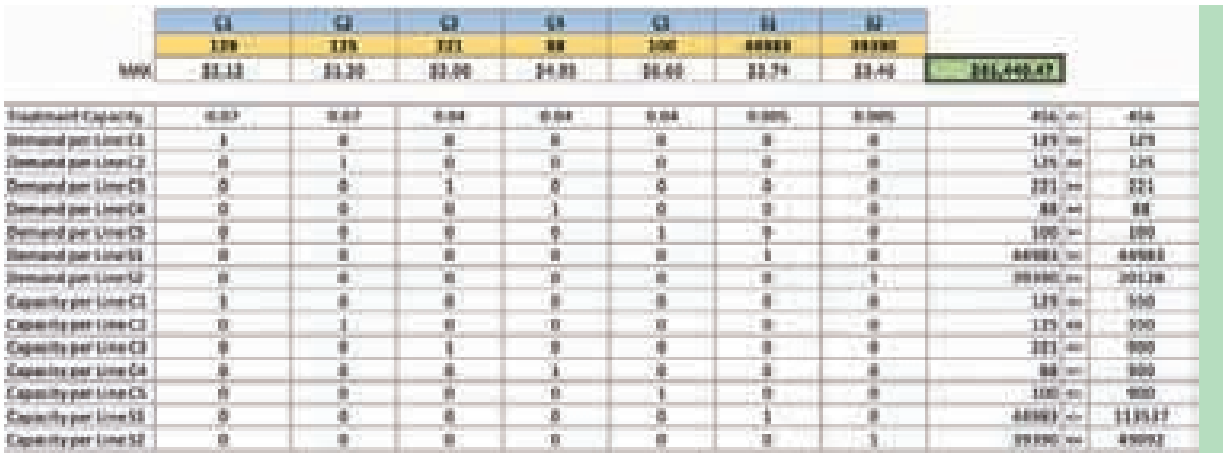


Figure 5. Solution in Excel Solver

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
I15	Capacity per Line C1	129.1664	0	550	1E+30	420.8336
I16	Capacity per Line C2	125	0	550	1E+30	425
I17	Capacity per Line C3	221.184	0	900	1E+30	678.816
I18	Capacity per Line C4	87.5	0	900	1E+30	812.5
I19	Capacity per Line C5	100	0	900	1E+30	800
I20	Capacity per Line S1	44982.592	0	113537.4545	1E+30	68554.86255
I21	Capacity per Line S2	39389.6064	0	49092.00813	1E+30	9702.40173
I7	Treatment Capacity	456	692.7264126	456	48.51200865	96.30941533
I8	Demand per Line C1	129.1664	-46.36712615	129.1664	420.8336	129.1664
I9	Demand per Line C2	125	-47.19310576	125	425	125
I10	Demand per Line C3	221.184	-25.70535016	221.184	678.816	221.184
I11	Demand per Line C4	87.5	-22.7635565	87.5	812.5	87.5
I12	Demand per Line C5	100	-21.10930415	100	800	100
I13	Demand per Line S1	44982.592	-0.728419709	44982.592	19261.88307	9702.40173
I14	Demand per Line S2	39389.6064	0	20127.72333	19261.88307	1E+30

Figure 6. Sensitivity Report

	C1	C2	C3	C4	C5	S1	S2			
	129	125	221	88	100	53520	49092			
MAX	$2.12	$1.30	$2.00	$4.95	$6.60	$2.74	$3.40	318,398.10		
Treatment Capacity	0.07	0.07	0.04	0.04	0.04	0.005	0.005	547.2	<=	547.2
Demand per Line C1	1	0	0	0	0	0	0	129	>=	129
Demand per Line C2	0	1	0	0	0	0	0	125	>=	125
Demand per Line C3	0	0	1	0	0	0	0	221	>=	221
Demand per Line C4	0	0	0	1	0	0	0	88	>=	88
Demand per Line C5	0	0	0	0	1	0	0	100	>=	100
Demand per Line S1	0	0	0	0	0	1	0	53520	>=	44983
Demand per Line S2	0	0	0	0	0	0	1	49092	>=	20128
Capacity per Line C1	1	0	0	0	0	0	0	129	<=	550
Capacity per Line C2	0	1	0	0	0	0	0	125	<=	550
Capacity per Line C3	0	0	1	0	0	0	0	221	<=	900
Capacity per Line C4	0	0	0	1	0	0	0	88	<=	900
Capacity per Line C5	0	0	0	0	1	0	0	100	<=	900
Capacity per Line S1	0	0	0	0	0	1	0	53520	<=	113537
Capacity per Line S2	0	0	0	0	0	0	1	49092	<=	49092

Figure 7. Solution in Excel Solver, re-run at 20% incremental capacity

Monte Carlo Simulation

Coming from the result of the linear programming optimization, the production demand cannot be met with the existing wastewater treatment capacity. Expanding the existing treatment plant capacity by about 20% is necessary to increase production quantity. But the company needs to be certain that investment in the additional wastewater treatment capacity will be profitable.

With this in mind, a Monte Carlo simulation would help compute the certainty of being profitable and its risk level. Monte Carlo simulation is a technique that helps analyze models in which the value to be assumed by one or more independent variables is uncertain. This simulation aims to describe the distribution and characteristics of the possible values of the bottom-line performance measure, which is the profit, given the possible values and behavior of the independent variables. We want to determine the certainty of the company's profitability through the formula:

Profit = (Unit Cost – Variable Cost) * Volume – Fixed Cost

Using the initial values from the linear programming model, the additional volume we can generate by increasing the wastewater treatment capacity to 20% is 1,859,382,000 pieces yearly. Refer to Table 1.

Computing the profit given the data of fixed cost (accrued in 1 year), variable cost, and unit price will give $459,272 profit per year.

Volume	1,859,382
Unit price	$ 6.22
Fixed Cost	$ 5,342,000
Variable Cost	$ 3.10

Profit = ($6.22 – $3.10) * 1,859,382 – $5,342,000 = $459,272

But since the values of our independent variables Volume, Fixed cost, Variable cost, and Unit price are uncertain, we have assigned values and probability estimates coming from the company's historical data as per Table 2.

We used a Crystal Ball application and input the variables to do a simulation 50,000 times. The simulation models (Figure 8) showed 96.104% certainty that the expansion project would be profitable given the additional investment cost of increasing wastewater treatment plant capacity. The 3.90% risk of losing money is almost negligible and has an insignificant effect than the certainty rate. This is simulated using the accrued investment amount in 1 year. If we simulate by accruing the investment amount in 5 years, the certainty rate increases to 100% as shown in Figure. 9.

Monte Carlo simulation shows that it is indeed profitable for the company to increase the

wastewater treatment capacity to produce more products to meet customer demand while considering the "0" outflow of untreated effluent in the environment.

Wastewater Treatment Capacity Expansion Project Planning by PERT CPM

Having a constraint on the wastewater treatment capacity but continuously strictly adhering to the control of zero discharge of untreated effluent to the common sewerage system, the factory is losing business opportunities by limiting its production to the minimum level. However, based on the sensitivity analysis of the Linear Programming Optimization presented earlier, the capacity can be increased by as much as 20% through the expansion of the present capacity of the wastewater treatment plant.

The expansion project composed of 10 major activities (see Figure 10) can be completed in 229 days (7.6-month period Critical Path) following the normal scheduling of the project through the Gantt chart as shown in Figure 11.

Carefully studying the Gantt chart, the critical path will follow the red colored horizontal bar graph from budget approval, complying with the legal requirements, and proceeding with the civil works and mechanical works (these are the main construction jobs necessary for the expansion of the facilities). The electrical works can be done simultaneously with the mechanical works, so it is not part of the critical path.

Finally, the finishing works will cap the main construction jobs. The procurement of the wastewater treatment technology and equipment from Japan (which is in blue) can be done simultaneously with the main construction works and therefore is not also considered part of the critical path. However, its installation, commissioning, and pre-production approvals will be the last set of activities that comprises the

Table 1. Additional Production Volume

Prodn Volume	in Kpcs
1st year	1,859,382
2nd year	3,718,765
3rd year	5,578,147
4th year	7,437,530
5th year	9,296,912

Table 2. Random Variables and Probability Estimates

Volume	Probability
1,500,000	0.1
1,700,000	0.2
1,800,000	0.4
1,900,000	0.2
2,000,000	0.1

Fixed Cost	Probability
$5,000,000	0.05
$5,300,000	0.15
$5,400,000	0.2
$5,500,000	0.2
$6,000,000	0.4

Variable Cost	Probability
$2.60	0.1
$2.80	0.2
$2.90	0.2
$3.10	0.3
$3.40	0.2

Unit Price	Probability
$4.17	0.0072
$6.90	0.683904925
$7.70	0.30601725
$7.85	0.00133033
$10.48	0.001520377

critical path of the project.

Using the Project Libre software, Figure 12 shows the critical path totaling 229 days or 7.6 months as derived from the table in Figure 11.

As illustrated in Figure 10, items in red font are those activities identified in the critical path. The processing for the legal requirements, civil works, mechanical works, and finishing works can be crashed by seven days each. The WWT installation, commissioning, and pre-production approvals can be crashed by five days each. The final activity, which is the production pre-approvals, can be fast-tracked without any cost involved. The crashing of these activities under the critical path will expedite the completion of the project by about 45 days. Hence, the resulting lead time of the wastewater treatment expansion project became 184 days (6.1 months) from the original completion time of 229 days (7.6 months). See Figure 13.

As to the total cost before and after crashing the project, Figure 14 indicates that there will be an increase of 14% in the project cost from the original of $5,342,000 to $6,070,000.

Through the expansion of the wastewater treatment facility, there will be an increase in the production capacity and that crashing the project by 45 days will enable the company to take orders earlier than the original plan and save $57,409 in daily profit. More than the financial advantage, the

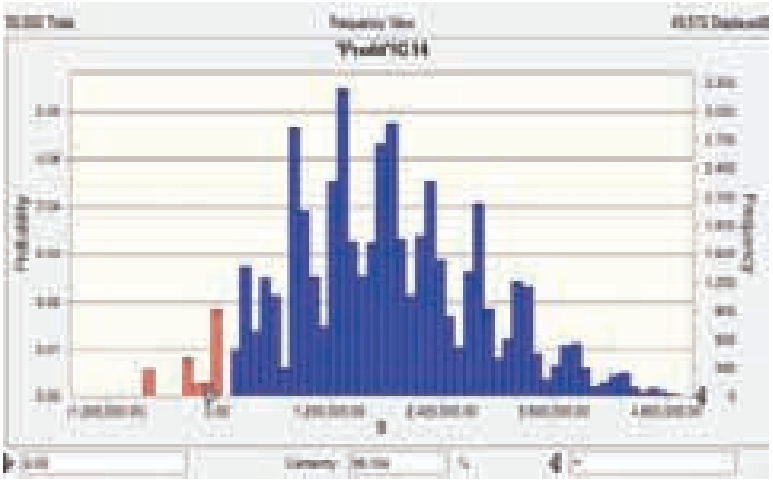


Figure 8. Crystal Ball Simulation Result (Frequency View)

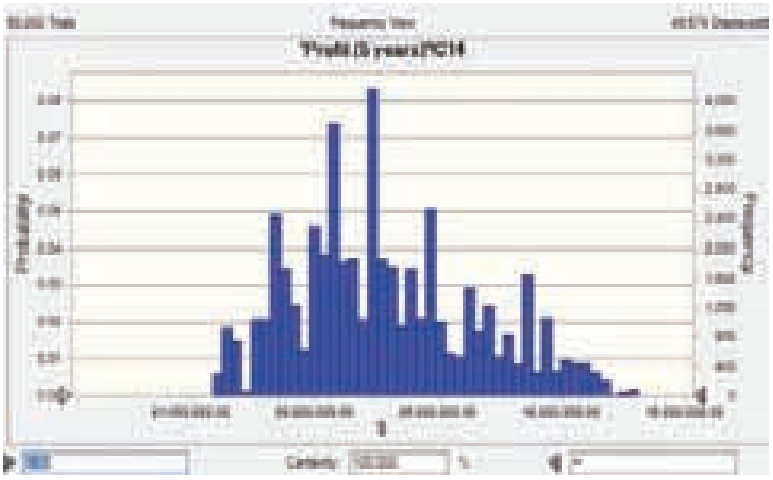


Figure 9. Crystal Ball Simulation Result for 5 years (Frequency View)

management can also achieve peace of mind by realizing "zero" overflow earlier than the expected time. They will not have to worry about any environmental legal implications of an accidental overflow of effluent that can happen any time before the expansion of the wastewater treatment capacity can be completed.

Analysis and Recommendation

The LP model demonstrated the optimal production level that would assure zero overflow in the wastewater treatment facility. Backed by the sensitivity report generated from the LP model, we set the increase in capacity in our Monte Carlo simulation by 20%. There was virtually NO RISK in investing in a 20% treatment facility expansion. We proceeded further with our PERT CPM model, wherein we proved that in building the additional capacity for the wastewater treatment facility, we could crash the project in 45 days. This generates NET savings for the company and, more importantly, gives it Peace of Mind as it assures "zero" overflow earlier than the expected time and stays compliant with environmental laws.

We, therefore, commend that:

1. GHQ Semiconductors Inc. should adjust its production to optimal levels to align with its present wastewater treatment capacity. In doing so, it can mitigate the risk of a potential overflow. It also sets the benchmark across the industry for an organization's genuine pursuit of sustainability in its triple bottom line.
2. From the results of the Monte Carlo Simulation, the company should seriously consider increasing its existing wastewater treatment facility to amplify its environmental compliance and to ensure peace of mind from the risk of overflows; and
3. Based on the PERT CPM analysis, it makes financial and operational sense for the

Activity	Description	Predecessor	Time	EST	EFT	LST	LFT	Slack
1	Budget Approvals	---	21	0	21	0	21	0
2	Legal Requirements	1	28	21	49	21	49	0
3	WWT Technology Requisition	1	90	21	111	94	184	73
4	Civil works	2	45	49	94	49	94	0
5	Mechanical works	4	60	94	154	94	154	0
6	Electrical Works	4	30	94	124	124	154	30
7	Finishing Works	5,6	30	154	184	154	184	0
8	WWT Installation	3,7	15	184	199	184	199	0
9	Commissioning	8	15	199	214	199	214	0
10	Pre-production Approvals	9	15	214	229	214	229	0

Figure 10. Project Activities: Normal Scheduling

Total Project Duration (Normal) time): 229 days (7.6 Months)

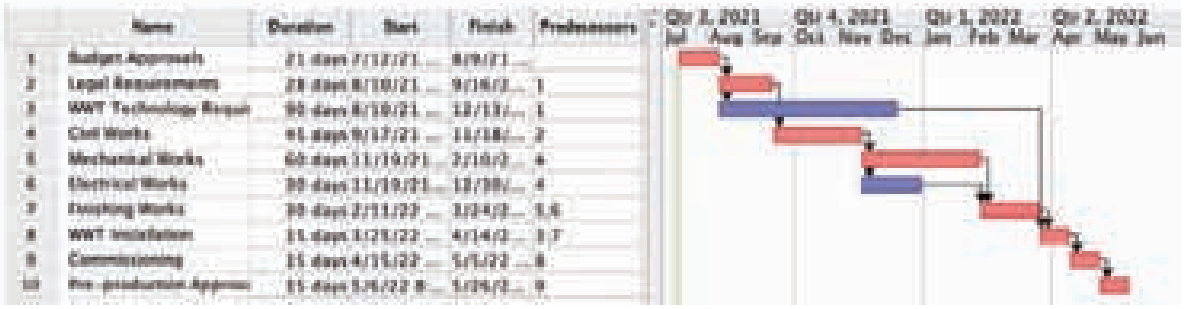


Figure 11. Gantt Chart of Project Activities: Normal Scheduling

company to expedite the construction of its treatment facility capacity expansion. By this, the company is investing soundly in environmental efforts that will help preserve our water resources and improve the Filipino people's well–being for generations to come.

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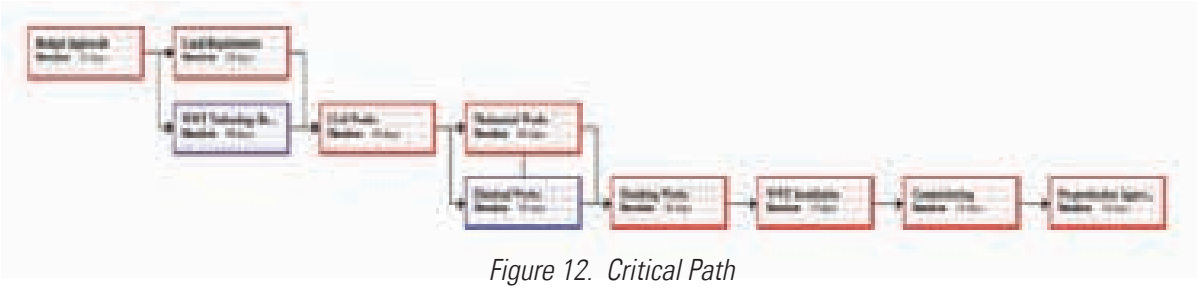

Figure 12. Critical Path

Activity	Description	Predecessor	Time	EST	EFT	LST	LFT	Slack
1	Budget Approvals	---	21	0	21	0	21	0
2	Legal Requirements	1	21	21	42	21	42	0
3	WWT Technology Requisition	1	90	21	111	64	154	43
4	Civil works	2	38	42	80	42	80	0
5	Mechanical works	4	53	80	133	80	133	0
6	Electrical Works	4	30	80	110	103	133	23
7	Finishing Works	5,6	21	133	154	133	154	0
8	WWT Installation	3,7	10	154	164	154	164	0
9	Commissioning	8	10	164	174	164	174	0
10	Pre-production Approvals	9	10	174	184	174	184	0

Figure 13. Project Activities with Crashing

WASTE WATER EXPANSION Crashing Data

Activity	Activity Description	Activity Predecessor	Normal Condition Time (Days)	Normal Condition Cost	Crash Condition Time (Days)	Crash Condition Cost	Allowable Crash Days	Crash Cost Per Day
1	Budget Approvals	—	21	$0	21	$0	0	$0
2	Legal Requirements	1	28	$12,000	21	$19,000	7	$429
3	WWT Technology Requisition	1	90	$2,400,000	90	$2,400,000	0	
4	Civil works	2	45	$620,000	38	$806,000	7	$26,571
5	Mechanical works	4	60	$1,080,000	53	$1,404,000	7	$46,286
6	Electrical Works	4	30	$520,000	30	$520,000	0	
7	Finishing Works	5,6	30	$800,000	23	$990,000	7	$12,857
8	WWT Installation	3,7	15	$400,000	10	$520,000	5	$24,000
9	Commissioning	8	15	$10,000	10	$15,000	5	$1,000
10	Pre-production Approvals	9	15	$0	10	$0	5	$0
				$5,842,000		$6,070,000		$111,148

Figure 14. Crashing Data with Costing on Waste Water Treatment Expansion

Improving the Supply Chain for Lift Trucks

Charlie Lim
Joey Nolasco
Marc Tan
Derrick Villanueva

Hydie was formed exactly 30 years ago and is involved in a wide range of material handling solutions and after-sales businesses. Its product portfolio includes warehouse trucks, among others. The company's products are present in almost all industries – manufacturing, construction, automotive, logistics, and mining. Currently, it has nine locations nationwide, with the main office located in Paranaque. Other locations are in Pampanga, Batangas, Cebu, Bacolod, Iloilo, CDO, Davao, and General Santos.

The problem to be tackled is the supply chain management of lift trucks. Lift trucks for material handling solutions in the warehouse come in many sizes and forms. However, the most common types sold in the market are Reach Trucks, Electric Forklifts, and Internal Combustion (Diesel or LPG) Forklifts. Capacities can range from 1.5 tons to 5 tons, with 2.5 to 3.5 tons being most commonly used. The lift truck business contributes to approximately 7% of Hydie's revenues. Unlike its other products, the revenue turnover for lift trucks is relatively fast because it is sold as an off-the-shelf item.

Hydie's lift trucks are sourced from China, where it has a co-branding agreement with an original equipment manufacturer (OEM) based near Shanghai. This OEM has been in the lift truck business for over 20 years and is one of the most reputable brands in the Chinese market. The products are ordered and shipped by full container load (FCL) and typically take 2-5 weeks to arrive at Hydie's central warehouse. The central warehouse has been utilized for at least twenty years; this is where all the shipments are unloaded and stored, and this is where all outbound deliveries originate when an order is placed.

Hydie sells about 120 lift trucks per year, with revenues averaging P135 million. Barring the effects of the pandemic, the lift truck business in Metro Manila and nearby Luzon provinces has been enjoying steady growth (about 3% to 10%) over the past few years. However, for Visayas and Mindanao (VisMin), it tells a different story. About 24% of units sold are to VisMin customers, but the revenue trend has remained stagnant and flat over the past three years. Hydie is losing more orders than what is considered healthy in VisMin. Based on data retrieved from the company's Customer Relationship Management (CRM), as shown in Table 1, about P30.9 million in lost sales is recorded every year. Also, based on the collected information on the CRM, the top causes for losing orders are as shown in Figure 1.

Simply put, the prices of Hydie are significantly higher than that of the competition, and customers

cannot wait long enough for lift trucks to be delivered. Meanwhile, Hydie's competitors in the industry can offer more competitive prices and shorter lead times. Also, the rest of the factors like Lack of Relations, Product Specifications, and Others will be ignored for now, since they are not caused by supply chain issues.

The top two causes of High Price and Delivery Lead Time are interconnected. Since Hydie has a central warehouse, it will only deliver a product to VisMin upon a customer's confirmed purchase order. The current process is shown in Figure 2. The OEM supplier ships the container to Manila, where the products are unloaded in Hydie's Paranaque warehouse and stored there. If an order is received from a customer from VisMin, then the warehouse personnel will mobilize and arrange to deliver the unit via sea under loose cargo (LCL). If Hydie sells an average of 29 units per year, this process is repeated 29 times as well, assuming customers only buy one unit at a time. This is where the additional costs come into play, and ultimately, the cost is passed on to the customer, which inflates the selling price.

Another problem with this process is the delivery time. Deliveries from Manila to major ports in Visayas and Mindanao can take 10-20 days on average. However, customers generally prefer to take possession of the unit within one week after the down payment is paid. If the appointed forwarder is fortunate enough to load the cargo as the ship is leaving and with available space, it can take only 4-5 days. However, this occurrence comes only once in a blue moon, and one cannot rely on chance to solve real-world problems.

Area	Ave units sold / year	Ave revenue / year (PHP x 1M)	Ave no of lost sales, units	Estimated lost sales / year (PHP X 1M)	Win Rate
Cebu	10	11.35	6	6.81	63%
Bacolod	4	4.56	4	4.56	50%
Iloilo	1	1.14	3	3.42	25%
Cagayan de Oro	7	8.03	5	5.73	58%
Davao	3	3.45	6	6.90	33%
General Santos	4	4.60	3	3.45	57%
TOTAL	29	33.15	27	30.89	

Table 1. Hydie Relevant Sales Data for VisMin

Figure 1. Causes of Lost Sales in VisMin

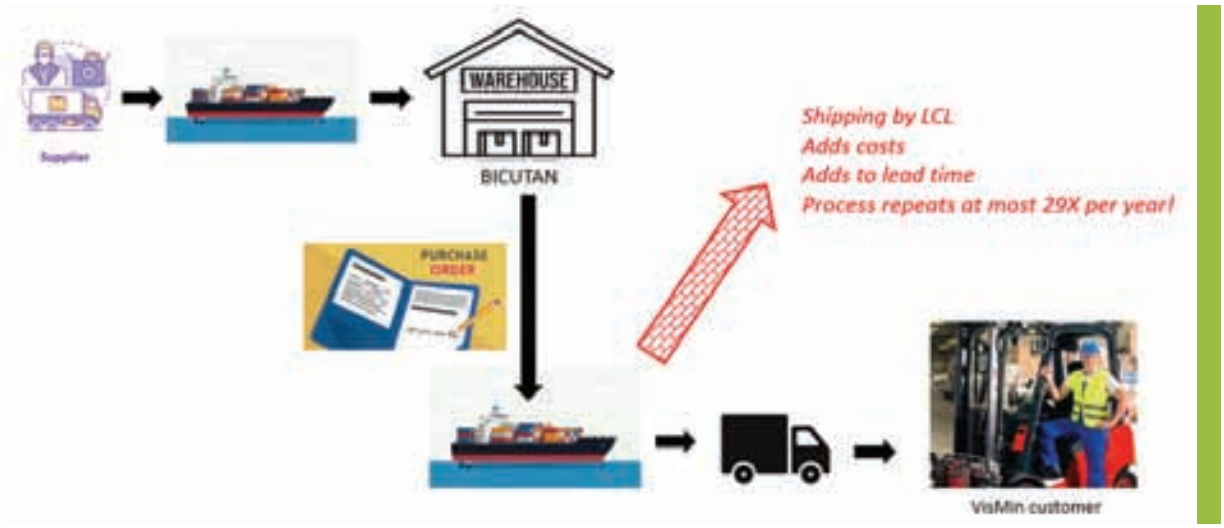

Figure 2. Hydie Supply Flow Process

Objective

This paper aims to streamline the logistics process to achieve lower costs of delivery and subsequently, enable Hydie to lower its prices due to the cost savings generated. Secondly, the delivery lead time is targeted to be less than a week for all major cities in Visayas and Mindanao. The result will be an expected increase in units sold in those areas.

Recommendation

In order to streamline the logistics process of lift truck delivery, the recommendation will be to lease one warehouse each in Visayas and Mindanao. It has to be on both locations since putting only one warehouse in Visayas or vice versa still leaves more than a one-week delivery lead time to the other region. The Visayas warehouse will serve as a central hub for distribution and aftersales servicing within the region, and this setup will be replicated for Mindanao. The challenge here is to identify the exact and appropriate location of each warehouse. The target is for each warehouse to enable the quickest accessibility to Hydie's customer base at the lowest possible cost and at a location with good prospects for growth. A warehouse cannot also be located anywhere. It should mandatorily be located where Hydie has existing branches because Hydie personnel need to be present to complement the warehouses to support the operations on the ground.

Location planning is essential to every business, and it is core to any supply chain management strategy. Every firm must use location planning techniques to properly understand each location's merits and make the correct decisions. In the case of Hydie, the core issue is that customers demand deliveries to be made within a week. The correctly identified location from which to ship the product would be able to meet this demand and thus meet the customer's expectations.

With the choices of possible locations narrowed down, these are now the options for warehouse locations in Visayas and Mindanao, respectively:

Visayas: Cebu, Iloilo, Bacolod

Mindanao: Cagayan de Oro (CDO), Davao, General Santos

The most suitable method of location strategy is the Factor Rating method. This was selected

because it can cover both quantitative and qualitative factors of what an ideal location should have, based on the company's preference. Other methods were also considered, like the Center of Gravity method. However, the resulting location using this method will likely be in the middle of the sea in Visayas since it is a group of islands scattered around. It will also likely result in a spot in the middle of nowhere for Mindanao since customer locations are concentrated in certain areas, but the entire Mindanao is geographically extensive.

The steps undertaken to arrive at the result are:

1. Identify the critical success factors for a warehouse location.
2. Create a decision matrix and indicate the justifications or facts for each location that will serve as the basis for scoring.
3. Assign weights to each factor according to its relative impact on the business. Weights are in the form of a percentage.
4. Create a Factor Rating with the critical success factors and their assigned weights.
5. Proceed to rate each factor according to the statements made in the decision matrix.
6. Calculate the rating for each location by multiplying the rating by the weights, thus coming up with a weighted score per factor.
7. Find the sum of each weighted score to determine which location has the highest score. The location with the highest score is the optimal warehouse location.

The following six critical success factors have been identified, and this is the basis for the conclusions indicated in the decision matrix:

1. *Centrally located within Hydie's customer base (20% weight)* – To deliver more expediently, the warehouse should be located close to the majority of the customers. Furthermore, Hydie's service technicians can respond quickly to unscheduled breakdowns with readily available spare parts in case of an unscheduled breakdown at a customer site.
2. *Sufficient space (20% weight)* – Ample space is needed for maneuvering the lift trucks and storage and as racking for select spare parts and consumables. For this purpose, a 200 square meter space is determined to be sufficient, give or take a few square meters depending on the availability of warehouses for lease.
3. *High level of security / Low crime area (10% weight)* – Criminal activity can be a major liability. Thus, the general safety of each location to not be susceptible to theft or other criminal activity damaging to the business is included as a factor. The level of security provided by the warehouse owner must be in accordance with Hydie's expectations, like 24-hour security and CCTV surveillance systems. The crime rates per population also play a part in the scoring.
4. *Potential for market growth (20% weight)* – Each location must be in an area where significant market growth is expected, as increased economic activity is proportional to increased sales of lift trucks. The Gross Regional Domestic Product (GRDP) was used as a basis to quantify this. The second basis is the current project pipeline taken from Hydie's CRM.
5. *Rental cost (15% weight)* – Rental cost per year must be in line or lower with market rates. This is of importance since Hydie is looking at a long-term rental contract. Auxiliary services such as loading and unloading, insurance, and security charges should be included in the price. The rates obtained for all locations range from P420 to 480 per square meter, with an increase of 2% year on year.

6. *Ease of incoming and outgoing transportation (15% weight)* – A 10-wheeler truck is needed to deliver a single lift truck; therefore, it is preferable to have wide roads and minimal traffic in the vicinity. It is also preferable to have a direct route toward the major highways and ports for ease and convenience of transportation. The selected locations should also have international ports that can accept and release shipments in a timely and efficient manner. In the case of Visayas, where sea transportation is needed, the frequency of trips per week should also be taken into account.

Optimal Warehouse Location for Visayas

The map in Figure 3 shows the current and potential customer base in the Visayas. The majority of the customers are located in Cebu. Second is Bacolod, and far behind are Iloilo and Tagbilaran. Hydie has existing branches in Iloilo, Bacolod, and Cebu, and therefore as a requirement, these will serve as the three options for warehouse location. Based on the metrics and rationale described, the decision matrix for the Visayas locations is shown in Table 2.

The sources of information that formed the basis of the decision matrix came from the following sources:

1. Hydie's CRM data
2. Pricing information from warehouse providers in each location
3. Crime statistics from the DILG report from 2019 (see Appendix A)
4. Economic data per region from the Philippine Statistics Authority

The factor rating table for the Visayas warehouse location is presented in Table 3. Based on the results, the optimal warehouse location is in Cebu. Cebu scored specifically high on its central location, market growth potential, and ease of transportation to and from neighboring major cities. Meanwhile, it had less desirable scores on rental cost and security.

Optimal Warehouse Location for Mindanao

The same methodology is applied to the Mindanao location, as shown in Figure 4. Most customers are located in CDO, Davao, and Gensan, with

Figure 3. Western Visayas Map

Table 2. Visayas Location Decision Matrix

Critical Success Factors	CDO	Davao	Gensan
Centrally located within Hydie's customer base	50% of customer base	21% of customer base	29% of customer base
Sufficient space	Available space 200 sq meters	Available space 180 sq meters	Available space 300 sq meters
		High traffic volume within the area	
High level of security / Low crime area	24/7 security and CCTV	24/7 security and CCTV	24/7 security and CCTV
	23.28 crimes per 100K population	22.39 crimes per 100K population	31.69 crimes per 100K population
Potential for market growth	861M GRDP in 2020 (x1000)	889M GRDP in 2020 (x1000)	468M GRDP in 2020 (x1000)
	97M sales pipeline as of Jun 2021	55M sales pipeline as of Jun 2021	40M sales pipeline as of Jun 2021
Rental cost	480 per sqm	480 per sqm	420 per sqm
Ease of transportation	Port of CDO – international & local shipments	Port of Davao – international & local shipments	South Cotabato Integrated Port – international & local shipments
	Major cities in Mindanao can be reached by land, not centrally located	Major cities in Mindanao can be reached by land, centrally located	Major cities in Mindanao can be reached by land, not centrally located

some units scattered in Iligan, Polomolok, and Tagum. Again, the warehouse options are where Hydie has existing branches. These options are Cagayan de Oro, Davao City, and General Santos City. The decision matrix for Mindanao, with the same critical success factors and logic behind Visayas, is shown in Table 4. The factor rating table (Table 5) shows the results of the Mindanao warehouse location.

Based on the results, the optimal warehouse location is in CDO. CDO scored specifically high on its available space and market growth potential. As CDO is located in Northern Mindanao and not near the center, it is not surprising to see a low score. Being a highly developed city, it also has slightly higher rental costs. Davao came in a close second due to its high score in ease of transportation, as it is located in the center of Hydie's customer base in Mindanao.

Impact on Business

Cost Savings

Figure 5 presents the resulting logistics process after the warehouses have been added. The China OEM supplier now ships FCL directly to either Cebu or CDO, both of which have world-class ports that can facilitate local and international shipments. The lift trucks are unloaded and

stored in the warehouse until a purchase order is received. The Hydie personnel in the branch arrange for delivery to the customer from the warehouses in Cebu and CDO, respectively. By doing this, the process of repeated deliveries from Manila to Vismin is eliminated.

The projected cost savings of this streamlined process are shown in Table 6. The shipping costs were taken from Hydie's Enterprise Resource Planning (ERP) system and based on the 3-year historical average. One 40-foot container can fit four units of lift trucks.

Based on an average of 29 units per year, Hydie orders seven containers worth for VisMin customers. Assuming that every customer purchases one unit at a time, 29 units have to be delivered via LCL from Bicutan to VisMin every year. The total cost for the current process is P4.16 million per year.

With the Cebu and CDO warehouses in place, the seven containers will be shipped directly from the supplier to the respective warehouses, where the units will be stored until they are sold. However, the cost of local transportation from Cebu and CDO to major cities in the region is more expensive because of the greater distance and additional modes of transport (in the case of Visayas). These incremental costs are captured in the table at P630,000 and P300,000 for Visayas and Mindanao, respectively. The total cost for the new logistics is P2.34 million per year.

In conclusion, Hydie stands to save P1.81 million per year on the streamlined logistics process. Other shipping costs like the current working capital and local truck deliveries within Cebu / CDO will be considered irrelevant costs since this process exists for both scenarios. Since the local team will also handle the warehouse and insurance will be included in the warehousing rates, there will not be additional warehousing manpower costs.

Shorter Delivery Lead Time

The delivery times have also improved with this new setup as intended by the study, based on Table 7. This also shows that the selected warehouses can still deliver within the 1-week (or shorter) time frame to other major cities within the region. For Visayas, an additional one to three days is required for cargo loading and unloading and conformity to shipping schedules.

Table 3. Visayas Warehouse Location Factor Rating Table

Critical Success Factors	Weight	Iloilo	Bacolod	Cebu	Weighted Score- Iloilo	Weighted Score - Bacolod	Weighted Score - Cebu
		(Scale of 1 to 5					
Centrally located within Hydie's customer base	20%	2	3	5	0.4	0.6	1
Sufficient space	20%	4	3	5	0.8	0.6	1
High level of security / low crime area	10%	4	5	3	0.4	0.5	0.3
Potential for market growth	20%	3	4	5	0.6	0.8	1
Rental cost	15%	4	5	3	0.6	0.75	0.45
Ease of incoming / outgoing transportation	15%	3	4	5	0.45	0.6	0.75
TOTAL	**100%**				**3.25**	**3.85**	**4.5**

Figure 4. Mindanao Map

Increase in Sales Volume

With more competitive prices and a faster delivery time, Hydie forecasts to have additional sales and profits for the next three years, as in Table 8. Due to the possible lingering effects of the Covid-19 pandemic, a conservative approach to sales forecasting will be adopted. Therefore, it is assumed that the incremental profits will remain constant for the next three years. The actual numbers will surely change from year to year, but the above numbers will represent the expected average figures. It is worth noting that the processing of the sales and storage of 7 to 8 units of forklifts a year will require no additional manpower, the existing personnel employed by Hydie at the site can absorb the additional responsibilities.

Financial Viability

In the real world, despite the data showing cost savings and increased sales, the fact is that the company has to invest money to get the project off the ground. The most common questions are, what is the financial return, and when will the investment be recovered? To answer these, the project's net present value is computed, using the cost savings and incremental profit as the positive cash flows and the additional working capital and warehousing costs as the negative cash flows. A discount rate of 10% is assumed.

As shown in Table 8, net cash inflows for both Cebu warehouse and CDO warehouse amounts have a net present value of P0.49 million and P2.42 million, respectively, over three years. The savings stem from the reduced cost of logistics, as explained earlier. The table above also considers the additional profit generated from additional sales to existing and new customers due to faster delivery of units and parts. The additional inventory is the incremental number of units that Hydie forecasts to sell in the next three years. The warehouse rental costs are priced at P480 per square meter for 200 square meters per month with a provision for a 2% increase year on year.

There will be no additional manpower required since there are already existing sales personnel in Cebu and CDO. The responsibilities of maintaining the inventory can be absorbed by the existing staff. Therefore there will be no additional costs involved for manpower.

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Table 4. Mindanao Location Decision Matrix

Critical Success Factors	CDO	Davao	Gensan
Centrally located within Hydie's customer base	50% of customer base	21% of customer base	29% of customer base
Sufficient space	Available space: 200 sq meters	Available space: 180 sq meters	Available space: 300 sq meters
		High traffic volume within the area	
High level of security / Low crime area	24/7 security and CCTV	24/7 security and CCTV	24/7 security and CCTV
	23.28 crimes per 100K population	22.39 crimes per 100K population	31.69 crimes per 100K population
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Table 5. Mindanao Warehouse Location Factor Rating Table

Critical Success Factors	Weight	CDO	Davao	Gensan	Weighted Score-CDO	Weighted Score - Davao	Weighted Score - Gensan
		(Scale of 1 to 5					
Centrally located within Hydie's customer base	20%	3	4	2	0.60	0.80	0.40
Sufficient space	20%	5	3	4	1.00	0.60	0.80
High level of security / low crime area	10%	5	4	3	0.50	0.40	0.30
Potential for market growth	20%	5	4	3	1.00	0.80	0.60
Rental cost	15%	3	4	5	0.45	0.60	0.75
Ease of incoming / outgoing transportation	15%	4	5	3	0.60	0.75	0.45
TOTAL	**100%**				**4.15**	**3.95**	**3.30**

Figure 5. Hydie's Logistics Process

Hydie forecasts to sell in the next three years. The warehouse rental costs are priced at P480 per square meter for 200 square meters per month with a provision for a 2% increase year on year. There will be no additional manpower required since there are already existing sales personnel in Cebu and CDO. The responsibilities of maintaining the inventory can be absorbed by the existing staff. Therefore there will be no additional costs involved for manpower.

Risk Analysis

In establishing new warehouses, there will always be a risk of inventory loss caused by theft or damages to inventory caused by vandalism or natural calamities such as earthquakes and floods. In order to mitigate those risks, insurance must be taken by Hydie to safeguard against such events. Hydie will also require the warehouse provider to undertake insurance against loss or damages to Hydie's inventory in cases where the cause is attributable to them. The cost of said insurance is included in the rental costs.

Conclusion and Next Steps

Establishing a rented warehouse in Cebu and Cagayan de Oro, respectively, will reduce logistic costs, help solve the delivery lead time issues and at the same time, enable further growth in sales in Visayas and Mindanao. Based on financial analysis, the project is very beneficial to

the company, and the initial investment can be sufficiently recovered in less than three years.

The next step would be to get the buy-in and approval from Hydie's top management, after which the prospective warehouse locations in the selected areas be further narrowed down. Once a specific warehouse has been identified, then the shipments from the China OEM can be diverted to Cebu and CDO, respectively. The last step is to monitor the outcome of the decision by recording the actual costs and incremental sales to see if the projections have been accurate and if adjustments to the strategy are needed.

Table 6. Cost Savings

Centralized Manila warehouse			Ship direct to Cebu and CDO warehouse	
Number of deliveries from OEM China Supplier / year	7		Number of deliveries from OEM China supplier / year	7
Average shipping cost per container	183,286.00		Average shipping cost per container	202,374.00
Total cost of shipping to Manila / year	1,283,002.00		Total cost of shipping to Cebu and CDO warehouse / year	1,416,618.00
Number of deliveries from Manila to Vismin / year	29		Increase in delivery charges from Cebu to other cities	630,000.00
Average shipping cost of LCL / year	99,250.00		Increase in delivery charges from CDO to other cities	300,000.00
Total cost of shipping to Vismin / year	2,878,250.00			
Total shipping costs if Manila warehouse	4,161,252.00		Total shipping costs if Cebu & CDO warehouse	2,346,618.00
TOTAL SAVINGS FOR THE NEW PROCESS / YEAR (for both Cebu and CDO warehouse)				1,814,634.00

Table 7. Delivery Times

From Cebu Warehouse to:	Distance in km	Travel time	Mode of transportation
Bacolod	225 kms	6 hours	Land – Sea - Land
Iloilo	275 kms	14 hours	Land - Sea
Tagbilaran	112 kms	3 hours	Sea
Dumaguete	149 kms	7 hours	Sea
Ormoc	213 kms	3 hours	Sea
Tacloban	310 kms	6 hours	Sea - Land

** Add 1 to 4 days for sea routes for shipping schedule and cargo processing*

From CDO Warehouse to:	Distance in km	Travel time	Mode of transportation
Davao	255 Kms	5 hours	Land
General Santos	360 Kms	7.5 hours	Land
Iligan	91 Kms	2 hours	Land
Butuan	179 Kms	4 hours	Land
Tagum	277 Kms	6 hours	Land
Zamboanga	492 Kms	11 hours	Land

Table 8. Incremental Benefits

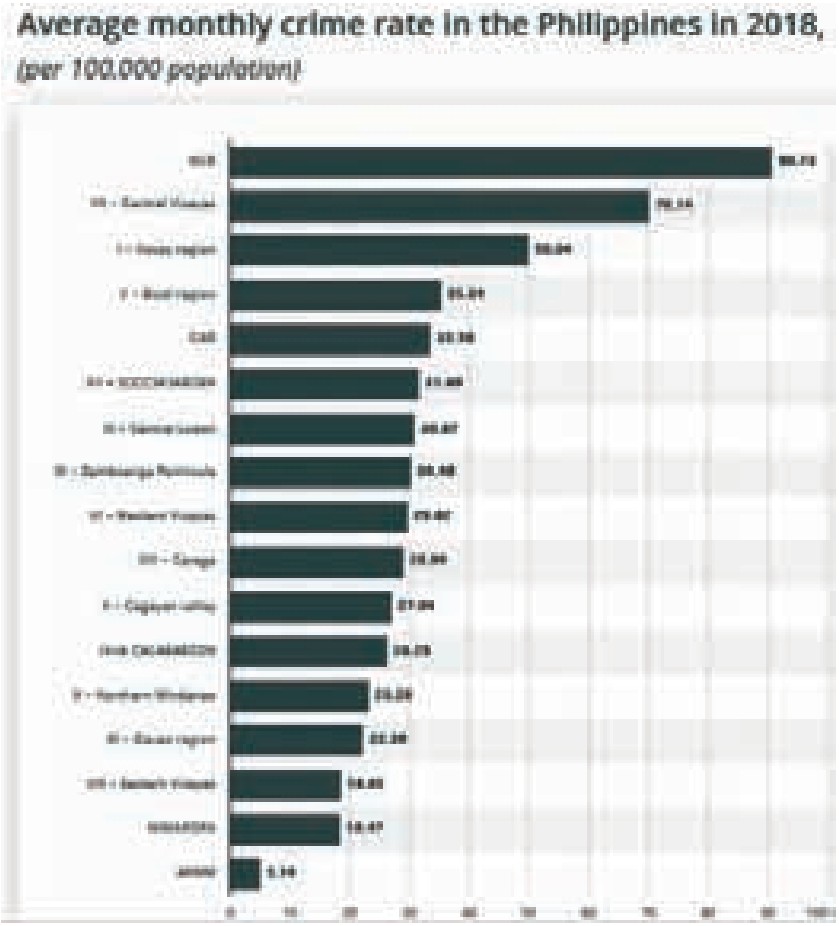
Forecast (Year 1 to 3)	Visayas	Mindanao
Incremental unit sales	7	8
Incremental profit	1,610,000.00	1,810,000.00
Precentage increase from current	47%	56%

Cebu Warehouse	Now	Year 1	Year 2	Year 3
Additional inventory	6,440,000.00			
Warehouse rental	1,152,000.00	1,175,040.00	1,198,540.80	
Incremental profit		1,610,000.00	1,610,000.00	1,610,000.00
Cost savings from logistics		521,650.00	521,650.00	521,650.00
Return of inventory				6,440,000.00
Total	-7,592,000.00	956,610.00	933,109.20	8,575,650.00
Discount rate	20%			
NPV	[illegible]			

CDO Warehouse	Now	Year 1	Year 2	Year 3
Additional inventory	7,280,000.00			
Warehouse rental	1,152,000.00	1,175,040.00	1,198,540.80	
Incremental profit		1,810,000.00	1,810,000.00	1,810,000.00
Cost savings from logistics		1,176,754.00	1,176,754.00	1,176,754.00
Return of inventory				7,280,000.00
Total	-8,432,000.00	1,811,754.00	1,788,213.20	10,106,754.00
Discount rate	20%			
NPV	[illegible]			

Table 9. Net Present Value

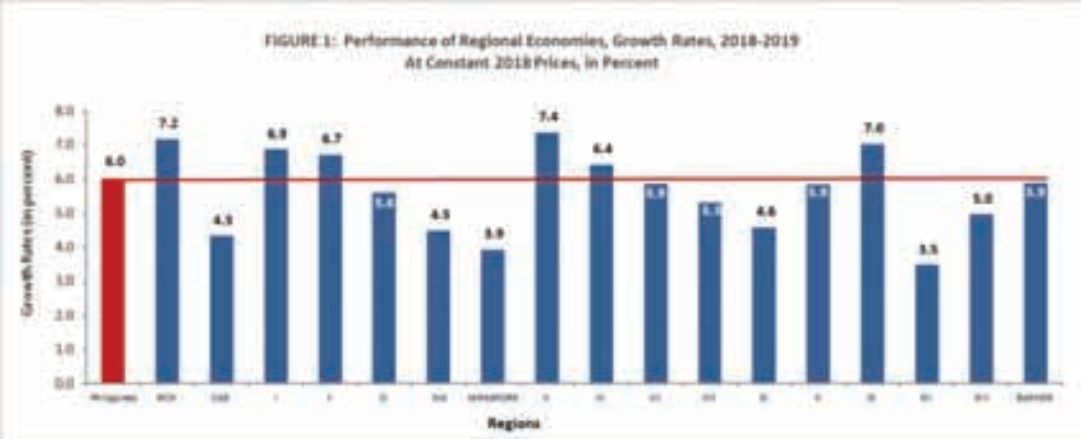
Appendix A. Crime Rates by Region 2018, from DILG 2018 report



Appendix B: Gross Regional Domestic Product per Region 2020, from the Philippine Statistics Authority

Gross Regional Domestic Product, by Region

	At Current Prices
	2020
Region VI (Western Visayas)	850,746,746
Region VII (Central Visayas)	1,164,719,190
Region X (Northern Mindanao)	861,506,489
Region XI (Davao Region)	889,457,659
Region XII (SOCCSKSARGEN)	467,905,541



Maclin Electronics

Lance Timothy Lim

Maclin Electronics, Inc. is a manufacturing company incorporated in 1963 by the Lim family patriarch, Jose Lim Sr., together with his older brother Lim Ket Kai. In its early years, Mr. Lim, along with a group of ingenious local engineers, focused on the research and development of the company's products and studied how each could sell well in the local Philippine market. During this time, entertainment was considered expensive as there were only several brands that sold audio-visual appliances at low price points. Mr. Lim saw an opportunity, and thus, the brand PROMAC was born, which signified the "PROfessional quality of MAClin products."

In its first few years, the company mainly sold portable transistor radios and radiophones made of wooden cabinets, both developed in-house. The following decade saw the company expand its product line, such as radio-cassette players and electric fans, as plastic material became more mainstream. In the early nineties, Maclin strengthened its presence in the audio-visual segment with the launch of mini-components, karaoke sound systems, and TV sets (both black & white and colored). Today, Promac is proud of its comprehensive product mix, ranging from LED and LCD televisions, speakers, karaoke systems, radios, and many more.

In 2006, management saw an opportunity to acquire another brand considered a player in the middle-income home appliance industry. Hence, with the board's approval, the company purchased the brand Union Global Home Appliances. For the longest time, Mr. Lim had always prioritized operational excellence and engineering, and thus the transition to manufacturing home appliances was smoother than expected. The second generation, though, also wanted to build brand equity and further ingrain the brand in the minds of the Filipino people. Because of this, the company partnered with then famous talk show host, Kris Aquino, as the endorser of Union Global. Sales skyrocketed, which further cemented the brand as one of the big players in the industry.

Soon enough, the company expanded into manufacturing laundry products and small kitchen appliances as it already had an economies-of-scale advantage compared to its competitors. Before this, the company only had one factory situated on a two-hectare property in Quezon City.

Figure 1. Single Tub Washing Machine.

Table 1.Contribution Margin.

Contribution Margin per Model	A	B	C
Selling Price per Unit	₱2,095.00	₱2,295.00	₱2,645.00
Variable Cost per Unit	₱1,279.14	₱1,369.49	₱1,439.81
Contribution Margin per Unit	₱815.86	₱925.51	₱1,205.19
CM Ratio	38.94%	40.33%	45.56%

Model	Net Weight	
Washing Machine A	5,692.47	grams
Washing Machine B	5,751.06	grams
Washing Machine C	6,160.56	grams

Table 2. Raw Material Weights.

Model	Labor Hours	
Washing Machine A	0.50	man-hours
Washing Machine B	0.50	man-hours
Washing Machine C	1.00	man-hours

Table 3. Man-Hours

In 2012, Maclin Electronics constructed a second factory based in Taytay, Rizal, where all laundry, small appliances, and other electric fans are being produced to this day.

Maclin Electronics offers a wide range of products categorized into six divisions: ventilating solutions, laundry, kitchen appliances, air cooling, storage, and audio-visual equipment. Its biggest item group (in terms of sales breakdown) would be its ventilating solutions contributing to 46% of total sales in 2019, as the brand is considered one of the well-known brands in the electric fan industry. The next would be its audio-visual division which contributes to 19% of total sales and is still well-known for its karaoke machines and entertainment systems. The company's laundry products contribute 17% of the total sales. In contrast, kitchen appliances, ranging from small products like oven toasters to large appliances such as gas ranges, bring in 8% of total sales. Air cooling solutions contribute 7%, while storage solutions like chest freezers and refrigerators contribute 3% of total sales.

Production Scheduling

One of the factories of Maclin Electronics is the manufacturing of laundry products such as washing machines and spin dryers. It currently produces six different models of the single-tub variant depending on its load capacity. Refer to Figure 1.

The discussion of this case will focus on three models, namely, Washing Machine A, B, and C. Reason for consideration is because these models share common parts in their assembly. With varying price points and a share in limited resources (e.g., imported parts, raw materials, labor hours, etc.), production scheduling should focus on profit maximization while allocating the company's resources as efficiently as possible.

For illustration purposes, the contribution margin (or gross profit margin) per model shall first be presented in this case. As shown in Table 1, washing machine C has the highest profit margin due to its higher sales price per unit.

Three constraints are present when it comes to

Figure 2. Ideal Design for Loading Bay

producing washing machines. The first constraint is the supply of washing machine motors, wherein the 100-watt variant is shared among all these three models. On average, 2,000 pieces of the 100-watt motor are shipped to the factory in Taytay every two weeks (or 1,000 pieces per week).

The second constraint pertains to the raw materials used to inject plastic parts into the washing machine. Four hundred bags are allotted for the production of the three models, with each bag containing 25 kg of plastic resin. The net weight of plastic raw material used for each model is stated in Table 2.

Finally, each model takes a certain amount of time to be produced, with only one production line to be utilized in this case. In a week, there are 720 man-hours per production line. The number of man-hours is given in Table 3.

Given the respective profit margin per model and the constraints provided: shipment of motor and plastic raw materials and the limited time of man-hours, how should the production manager schedule one full line for the week?

Loading of Trucks

Another problem management faces is the long turnover time of trucks, which leads to traffic buildup and congestion in the warehouse area. Estimates of 60 or more trucks arrive in the company's warehouse every day, which means an average of 7.5 trucks per hour. The warehouse area only has 4 loading bays without any elevated platform for ease in loading. See Figure 2. Because of this design, it takes more time for warehouse personnel to load a 6-wheeler truck as appliances are still lifted and carried to the truck instead of hauling them straight to the van.

The design of the current loading dock of the company has led to a mean service rate of 2 trucks per hour per loading bay or a 30-minute loading time per truck.

The warehouse area follows a single-line system, where trucks simultaneously fill in freeloading bays after the previous truck leaves the area. With this in mind, management discovered the following measures given the current scenario using the MMs Queue Model shown in Table 4.

Most of the trucks spend ample time waiting for their turns to be loaded. The expected time in queue is 1.73 or almost 2 hours, while it only takes 30 minutes to serve each truck. The company's strategy is to increase its number of loading bays to see whether this would minimize waiting time and thus decrease warehouse congestion and costs.

Weekly Production Schedule Using Linear Programming

One of the main challenges of a production manager is how to allocate the company's resources in scheduling the right models that

Table 4. MMs Queue Model

M/M/s Queue		
Inputs		
Unit of time	hour	
Arrival rate	7.5	customers/hour
Service rate per server	2	customers/hour
Number of servers	4	
Outputs		
Direct outputs from inputs		
Mean time between arrivals	0.133	hours
Mean time per service	0.500	hours
Traffic intensity	0.938	
Summary measures		
P(system empty)	0.007	
P(all servers busy)	86.5%	
Expected number in system	16.725	customers
Expected number in queue	12.975	customers
Expected time in system	2.230	hours
Expected time in queue	1.730	hours
Percentage who don't wait in queue	13.5%	

maximize profitability. In the case introduced in the previous section, the manager is faced with a dilemma on which models to schedule in his weekly production run given his constraints on imported parts, plastic raw materials, and time. All three models share the same resources but vary selling price and costing. An additional assumption is made where all models have outstanding sales orders – pending until the delivery of finished goods. The production schedule must then run SKUs that will yield the highest profits for the company in this specific week.

Details on the production's constraints have been discussed earlier, and the assumption is that resources can be used as long as they are still available. Thus, running the problem in Solver (see Table 5), the following models should be prioritized in the production schedule.

The production manager must then focus his resources on the two models with higher profit margins, namely washing machine B (560 units) and washing machine C (440 units). This schedule will yield a profit of 1,048,200. Both washing machine motors and the time spent will be maximized with this schedule, while 4,070 kg of plastic material shall be left unused.

Increase in Loading Bays Using Queuing Analysis (MMs Model)

In line with management's plans for aggressive sales growth, the logistics and warehouse managers must find a way to improve truck turnover, leading to increased delivery volume per day. Trial-and-error is done to see the effects of adding one more loading bay to the waiting time of the trucks. Management can then decide whether the costs of adding x number of loading bays are justifiable to achieve supply chain efficiency. Initially, one loading bay is added to see how it affects queuing in the warehouse area.

In Table 6, the expected time in queue significantly decreased to 11.1 minutes (from 2 hours), where an average of 1.4 trucks are waiting in queue compared to 13 trucks when there were only four loading bays.

In Table 7, the expected time in queue is further decreased when there are six loading bays—from 11.1 minutes to 3.06 minutes. There is minimal waiting time for the trucks as loading can be done more simultaneously.

Peak season is also considered, with 80 trucks arriving per day (or ten trucks per hour). Refer to Table 8. With the set-up of 6 loading bays, the waiting time is still acceptable at 18 minutes, with only three trucks waiting at a point in time.

Recommendation

As a manufacturing company, Maclin Electronics has to focus on value-adding activities that maximize its profits, given a limited number of resources. Several other factors still need to be considered before making a final decision. To present the case in this paper, a simple illustration of each problem is only made to show the use of management science as a tool in aiding the manager's decision-making.

Table 5. Solver Template

Case/Problem Name:	Production Schedule												
Problem Objective													**Total Objective**
	1	2	3	4	5	6	7	8	9	10	11	12	
Decision Variable ID	A	B	C										
Quantity (leave blank)	0	560	440	0	0	0	0	0	0	0	0	0	
Unit coefficients	815	925	1205										
Total Objective	0	518,000	530,200	0	0	0	0	0	0	0	0	0	1,048,200

Constraint Coefficients													
1 Washing Machine Motor	1	1	1										
2 Plastic Raw Material	5.69	5.75	6.16										
3 Man-Hours	0.5	0.5	1										
4													
5													
6													
7													
8													
9													
10													
11													
12													

Constraint Results													Used	Available	Unused
1 Washing Machine Motor	0	560	440	0	0	0	0	0	0	0	0	0	1000	1,000	0
2 Plastic Raw Material	0	3220	2710	0	0	0	0	0	0	0	0	0	5930	10,000	4070
3 Man-Hours	0	280	440	0	0	0	0	0	0	0	0	0	720	720	0

Table 6. Addition of 1 Loading Bay

M/M/s Queue		
Inputs		
Unit of time	hour	
Arrival rate	7.5	customers/hour
Service rate per server	2	customers/hour
Number of servers	5	
Outputs		
Direct outputs from inputs		
Mean time between arrivals	0.133	hours
Mean time per service	0.500	hours
Traffic intensity	0.750	
Summary measures		
P(system empty)	0.019	
P(all servers busy)	46.2%	
Expected number in system	5.135	customers
Expected number in queue	1.385	customers
Expected time in system	0.685	hours
Expected time in queue	0.185	hours
Percentage who don't wait in queue	53.8%	

Linear Programming is used to calculate a production manager's scheduling that will yield the highest profit for the company. When faced with a situation where raw materials for the week are limited, it should be in the manager's best interest to schedule models that have higher profit margins and better production volume. To use up as many resources as possible, the company's production department will schedule washing machines B and C in its run. This schedule will yield the company a profit of ₱1,048,200 from these product lines alone, and where its imported parts and time will also be fully utilized.

Finally, queuing analysis is used by both logistics and warehouse managers to see the effectiveness of adding more loading bays to decrease the waiting time of trucks. As a result of the reduced waiting time, the warehouse area can accommodate more incoming trucks for a higher fill rate and thus higher sales. After running the analysis, management can decide whether to add 1 or 2 more loading bays depending on the cost-benefit analysis of the proposal. Adding at least one will help decrease waiting time from 2 hours to just 11 minutes. Supply chain costs can thus be minimized in the long run and shall justify the additional costs of putting up more loading bays.

Post Implementation

Weekly Production Schedule Using Linear Programming

Using linear programming in creating weekly production schedules has systemized this process for the factory based in Taytay. The production department no longer has to play the daily guessing game of what model to run next based on the availability of parts. They now have access to complete information such as accurate inventory reports, lead time of arrival of parts, and others, allowing them to achieve their production efficiency goals proactively.

As presented in this paper, linear programming through the Solver template is one tool that can be used to aid production scheduling. Although there are still numerous factors that may affect

Table 7. Addition of 2 Loading Bays

M/M/s Queue		
Inputs		
Unit of time	hour	
Arrival rate	7.5	customers/hour
Service rate per server	2	customers/hour
Number of servers	6	
Outputs		
Direct outputs from inputs		
Mean time between arrivals	0.133	hours
Mean time per service	0.500	hours
Traffic intensity	0.625	
Summary measures		
P(system empty)	0.022	
P(all servers busy)	22.7%	
Expected number in system	4.129	customers
Expected number in queue	0.379	customers
Expected time in system	0.551	hours
Expected time in queue	0.051	hours
Percentage who don't wait in queue	77.3%	

Table 8. Peak Season (Increase in Arrival Rate)

M/M/s Queue		
Inputs		
Unit of time	hour	
Arrival rate	10	customers/hour
Service rate per server	2	customers/hour
Number of servers	6	
Outputs		
Direct outputs from inputs		
Mean time between arrivals	0.100	hours
Mean time per service	0.500	hours
Traffic intensity	0.833	
Summary measures		
P(system empty)	0.005	
P(all servers busy)	58.8%	
Expected number in system	7.938	customers
Expected number in queue	2.938	customers
Expected time in system	0.794	hours
Expected time in queue	0.294	hours
Percentage who don't wait in queue	41.2%	

the scheduling of models, like delays in the arrival of parts, machine downtime, and so on, having a more scientific approach allows the company to anticipate the unpredictability of incoming sales orders and level them to ensure maximum profitability given its constraints. As one of these benefits, the company has lessened its lead time of fulfilling orders from 2 to 3 weeks to 1 week.

Increase in Loading Bays Using Queuing Analysis

Queueing Analysis has allowed the company to evaluate its current loading process and see whether allotting more slots would ensure higher truck turnover times. Prior to this exercise, trucks were often issued violations due to the traffic buildup caused outside the factory. As mentioned earlier in this paper, an average of 12 trucks are often in queue for 2 hours versus a 30-minute loading period, which indicates a lack of value-adding time for these trucks. In addition, due to the limited capacity of the company's loading bays, the logistics and warehouse department couldn't accommodate all arriving trucks, which meant the company could not maximize its sales opportunities.

The company had to introduce new data collection and analysis processes and invest in more people to accommodate the increase in loading bays. As a start, only one loading bay was added based on the recommendation of this paper. This alone has improved traffic congestion in the facility as the company noticed improved truck flow and a lower queue count (from around 12 trucks to 5 trucks waiting at a time). Daily sales volume has also increased by around 45% to 60% because of the increase in capacity of the loading bays, which meant more truck deliveries to the company's customers per day.

However, the following analysis assumes the constant arrival of trucks in a particular period when the inflow of such can be hard to determine. Various factors such as late receiving of the customer or traffic can delay the arrival of trucks at the factory and thus creates an uneven input variable in the application of the MMs model. Probabilistic techniques such as Markov analysis can be used to determine what is most likely to occur given one's current situation (i.e. arrival versus non-arrival of truck A), which can then help the manager anticipate whether to open up

additional loading bays during high truck inflow or lack of it. This approach allows the company to reallocate its resources (i.e., manpower) to other value-adding activities whenever they are not needed in the factory's loading bays. Studies on probabilistic techniques can be undertaken to develop further the company's case on having a better solution to its loading bay woes.

The results based on the recommendations of this paper have shown how models can ultimately improve efficiencies not only in a manufacturing setting but relatively in any real-world situation. From how the company's service department answers to customers to how purchasing plans its ordering of raw materials, the introduction of scientific models has given the company an added edge in its operations. The presence and application of such can mean increases in profitability for the company in the years to come.

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Contributors

Everyone on the list is currently taking up or has completed his/her Master's Degree in Business Administration at the Ateneo Graduate School of Business (AGSB).

CAMILLE ANTE is an Independent Wealth Consultant, a Licensed Financial Advisor, a Pastry Chef and Entrepreneur, and a former Marketing Professional. She holds a BS Commerce degree in Marketing Management from De La Salle University-Manila. She had undergone French Pastry Arts training from the Ducasse Education at the Enderun Colleges. She also studied at the International Association of Registered Financial Consultants and gained Registered Financial Consultant and Registered Estate Planner designations. After her corporate stint as a marketing specialist at an AVM distribution business for two years, she opened Susana's Kitchen, a home-based baking business which caters to corporate clients and airport lounges. She joined AIA Philippines as a side business while she continued to focus on growing her business. She is a 6-year Million Dollar Round Table Qualifier and Member. She also partnered with ATRAM Wealth as an Independent Wealth Consultant.

CHARITY BALDEMOR is a Vice President for Operations with 20 years of experience in procurement and logistics for a manufacturing firm. She also has over seven years of experience in the power industry working as head of marketing and power trading operations. Charity earned her Bachelor of Science degree in Computer Engineering at the University of the Immaculate Conception in Davao City with Cum Laude honors. She is currently working on business development initiatives in renewable power generation and distribution in Luzon.

FRANCIS JEROME DE LARA earned his Bachelor of Science degree in Civil Engineering from University of the Philippines Diliman in 2013. He joined First Balfour's Junior Management Trainee Program at the onset of his career in construction and has undergone technical and leadership training to enhance his capabilities as a professional and as a future leader. He is the deputy Technical Manager of the ongoing tunneling project that will connect La Mesa Reservoir to the Balara Treatment Facility.

MELVEN DIMAPILIS

SOANA MARI FUENTES is a CPA in public practice. She is one of the founding partners of FCO Accountants, an accounting firm based in Cebu City that has been in operations since 2015. Before that, Swan was in the bancassurance industry for eight years, with five of those years in training, and three years in Sales Management as her last stint. Swan is a dedicated mother of five growing children and the Operations Chair of her organization. Nevertheless, she thrives on both roles because she fulfills them with mindfulness for commitment, dedication, and passion.

CRISTINE GALANG is an IT Executive who amassed over 15 years' experience in the Fast Moving Consumer Goods (FMCG) and Technology and Consulting industries while working in the Philippines and Canada. She specializes in Project Management, particularly in SAP systems. She is also an Adjunct Professor at the University of Asia and the Pacific (UA&P) where she teaches courses across their Bachelor's and Master's programs.

JENNIFER JARDIN is a manager of ROHM Electronics Philippines, Inc., a semiconductor manufacturing company located in Carmona, Cavite. She handles the Production Control department of the Transistor and Diode manufacturing division. Her work is to control various operations of the production control process from planning, material warehousing, progress monitoring, budget and inventory control. Her improvements on lessening

lead time and reducing the 3-big losses (Defect loss, Material loss, Inventory Loss) of production made a big impact on increasing the profitability of the company by lessening the 1pc-manufacturing cost of products. She graduated BSECE at the Technological University of the Philippines as a DOST scholar in 2001.

CHARLEMAGNE LIM is currently the Country Sales Manager for material handling company MHE Demag (P) Inc. for the past seven years.

EMILIO LIM, SVD is a Roman Catholic Missionary priest of the Society of the Divine Word. He holds an M.A. in Philosophy and an ecclesiastical diploma in Theology from Divine Word Seminary in Tagaytay City. He also completed an associate degree in Professional Communication from the University of New England in Australia. His twenty-one years of mission in Hong Kong include pastoral work for local Chinese and Filipino migrant workers. Returning to the Philippines in 2015, he was appointed school principal and later as school director of Saint Jude Catholic School in Manila. He continues his priestly ministry in broadcast and online media through the Sunday Healing Eucharist of ABS-CBN Kapamilya Channel and TV Maria Philippines.

LANCE LIM took up his undergraduate degree at the University of the Philippines Diliman majoring in BS Economics. He initially worked in a universal bank prior to moving to their own family business. He is the Operations Manager at Maclin Electronics, Inc. who handles both the production and logistics departments of the company.

MA. RAQUEL MAHINAY

ROCHELLE MARCELO-DELA CRUZ is a Certified HR Professional with over 13 years of experience in the BPO, Shared Services, IT & Engineering, and FMCG Shared Services Industries. She is the HR Business Lead of Mondel z Business Services supporting their Employee Services Operations in the Philippines and AMEA, Portfolio and Performance Management in the US, and Finance Experience Team in Europe.

GEORGIE MORAL

JOEY NOLASCO works as a Business Transformation Specialist with Accenture.

REY PAGTABUNAN

RENANTE PALPARAN is a Mechanical Engineer by profession and graduated with honors (academic distinction award) from STI-West Negros University. Rey was a recipient of the DOST scholarship program (formerly the National Science & Technology Authority or NSTA). He pursued his career in the semiconductor manufacturing industry in one of the pioneering Japanese firms in the Philippines located in one of the Export Processing Zones in Cavite. His almost three decades of exposure in a fast-paced and continuous improvement (KAIZEN)-driven environment allowed him to handle and share his knowledge and experiences in various corporate committee chairmanships such as Wastefulness (MUDA) Reduction, Energy Conservation, Chemical Safety, Machine Safety, Traffic Safety, Hazardous Substance, and Employee Welfare.

JOMAR PINEDA is a licensed Electronics Engineer. He earned his Bachelor of Science degree in Electronics and Communications Engineering at Adamson University in 2003 specializing in Physics of Semi-Conductor. He gained his knowledge and experience in production, material control, inventory control, management of spare parts and Procurement when he joined Shindengen Philippines Corporation in 2004. A two-time top

performer awardee, he was recently awarded the Best leader in Emerson FY19 Commercial and Residential Solutions Summit. Jomar handles both the Planning and Supply Chain department of Emerson Hermetic Motor. His direct reports are Materials Analyst and Supply Chain Analysts who provide support to North America Planning, Trade Compliance, and the Procurement department.

JASMIN SUAREZ is the Country Brand Lead for Eliquis at Pfizer Philippines, responsible for driving the country brand strategy to ensure the realization of revenue and profitability targets. Prior to joining Pfizer, she was Brand Manager for Singapore, Malaysia and the Philippines for Allergan's Eyecare Business. She also had a short stint at Bayer Philippines, but she started her career at GlaxoSmithKline as a management trainee, where for nine years she gained experience in various categories. Jas holds a Bachelor's degree in Business Economics from University of Philippines Diliman.

MARC TAN has been the Strategic Planning Officer and Building Manager of real estate company W Landmark Inc. for the past three years. Concurrently, he is also the Managing Director of his firm, RMT Training and Business Consultancy.

DERRICK VILLANUEVA is the General Manager of family-owned business Crown Asia Chemicals Corporation, in charge of the PVC Division.

ATENEO DE MANILA UNIVERSITY
GRADUATE SCHOOL OF BUSINESS

PROJMA

THE FUTURE OF NOW

TRANSFORM IN THE DIGITAL ERA

Embracing Digitalization: Continuous Innovation Accelerated by Progressive Companies

PROJMA S06 PRESENTS ***"THE FUTURE OF NOW: TRANSFORM IN THE DIGITAL ERA"***

The Future of Now: Transform in the Digital Era happened digitally via Zoom last August 14, 2021. The event was attended by 531 participants — a combination of AGSB Students, Faculty, Alumni, and External Participants.

The team invited speakers from different industries whose businesses have started implementing or have been implementing strategies to adapt to the better normal demands through digital transformation and innovative approaches.

The event was hosted by AGSB's very own Rosie Domingo and Leo Nogas and was graced by the presence of the beloved Dean of AGSB, Dean Jet Magsaysay, to deliver the opening remarks.

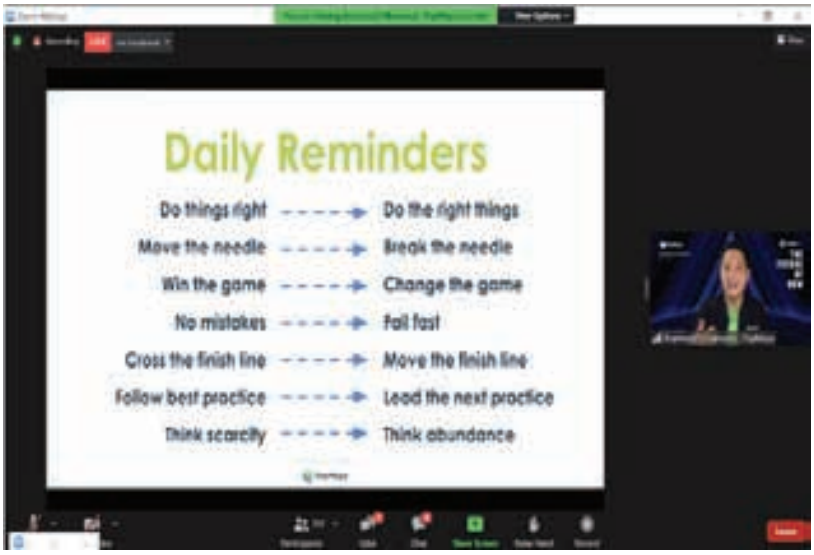
The webinar aims to engage the Ateneo community, provide timely information on business trends and connect with audiences outside the AGSB. It also aims to impart valuable insights such as the benefits of maximizing technological innovation, familiarization with up-to-date technological tools and systems, effective strategies and tips on adjusting to the evolving digital business environment, and imparting experiences encountered and practical business solutions.

The event's success is also accredited to the sponsors whose support helped enhance the webinar experience for the audience.

The event was made possible by the Project Management Class of the Standard Program S06.

The event's success is also accredited to the sponsors whose support helped enhance the webinar experience for the audience.

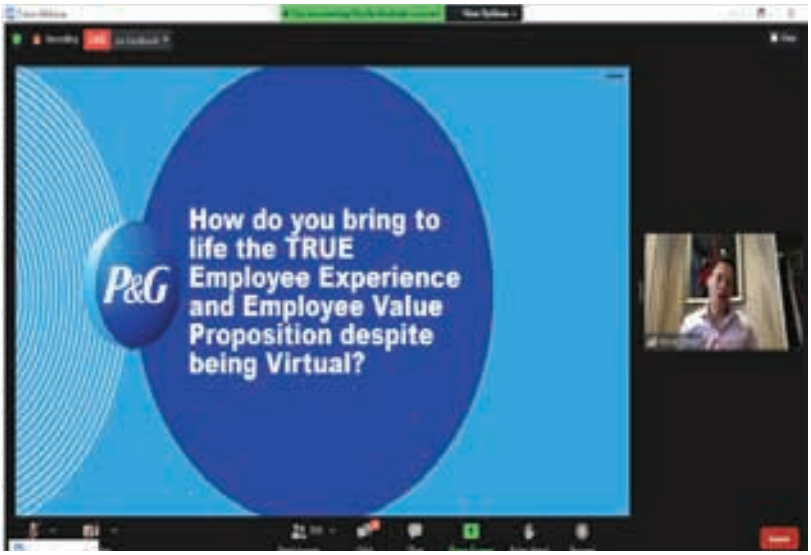
The quality of the speaker can make or break an event as they are on the frontline, tasked to set the tone, impress and engage the crowd, and make the event memorable to the audience. Everyone present agreed that this webinar is one of the best virtual events hosted by Ateneo Graduate School students. The speakers lined up played a big part in its success.



The first speaker is an expert and advocate of digital transformation and e-commerce. Mr. Jaypee Soliman leads Unionbank as the Vice president and the Head of SME Segment and SME Platforms under the Customer Experience Group. The speaker is very energetic and spontaneous. He provided awe-inspiring presentations and concrete examples of digitization initiatives in the banking industry. He shared his experience in the field of innovation and digital transformation considering his depth of understanding and expertise. The audience was captivated by his timely and relevant answers to the questions asked during the event especially on the downside of digitalization.

The second speaker is currently the Director and Head of Enterprise Growth in PayMaya. Mr. Raymund Villanueva continues to make an effort to be well-versed in the digital space as the digital landscape evolves, aiming to put the Philippines on the global digital map, one innovation, one brand at a time. The speaker provided practical tips to the audience on how to handle digitization initiatives. He gave relatable examples and answers that he was able to capture the audience's attention. The tips and daily reminders he used at work gave the audience an insight into how to do business better. His people-centric approach enabled him to engage the listeners throughout his talk. Furthermore, he was the crowd favorite based on feedback from the

attendees.



The last speaker has nearly over 19 years of Human Resource Experience and has worked across 3 different countries – the Philippines, Vietnam, and China. Mr. Vince Dizon is currently the HR Country Leader of Proctor & Gamble Philippines and was featured in Rappler talking on the company's approach in keeping workers healthy and how the company plans to move forward toward a "better normal." His in-depth understanding and ability to present the subject in a very engaging way have received exceptional feedback from the attendees. He uttered on the importance of authentic human connection in forging a strong and enabled

virtual organization. Finally, his timely and relevant answers like "Virtual enables us but virtual is not us" have captivated the audience.

Indeed, these speakers performed an exceptional role that energized the audience and offered new perspectives on the aspect of digitization and innovation. The diversity of the speakers, who came from different industries, provided an impeccable presentation, a strong sense of narrative, and deep field expertise, which truly made the event phenomenal and successful.

Social media was crucial in executing the event to ensure communications reached the relevant target audience. Carrying out multiple organic and boosted marketing efforts through various platforms such as Facebook, Instagram, Viber, and Telegram, guaranteed the main page an overall reach of 34,316 and 346 followers as of Aug 31, 2021. This reach also considers the support given by the AGSB Student Council in announcing the webinar on both their Facebook and Instagram platforms.

Apart from the Zoom Webinar participants, the project organizers have also opted to stream the event via Facebook Live for better accessibility to interested participants. The live event reached 1,823 users and garnered over 764 engagements on the social media platform.

As the pioneer webinar event of the AGSB Department of Operations and Information Technology, "The Future of Now: Transform in the Digital Era" received an overwhelmingly positive response from the audience. The event was rated an outstanding 4.8 out of 5 in the audience feedback form conducted via Google Forms distributed after the event.

Furthermore, attendees provided comments on how the institution can improve in executing similar events in the future. "Do more events like this to increase awareness on the updated trends on business, which can help MBA students pursue a startup business," stated a DOIT student. Together with the overall favorable response, attendees enthusiastically expressed their interest in attending similar-themed events organized by AGSB in the future.

The Project Management Class of the Standard

Program S06 comprises eleven full-time working professionals from different industries who contributed to the project through their own skills and knowledge from their respective fields. However, most, if not all, were inexperienced in planning and organizing a full-scale webinar program for a maximum of five hundred participants, which added to the challenge of delivering a brief but engaging event.

Fortunately, the project leads and each team member had the support of their contacts, the DOIT department, and the AGSB administration, which served as guidance in the preparation and execution of every initiative. The support was overwhelming that the team had to direct event registrants to Facebook Live Streaming since the Zoom webinar registration reached its maximum capacity only on the second day after announcing its launch. All expectations were surpassed, which added a little pressure and excitement for the team being an amateur to the online platform event organizing project.

The event was a success based on the post-mortem discussion and feedback from professors and the audience. The program flow went smoothly, and the selected speakers delivered a brief yet engaging and informative presentation.

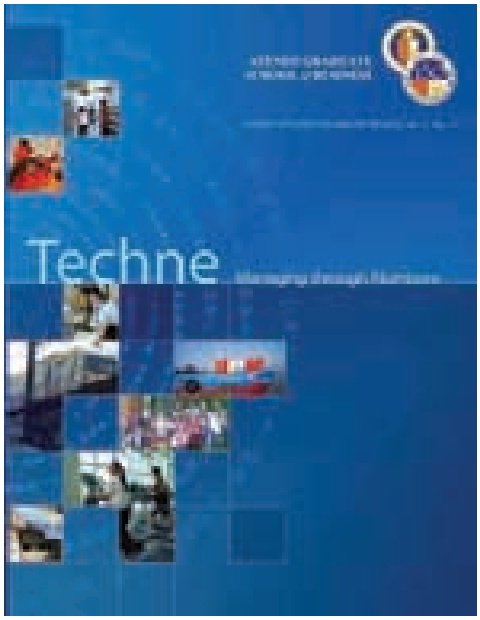
With this kind of event, collaboration and open lines of communication were critical to the operations. Given the limited preparation time, the team needed constant alignment of progress and discussed challenges being encountered at each phase. Each department had to act fast but in a synchronized flow to ensure that all points were considered.

At the end of the day, having a shared standard, vision and goals helped keep things together.

For the team, organizing and executing a large-scale online event was a groundbreaking experience. Considering its impact on hundreds of people who engaged industry leaders through their devices in the comfort of their homes, the event served as the promulgation of the strong influence of the internet and innovative technologies on the modern audience.

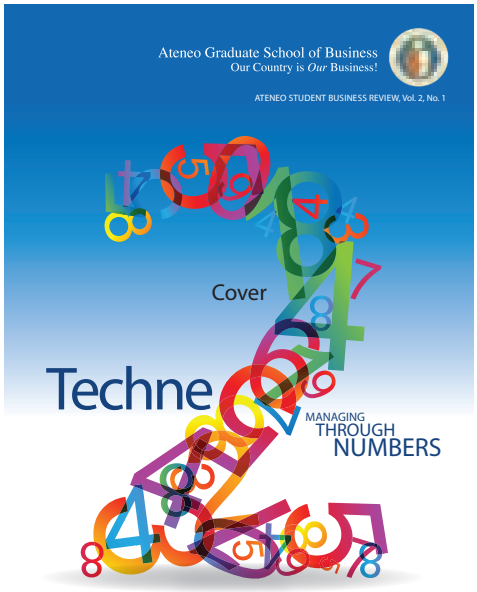
Official Poster

Previous Techne Issues



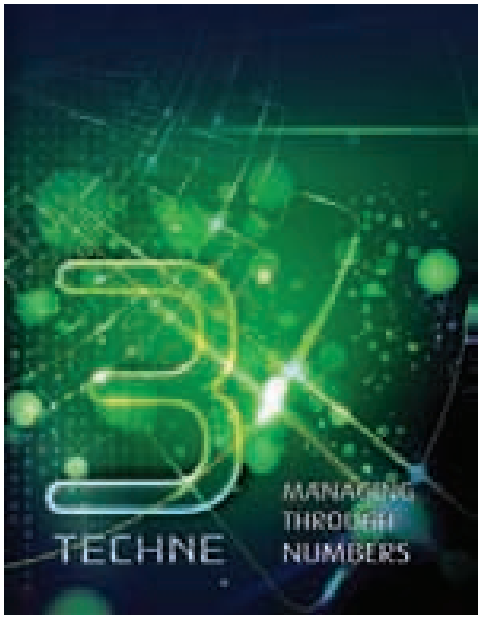
TECHNE 1

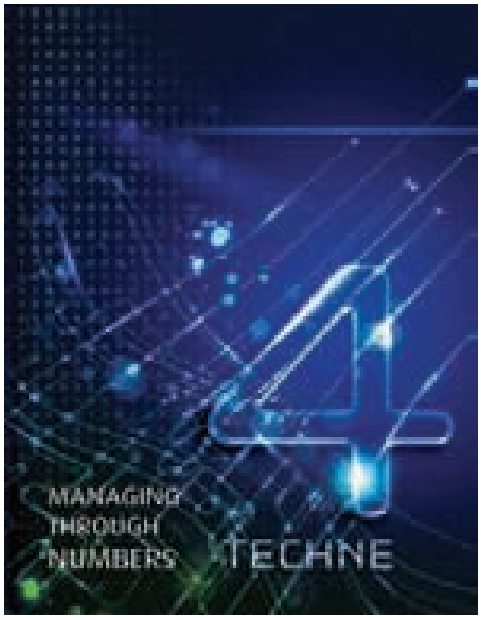
The maiden issue of Techne features six articles that discuss management science applications in small- and mediumsized enterprises, as well as in large-scale undertakings in the private and public sectors. The applications employ widely useful management science tools, such as linear programming, queuing, and simulation. The issue reflects the high quality of student understanding as well as their pragmatic bent.



TECHNE 2

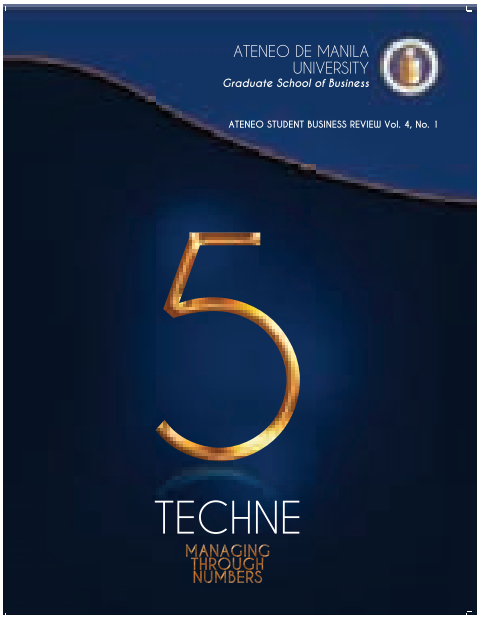
The second issue features seven articles that apply quantitative methods to arrive at efficient and effective decisions and interpret common activities such as buying toys, raising funds, or joining a volunteer program, and translate them into mathematical models. The issue also focuses on topics on environment, scheduling, business management, and health. Optimization is also highlighted in all of its articles.





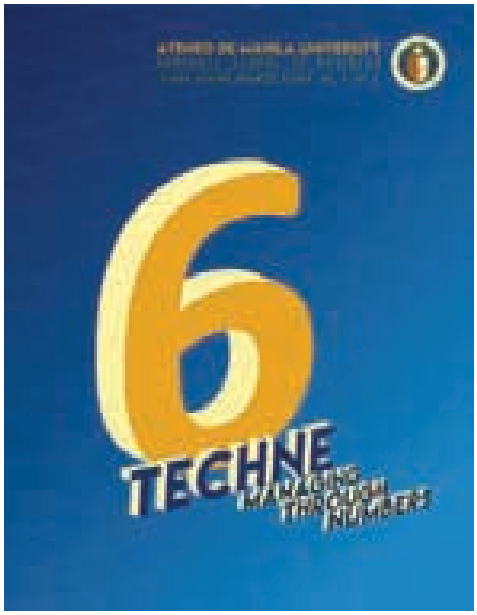
TECHNE 3 and 4

The third and fourth issues combine as a double back-to-back issue with a total of 13 articles covering technical applications for large corporations, government, schools, SMEs, entrepreneurs, and CSR initiatives. Articles discuss the best way to move people and things, reduce time, optimize resources, and justify green initiatives (the focus of Techne 3) backed by the use of mathematical tools such as Monte Carlo simulation, linear programming, linear regression, queuing models, project management, inventory management, integer programming, process improvement, and quality management.



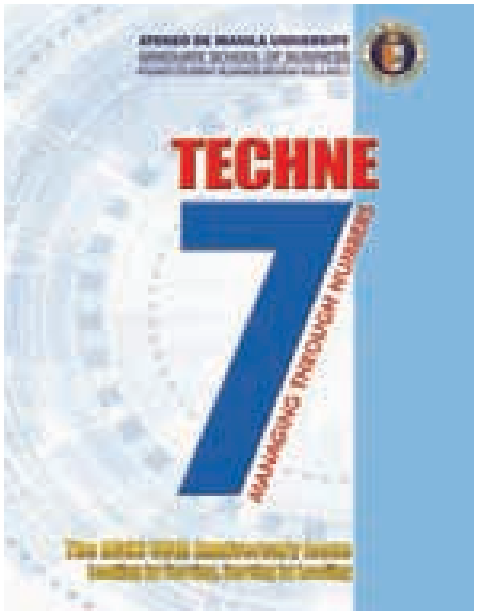
TECHNE 5

This issue features six articles written for the operations management course with focus on systems and the goal of seeking the one best way to do things. Logical processes such as fishbone diagrams, Pareto charts, poka-yokes, process flow diagrams, time and motion studies, facility designs, and layouts were applied by the authors on varied scenarios that include preparing burgers and setting up a feeding program for school children, organizing career development sessions and institutionalizing enterprise resource planning, operating a radiology department, and using biometrics.



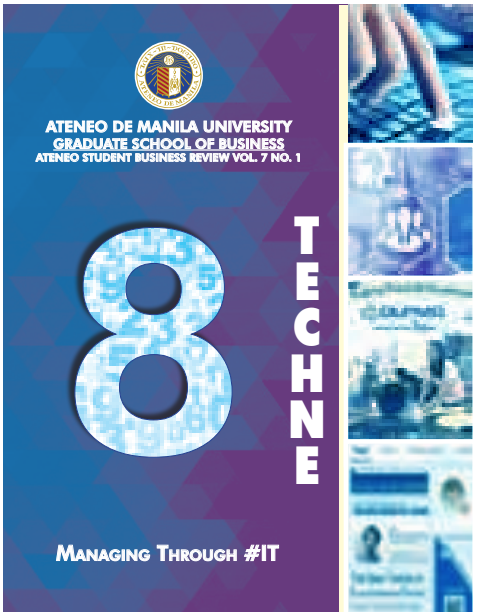
TECHNE 6

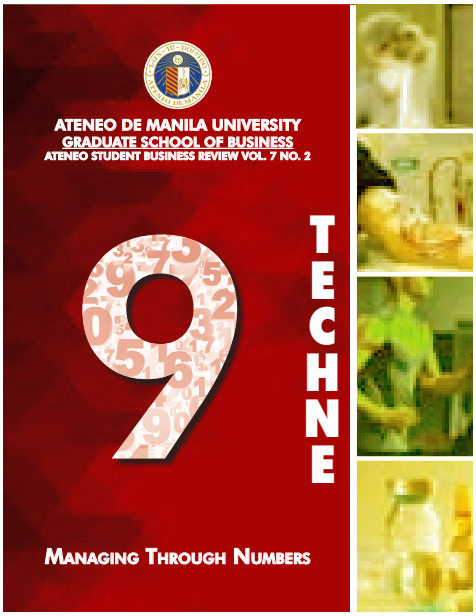
The sixth issue features seven articles touching on various aspects of our lives, from milk matters for infants and books for elementary school kids to projects for professionals and enrollment tips for graduate students, a fitting tribute to our goal of nation-building and being a man for others. It highlights our students' expertise in the operations field shown by their innovative use of the various management tools and techniques in various projects and research.



TECHNE 7

The seventh issue features six articles with varied interests: examining the effectiveness of the Ateneo Blue Plate feeding program, improving a local health clinic, tackling the sustainability issue in the fashion industry, and applications to nation building using various tools of management science and operations management.





TECHNE 8 and 9

The eighth and ninth issues combine as a double back-to-back issue with a total of ten articles with three on IT, five on Operations Management and two on Quantitative Methods. matters: Topics covered supervised machine learning, total quality assurance, school enrolment attrition, hospital ambulatory services, loan turnaround, hemodialysis, processed meats, fitness center, pharmaceuticals, and mobile phones.