INTERIOR DRYWALL SYSTEMS: PROSPECTS FOR THE THAI MARKET

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ABSTRACT

All of us spend most of our time indoor. So, building is very important for resident wellbeing. people seek and will to pay for places that have a positive effect on their wellbeing. Nowadays, construction industry has a lot innovative construction material that solves people pain point and need. Drywall is another interesting solution which has a bright future in this industry.

This paper's objective is to identify the factors that could drive drywall penetration in Thailand by using interview method with sellers and purchasers in Thailand and countries with a successful case, The United State and Singapore.

The findings of this research demonstrate that key drivers in the United State and Singapore are different but both have the similar objective, sustainability, wellbeing and safety of people in their country. So, in order to expand drywall market in Thailand we should increase awareness of safety, sustainability and wellbeing to all construction stakeholders.

KEY WORDS: Drywall/ Gypsum/ Construction material/ Sustainability/ Wellbeing

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CHAPTER I
INTRODUCTION

1.1 Background of the topic

As Bluyssen (2009) mention people spend up to 90% of their time indoor such as school, work place, home, hospital, shopping mall and restaurant. Therefore, building is very important for human wellbeing. A Good building must consist of good components. For example, structure wall is one of components that helps residents meet both aesthetic and function they expect.

Walls are separated into two types: external and internal wall. External wall is used to separate outside and inside the building. A Function of external wall is protecting residents and properties from external factors such as sun, rain, wind, and thermal. On the other hand, internal wall is used as partitions to separate space inside the building in order to create different function and feature to the space.

Walls as construction materials are divided into two basic categories drywall (dry system process) and mass wall (wet system process). Drywall is a stand-alone partition that is made of metal or wood frame, insulation, and finish elements or surfaces which is gypsum board. Benefit of drywall is that it could be custom made the system to have different function and feature such as sound protection rate, sound absorption rate, fire protection rate or thermal control which appropriate with each area. However, drywall could be used for internal purpose only. Also people's perception is that drywall is not as strong as mass wall.

On the other hand, mass wall is usually made from solid material such as brick, block, and concrete. Mass wall could be used externally and internally. Mass wall are could be used as a building structure and used for both of dry and wet area. However, if you look for partition between spaces with specific purpose such as acoustic, fire or thermal, drywall is better, easier and faster.

1.2 What is drywall

Drywall is non-load bearing wall that is nonstructural element of a building. It does not work by bearing the weight of the elements of the building resting upon it by conducting its weight to a foundation structure. Drywall installs by fix gypsum board on metal frame by gypsum screw. Drywall installation process is a dry process which makes job site cleaner than wet system such as brick and block wall.

Gypsum board made from gypsum plaster sandwiched between papers. The gypsum plaster is heated to dehydrate water then slightly rehydrated to produce the hemihydrates of calcium sulfate ($CaSO_4 \cdot ½ H_2O$) and becomes rigid and strong enough to use for a construction work. The core of gypsum board could be mixed with fiber and various additives to increase performance level such as fire resistance, moisture resistance for functional area.

The first plaster board plant established in 1888 at Rochester, in Kent that called Sackett board. Sackett board or plasterboard. 1894, Augustine Sackett and Fred Kane created Sackett board. They were graduated from Rensselaer Polytechnic Institute. After that, plaster board started to develop in 1910 by changing wrap material of board edges and layers between plaster from wool to paper. Moreover, in 1917 the first Europe gypsum board factory was founded in Liverpool then 1926 in London (Eurogypsum, 2007).

1.3 Why explore the topic

The construction business is an important industry that drives country's economy and society as well as being a good measurement which is apparently able to indicate the economy of that country whether it is in an upward trend downward trend.

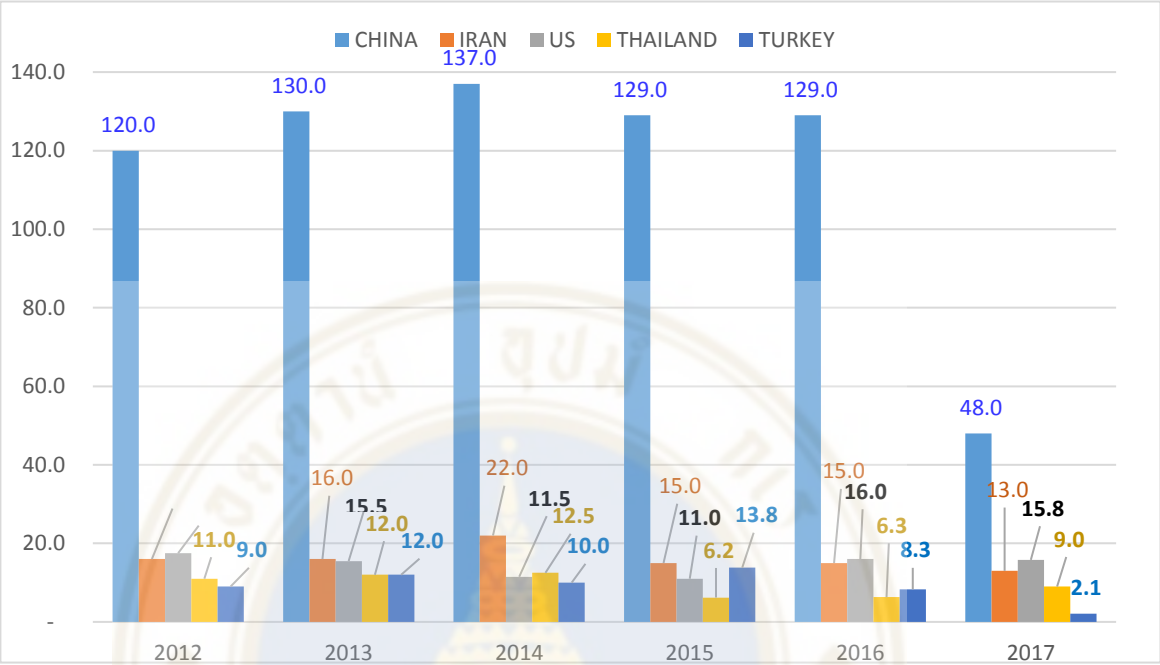
However, construction causes of the problem that make bad air pollution in a construction area. It is obvious that the developed countries, which are concerned a lot about air pollution, are setting up a central government agency to organize and enforce the law and policy to control air pollution. For example, Singapore which is a developed country with limited natural resources, has various law enforcements and policies that help to develop the country sustainably. Singapore government agency that is responsible for pollution is the National Environment Agency (NEA). NEA conducts

policies that protect the environment such as air quality control, water quality control, energy efficiency, health and recycling.

Nowadays, consumer behavior has changed. The demand for products in the construction materials and home furnishings category has been increasing and consumers prefer convenient lifestyle and look for a variety of product choices. Gypsum, a safety material which use as ingredient of many kind of food, is one of good choice for them. In 2012 annual report show the drywall market in Western Europe is expected to expand by 3.6 percent per year, which is a better performance than year 2006-2011. The main market that is expected to have good trend is Italy, France and the United Kingdom. Demand for drywall in Western Europe will increase due to the increase in new residential building from the previous decline in 2011.Furthermore the non-residential buildings have a trend to grow fast between 2011 and 2016 (Freedonia, 20012). It means gypsum has been accepted as a top construction material choice in worldwide for a long time. So I believe that it should have a room for drywall system in Thailand market to be filled for both of residential and non-residential construction sector.

Lastly, gypsum is one of the potential construction materials because drywall installation has less dust than wet work as brick wall installation. More than that Thailand gypsum mineral has a better quality than many countries. In addition, Thailand is one of the few countries around the world that has large gypsum quarries. From statistic of Statista (2019) in year 2012-2017 Thailand is the fourth rank of countries in the world which can produce a large amount of gypsum after China, Iran and United States as the chart below.

Table 1.1 Top 5 gypsum producers in the world in year 2012 to 2017 (in M. metric tons)



The objective of this paper is to find out feasibility of drywall system in Thailand market by study from case study of success countries which are Singapore and the United States. I believe that the finding in this paper could help construction material provider understanding the market and could explore their opportunities to develop their business and Thailand construction industry in the future.

CHAPTER II
LITERATURE REVIEW

The objective of this research is to find out key driver that encourage people to use drywall for interior partition by study success stories from other countries which are Singapore and the United States.

2.1 The United State Case

2.1.1 History and Perception of Construction Business

The United States is one of the leading country in sustainability. The World Watch Institute reports the United States buildings generate 50 per cent of Chlorofluorocarbons, 33 per cent of Carbon dioxides emissions and 40 per cent of construction material waste of country.

The United States has non-profit private organization that takes care of construction sector of country, U.S. Green Building Council or USGBC. In 1998, USGBC launched LEED certification which aimed to help owners and stakeholder of building be responsible for environment with use efficiently resources. There are similar to BCA of Singapore and BREEAM of The United Kingdom.

LEED, or Leadership in Energy and Environmental Design, is the most broadly used green building certificate in the world. Now LEED standard has been applied by approximately 90,000 projects in 165 countries around the world with project certified about 2.2 billion square meters (U.S. Green Building Council, 2019).

2.1.2 Drywall Evolution

From the history, The United State is the leading and pioneer country that uses drywall. The United States gypsum evolution started in United State Gypsum

Corporate bought Sackett Plaster Board Company in 1910 and introduced their first gypsum board to the market in 1917 (Powell et al, 2006).

During World War I gypsum board was used for military barrack. Also, during World War II, gypsum board consumption rapidly increased with huge volume again with the same reason. After World War II drywall become popular in residential sector which use by home owner. After World War II the United State Congress encouraged its citizens to have home ownership and education by offering low or no interest loans. So, more comfortable economic position allowed people to be educated, have family, children and home (Gypsum Association, 2019)

Another driver is the United States has strong environment concern. As the research of Fořt, J., & Černý, R. (2018) shows heating process of Portland cement production generate carbon dioxide emissions about 950 kg. per ton. Contract with gypsum which generate carbon dioxide emissions only 140 kg. So, drywall is accepted and become a popular solution because it is a light wall system with quick installation and has good performances. USGBC website also support drywall by providing an hour gypsum knowledge e-learning course to educate benefits of gypsum drywall and ceiling using versus other materials to peoples.

2.2 Singapore Case

2.2.1 History and Perception of Construction Business

Singapore concerns about sustainability and efficiency of construction because Singapore is a small country which has limited resource and labor. Building sector in Singapore consume, energy more than half of total in the country. Hence, their government has policy to certify green building to all building in 2010 with targeting 80% (Siva et al., 2017).

BCA or Building and Construction Authority is an organization founded by Ministry of National Development of Singapore in 1999 by merging of the Construction Industry Development Board and the Building Control Division of the former Public Works Department (Building Up, 2000). BCA has more than 15 functions and academy in an agency to develop resident wellbeing.

Then 2005 they launched Green mark certificate to raise environmental friendly awareness among construction stakeholder to use technology which can increase construction productivity (Building and Construction Authority, 2017a). And Singapore also has Buildable Design Score Index which is an indicator that applicable to architecture, civil and structural Engineering firm to tracking the performance of construction project. Buildable Design Score has drywall system as a mandatory item in wall system category (Building and Construction Authority, 2017b).

2.2.1 Drywall Evolution

Influencer and user experience are the factors affecting the drywall success in Singapore. Influencer is a person or group who has the capability to persuade the behavior or opinion of other people. A study by Simply Measured shows that 92 per cent of consumers trust word of mouth and recommendation from their personal connections, while only 33 per cent trust ads (Carlson, 2016).

Singapore is one of country in South East Asia which was successful in using drywall widely for more than 10 years because of government support. BCA is the most importance government influencer which enforced construction business in Singapore to use drywall for interior partition as a replacement to mass wall because production of cement, raw material of mass wall, is generate about 8% of carbon dioxide emissions of the world (Chen et al., 2010) and operation phase of construction is spent up to 85 per cent of total Carbon dioxides emissions of building sector by energy and electrical use (Wu et al., 2012, 17) (Asdrubali et al., 2013.). So, fast and less dust, drywall has higher Buildable Design Score than other material for partition wall (Building and Construction Authority, 2015)

2.3 Construction Project Management theory

As we are going to identify what are factors and reasons that make stakeholders make the decision to use drywall in their construction projects. Then construction Project Management would help us to understand who are construction

project stakeholders, what is their pain point, when and how to persuade them to use drywall.

Construction project management is a model which describe about planning, collaboration and control of the project from beginning to completion of the project which determine form criteria of utility, quality, time and budget by balance the relationship between resources to integrate, monitor and choose the choice of seeking customer satisfaction with the results of the project (Walker, A., & Kwong Wing, C.,1999). And Project Management Institute (PMI) has explained that steps of construction project management divided into 5 phases as followings.

2.3.1 Pre design concept Phase

Pre design concept is a project design concept, information gathering and first drafted of design process. People who are related in this phase are owner of the project, architect, interior designer.

2.3.2 Design and specification Phase

Design and specification phase is a design and completion of technical and material specification process. Stakeholders of this phase are project owner and designer. Designer is the key influencer who selects material that appropriate with their design and function to propose to owner.

2.3.3 Contractor selection Phase

Contractor selection process is the process that identifies who are contractor and installer for the project. In this phase owner is the decision maker who select contractor by base on project budget and quality of contractor candidate.

2.3.4 Finalize material and place order Phase

Finalize material and place order phase. This phase contractor is the key stakeholder to finalize material selection of project with their distributor. Usually they will use the material as the list from designer specification sheet. However, if they would like to change material from list, they should consult with owner and designer before make the decision.

2.3.5 On site Phase

On site process is the last step of the construction process. This is the installation process until the project opening for end user to use the building. This process has contractor and installer as stakeholders.

The project in a country, which has building or environment regulation, has another stakeholder is government agency, who takes care that regulation since first to last phase of the project.

CHAPTER III
RESEARCH METHODOLOGY

3.1 Research design

This paper uses qualitative research such as interviews and case study methods to discover qualitative information in order to get the answer of the topic question. The qualitative research is an observation to collect non-numeric information method which will answer when their certain phenomena are occurring. They are used in many academic disciplines, especially focused on human elements of society and natural sciences. In the lesser academic context, the area of application includes research, qualitative market and business.

The interview could separate in two groups. First group (3 persons) is management of gypsum activity in Global, Thailand and Singapore. Second group (4 persons) is architectures who have work experience in Thailand and Singapore. This interviewee group could compare and share similarities and differences between both markets by their experience.

3.2 Brief personal interviewee backgrounds

3.2.1 First group: Management of gypsum activity in each area

Interviewees 1: G1 (Male)

Interview date: February 7, 2019

Location: Coffee shop at Central Rama9

Duration: around 1 hour

Personal information

G1 is a National Sale Manager of one Gypsum manufacturing in Thailand, he has been working experience in Thailand construction business for eight years and works in gypsum industry since 2014. He is responsible for sale development strategies

and managing project sales team in order to achieve goals, targets and revenues for Thailand market.

Interviewees 2: G2 (Male)

Interview date: February 15, 2019

Location: Conference call

Duration: An hour

Personal information

G2 is Country Manager of one Gypsum manufacturing in Singapore. His team has six members which include 4 sales, a technician and him. He works in this industry for two years.

Interviewees 3: G3 (Male)

Interview date: March 20, 2019

Location: Conference call

Duration: Two hours

Personal information

G3 is Global Advocacy and Standardisation Head of Gypsum manufacturing, he has been working in gypsum industry for twelve years. His responsibility is supporting in Europe, The United States and Asia. So he could share his idea from every country which uses drywall.

3.2.2 Second group: Architectures who have experience in Thailand and Singapore.

Interviewees 1: A1 (Female)

Interview date: February 10, 2019

Location: Restaurant at Ratchapruk road

Duration: An hour

Personal information

A1 is Project developer of a leading real estate company in Thailand for two years. She was worked as Client partner in consultant firm at Thailand for a year before.

She also has work experience in Singapore as architect for six years after she finished her bachelor degree.

Interviewees 2: A2 (Male)

Interview date: February 16, 2019

Location: Conference call

Duration: Two hours

Personal information

A2 is a design team leader of architect company in Singapore for nine years. He also has work experience in a big Thai architect company as architect for three years after he finished his bachelor degree.

Interviewees 3: A3(Female)

Interview date: February 17, 2019

Location: Conference call

Duration: An hour

Personal information

A3 is a senior architect of Architect Company in Singapore for ten years. She is an expertise in residential and hotel design. She has work experience as architect in multicultural architect company in Thailand for one year before she moved to Singapore.

Interviewees 4: A4 (Female)

Interview date: February 17, 2019, March 3, 2019

Location: Coffee shop at Central World

Duration: An hour

Personal information

A4 was architect of Architect Company in Singapore for two years. She also has work experience at Thailand as an architect for two years before at Singapore. Now she is a manager of research and a consultant firm for 4 years. She is really interested in Green buildings.

3.3 Research Question

This papers use an interview method that is suitable to get a deep understanding stakeholder insight, pain point and market situation. Outcome of interview is not only scope in the question that I set but also could get other view more than expectation.

The question that I use lead to get the information about who are drywall influencers and material decision makers. After I got information, I could analyze market situation which useful for market penetrate in the future.

The following questions are used to interview the interviewees group 1.

1. Which material that your market use for interior wall? (wet work, dry work) Which product? Which characteristics? Which area?
2. What is the reason to use that type and material?
3. Who are influencers / decision makers to select the type and material of interior wall in your market? Do they select drywall/ Why?
4. What phase that appropriate to approach drywall in your market?
5. Is there are regulation in your country? What do they say?
6. What are factors that make people use drywall in your market?
7. What are factors and which kind of work that make people don't use drywall in your market?
8. Since when your country starts to use drywall? Is it popular?
9. When and how drywall become popular in your country?
10. How do you promote drywall in each phase of construction project phase (design planning, specification, tendering, secure spec, on site)?
11. What are substitute materials of drywall? Why? How do they work?
12. How about BIM program? Is it help?

The following questions are used to interview the interviewees group 2.

1. What kind of your project?
2. Which material that your usually project use for interior wall? (mass wall, drywall) Which product? Which characteristics? Which area?
3. What is the reason to use that type and material?
4. Who are influencers / decision makers who select the type and material of interior wall? Do they select drywall/ Why?
5. Is there any regulation about building material in Thailand and Singapore? What do they say?
6. What are factors that make people use drywall in both country?
7. What are factors and which kind of work that make people don't use drywall?
8. What is your opinion in drywall? like and dislike?
9. How about other party as owners, contractors and end users? Do they are influencers / decision makers?
10. What are substitute of drywall? Why? How is it?
11. Please compare similar and different material selection criteria between 2 countries.

CHAPTER IV
FINDINGS (DATA ANALYSIS)

After literature studying, interview and research result, there are many interesting points. The analysis below gathers information from the stakeholder in order to find the key success drivers which could affect the success of drywall business are Economic effect, Sustainability trend and Regulation and Standard.

4.1 Economic effect

4.1.1 The United State

During World War II, gypsum board consumption in The United State rapidly increased because the military had used gypsum board to build military barrack. Around 2.5 billion square feet of barrack have made of drywall installation since it is three times faster than traditional wall and easy to install.

After World War II the United State face many building destroyed and baby boom crisis. At that time the United States government also encouraged their veterans to have home ownership and education by providing loan with low or no interest. The problem is that there was a high demand for but at that time the United States face the severe labor shortage and high wages. So these reasons encourage people to use their skills during World War II to install their houses by themselves. Building houses using drywall is easy as building a house from papers. Drywall is sound protection, fire proof and thermal control material. So, the number of resident sector construction was using drywall increased approximately 50 percent in ten years and the new houses were built more than 21 million around the United States to served 10 million babies born at that time. Drywall was accepted for its fast installation and easy and lightweight solution. The advertisement below shows a drywall as a fire protection wall with a campaign with

“no time lost is in preparing materials, changing types of labor, or waiting for the building to dry.” from USG, the United State first gypsum board producer, at that period.

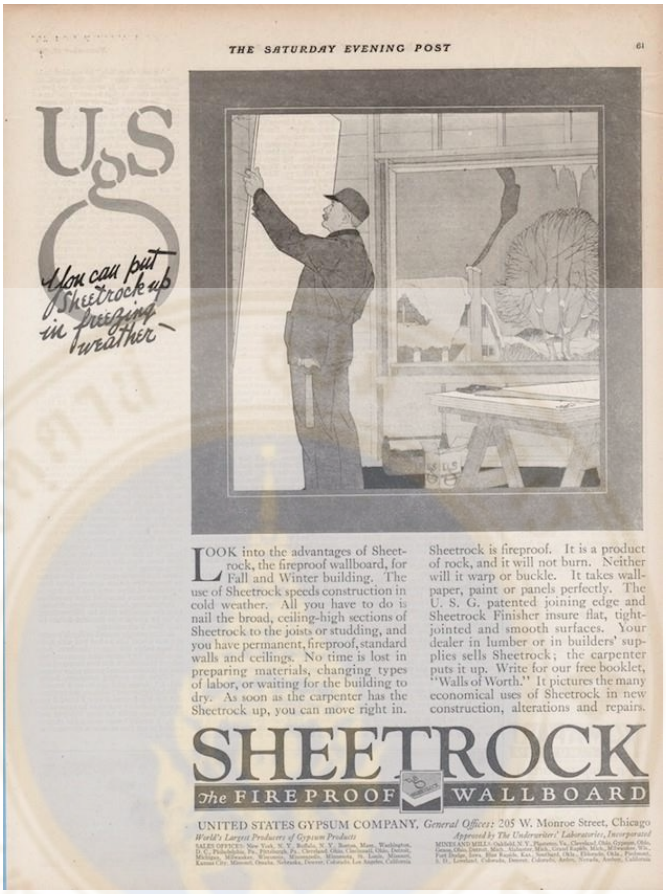


Figure 4.1 USG drywall advertising

In 1973, drywall advertised the United State with lightweight benefit. The tallest buildings of the world in 20th Century is the Sears Tower and the John Hancock Tower both of them has more than 100 stories and were used drywall as the partition to save their load bearing structure. Currently, people might still have a perception that mass wall is stronger but they used to use drywall regarding the convenience to find the drywall component in the market, an easy installation and the most importance is it can achieve performance that they need and mandatory with lighter weight and less thickness. It is guaranteed that over 97% of new buildings in the United State are using drywall (Gypsum Association, 2019).

4.1.2 Singapore

Singapore also faces the high labor cost problem. The information from G2, Country Manager of Gypsum manufacturing in Singapore, show that Singapore construction labor cost per day is 60-80 US dollar which 8.5 times higher than Thailand. In addition, because land limitation in Singapore, buildings in Singapore are very close to each other. During the construction period, there are more dust and noise. Therefore, timing is the key driver to drywall success.

Also, because of land limitation, Singapore does not have space to produce and keep stock of construction material so importing construction material from others countries is a better choice.

Buildable Design Score is one economic driven key there. The buildable score is a figure which computed by level of simplicity and standardization used in a design process of building sector in Singapore to raise more efficiency and productivity. The Buildable Design Score Index is Singapore construction mandatory and has minimum score in each sector. And as per drywall having a higher score than other materials Thus make stakeholder chooses drywall over other materials that have lower scores and have to invest in other part of the building to increase the overall score

Economic of scale makes the price of gypsum board in Singapore is not high as the beginning because HDB, the Housing & Development Board, uses it as common construction material. HDB established in 1960 by Singapore government to plan and provided quality public housing with affordable for their citizen. HDB is a importance driver of drywall in Singapore because Singapore has HDB residential building more than one million flats in 23 towns and three estates across the island. Today HDB residence is over 80% of Singapore's residence population (Housing & Development Board, 2019).

All of HDB buildings use drywall as their house interior partition because of Build able Design Score control and drywall is flexible to adjust space suit with HDB residence lifestyle and function in the future also. Example St. George’s Towers with 738 units and Ang Mo Kio Court with 590 units. Therefore, currently it would be has more than 80% market share of drywall in Singapore construction industry.

4.1.3 Thailand

The first Thailand cement factory established in 1910. After that, Thai people seemed to be familiar with wet work process. Cement is a common construction material for Thai people. Nowadays, Thailand cement production capacity is approximately 60 million tons per year. However, only 33 million tons per year that belongs to local market around 28 tons and export to other country around 5 million tons.

Thailand does not face limitation of land problem and it has a lot of natural resource like clay, sand and rock that are component of traditional wall. More than that, Thailand did not get affect much from World War II or any incident that might have destroyed buildings within the country. Thailand has lower labor cost, around 9.5 US dollar per day. So, timing is not Thailand's priority.

Contrast with the United State which started drywall market in residential sector, in Thailand non-residential sector uses drywall as the interior partition before residential sector for a long time. Until now it does not success in residential sector because of end users believe that drywall is not durable. Ten years ago, a few of top developers stared to use precast, casting concrete wall panel, as an external wall but they are still not use gypsum drywall. Until 2016, because consumer behavior changed homeowner need to adjust space and function of their home by themselves. Flexibility is very important and drywall could answer their need. One of big developers in Thailand made the decision to use drywall in their high end project because their project need lightweight system with acoustic performance and flexibility to adjust in the future. This project could success by technical support, mock up at developer office, demonstrate at job site, installation training and House salesman coaching. And this project use drywall as a differentiation point to promote their project.

However, Thailand drywall market as a whole is still not popular and has only 3.5% share of all gypsum application. Also, demand of drywall in Thailand is very low, comparing with other countries.

4.2 Sustainability trend

4.2.1 The United State

In developed countries, sustainability trend and environmental friendly got attention from people and corporate. These concepts create a trend of green product and green buildings.

What is green building? Does energy saving building is green building or not? And what will we use to measure that this building is green or not? Therefore, the United States has developed a standard to measure whether the building is a green building or not and can be used to evaluate the green level of that building also. This standard is called LEED.

Because of construction process causes direct and indirect environment problems. The U.S. Green Building Council (USGBC) launched the famous world green building scheme which is LEED or Leadership in Energy and Environmental Design in 2000 to provides the framework to build highly efficient, healthy and cost-saving green buildings. So the definition of green building by LEED is not similar to the energy saving building because energy saving building is usually measure energy saving cost when use the building without considering other energy during building life cycle such as the material transportation energy, recycle content and does not cover the use of other resources effectively such as water using.

Now, LEED is recognized as global leader of green building certification which helps transforming a typical construction industry to green buildings around 90K projects in 165 countries around the world. In Thailand, LEED certify to many high end project, such as 98 Wireless condominiums, a high end high rise residential building on Wireless road. This is the first LEED certification for multifamily residential project in Thailand. Another example is the One Bangkok which Wang (2017) reported it is a $3.5 billion mix-used project, that going to be the first LEED Platinum certification for Neighborhood Development project in Thailand.

LEED certification has many categories for each construction sector and has many level of certificate as the figure below.

Figure 4.2 LEED certification levels

Figure 4.3 LEED certification by sector

LEED certificate could help to support drywall penetration indirectly by their score of material because gypsum board has higher score due to its recycle content percentage and performance.

4.2.2 Singapore

Before 2005, Singaporean's perception about drywall is not good because they felt that drywall was very weak and not durable. However, after Building and Construction Authority (BCA) launched the Green Mark certification, the green building rating system that uses for evaluating an environmental impact and

performance building, in 2005 and promote drywall by motivating all parties to use drywall. Gypsum board is categorized as environmental friendly material which has 30% recycled content and generates carbon dioxide emissions 5 times less than cement. More than that from Meinhardt consultant report of hotel project at United Arab Emirates case study shows that drywall working time is 3 times faster than mass wall. This also means it produces less pollution than mass wall.

Importantly, BCA also educated their population that green building not only benefits country environment but it also benefits the residents and investors also. It gains benefit by bring energy-efficient elements in the building which could reduce costs by energy saving way. (Building and Construction Authority, 2015). And they also corroborate with HDB to use drywall as interior partition in every HDB house. This is a very good strategy to make people familiar and have a better perception with drywall.

4.2.3 Thailand

Thailand also has green building association which aims to develop green building standards.

Thai Green Building Association is set up from a collaboration of Association of Siamese Architects and The Engineering Institute of Thailand. Goal of Thai Green Building Association is taking care of Thailand sustainability and environment for construction sector. Thai Green building association encourages people to start developing a green building in Thailand. Thai Green Building also has TREES certification which is a guide to assess energy and environmental sustainability for building.

Because of sustainability trend, some commercial buildings in Bangkok choose to submit for green building certificate that is accepted worldwide like LEED from USA, BREEAM from UK and Green mark from Singapore more than TREES of Thai Green Building. The international certificates seem to gain more attentions from foreign tenants. Also space rental fee for green building increases by 5-10% per year. Example FYI center, LEED certified building, which opened the building in 2016, had reserved tenant 70% before construction has finished.

However, there is no any official law and regulation for green building in Thailand.

4.3 Regulation and Standard

4.3.1 The United States

The United States government imposed stringent building by-law and regulation especially fire protection, acoustic performance and thermal insulation requirements. These could be fulfilled by using drywall system. (Kubba, S., 2012). In the United States, the construction regulation is commonly known under the name "Building code". The Building code cover with only new construction buildings. If the old building that need to be a modified or renovated, the law will be applied as well. The Building code in the United States includes four codes which are Building Code, Plumbing Code, Mechanical Code and Electrical Code (Baum, J., 2005).

Because the United States is a very big country which consists of 50 states with different terrains and climates. Therefore, the United States has the International Code Council (ICC) which creates a prototype or model building code and the National Fire Protection Association (NFPA) which provides requirements and standards regarding the safety and fires of building. Then each state adapts those models to apply on their local building code.

Example about fire protection regulation which could help to penetrate drywall is NFPA 221 Standard. The standard is about high challenge fire walls, fire walls, and fire barrier walls which launched by The National Fire Protection Association. Building and structural firewalls are usually made of reinforced concrete or concreate. Interior fire barrier walls are regularly constructed by drywall, firestop gypsum board partitions with wood or metal framed studs, which is faster, smoother surface and lighter than other material wall.

4.3.2 Singapore

Singapore did not have a regulation which require an official skill license from installer. Instead, installer will be divided to install the job which they are specialist only. For example, drywall installation must be a specialized drywall installer who was trained already. However, the gypsum suppliers provide intensively a product knowledge and installation training for installers and give a certificate to guarantee the quality of installation services. These practices increase value of installers and it also

benefits the gypsum suppliers since they can promote their solution and expand drywall installation standard to market. After drywall become popular in Singapore, the installation service of gypsum becomes basic skillset and consumer is able to find this kind of services easily.

In terms of construction, Singapore has many organizations that control the construction sector such as SCDF who take care about building fire rate as NFPA of the United States. But the key person of building regulation in Singapore is BCA which controls Buildable Design Score. The Buildable Design Score is one of the main mandatory. The Buildable Design Score has a minimum score which if the project does not pass, the building cannot be constructed. The total full score is 110 point that includes three parts; Structural System (maximum 45 points); Wall System (maximum 45 points); and Design for Manufacturing and Assembly technologies (maximum 20 points).

Below is an example table of minimum score in each building sector for superstructure works (Building and Construction Authority, 2017).

Table 4.1 Minimum Buildable Design Score for Superstructure / Remark: GFA is Gloss Floor Area.

CATEGORY OF BUILDING WORK / DEVELOPMENT	MINIMUM BUILDABLE DESIGN SCORE FOR SUPERSTRUCTURE WORKS		
	2,000 m^2 ≤ GFA < 5,000 m^2	5,000 m^2 ≤ GFA < 25,000 m^2	GFA ≥ 25,000 m^2
Residential (landed)	73	78	81
Residential (non-landed)	80	85	88
Commercial	82	87	90
Industrial	82	87	90
School	77	82	85
Institutional and others#	73	79	82

Drywall is included as one criteria that could increase the score in the category of wall system of Buildable design score calculation.

4.3.3 Thailand

Thailand has Thai Green building association but there is no any officially law and regulatory to control these kind of green building in Thailand.

Thailand has adopted and applied many building regulations of the United States to Thailand Building Code and standards. This is because the United States has the most complex and interesting building control systems in the world. For example, Thailand Building Code of year 1979 about the construction of buildings in areas that might be affected by earthquakes was improved from Uniform Building Code of the United States of year 1985.

Thailand also has construction code about fire resistance. It says that main structural material must have a fire resistance rate not less than two hours. For interior part, high-rise buildings that high equal or higher than to 23 meters and the large buildings which have gross floor area equal or more than 10,000 square meters in Thailand must have one hour fire resistance rate wall or door that made from fire resistant material to block the flames or smoke when a fire go to a stair that is not fire escape of the building.

But Thailand construction code does not have regulation in any other function wall and does not specify or suggest of materials which can encourage drywall usage.

CHAPTER V
CONCLUSIONS / RECOMMENDATIONS

5.1 Conclusion

5.1.1 The United States success driver

The main key drivers of the United State are regulation and people is need. The interesting point is all building regulations in the United States are come from its people. For example, fire protection area, building thermal control and sound protection between space and space. Value added gypsum board (performance gypsum board) as Firestop board, Insulation laminated board or Gypsum fiber board can fulfill these needs. These materials can be installed easily and fast. They are thinner and cost lower than brick and block.

For sustainability is only an optional in the United States. But because of sustainability trend so mostly commercial building would have green certificate warrantee to promote their project. It looks like green certificate is a marketing strategy. But at least it is good that it can helps to encourage construction industry concern about wellbeing of people and the environment there.

5.1.2 Singapore success driver

Singapore key driver is similar the United States; regulation and people's need. But the difference is the regulation in Singapore mentions about sustainability and environmental friendly. So sustainability is not optional in Singapore.

Because of land and natural resource limitation labor cost, including so Singapore finds the need to use resources efficiently. As a small country, government policy can be implemented easily.

Singapore government agencies also have a strong marketing campaign to promote and educate the benefit of their policies. They also introduce and provide knowledge about how and what will help to achieve it and let people have direct an

experience. Through various government medias such as websites, magazines and project references.

Economic worthiness is another key driver of Singapore and the United States because drywall has lower total overall cost when combine material cost, labor cost and operation cost together. Thinner thickness of drywall also creates more space. Last is drywall help them achieve the required performance.

5.1.3 Thailand

Key factor that make drywall success in Thailand is similar to other two countries which is drywall performance that can achieve project requirement.

Thailand regulation does not deeply and much about the safety design of internal partition from the wall performance which drywall can support to achieve.

Another reason is Thai people still have perception that drywall is not strong because they hear "knock-knock" sound when tapping the material, which is caused by hollow of frame between two side boards. This perception is similar in every country but in country which has substitute product and system they are might not choose drywall if does not has other key drivers to support drywall. Time, labor cost, land and resource limitation which are advantages of drywall are not Thailand concern.

5.2 Limitation in the scope of study

First of all, the tipping point of drywall success in other countries happened very long time, especially the United States so the information is limited. Another difficulty is that research and study information from other countries are difficult to access the source of information. And the information must be studied deeply and carefully because of culture and perception differences.

And most interviewees are not in Thailand so I have to use technology as social media applications such as Skype, WhatsApp, Line and Facebook Messenger to interview them with different time zones.

For the first group, because they are at management level so they have tight schedule. So I use alias with their names and organization names.

5.3 Recommendation

A chart below shows stakeholders and key influencers of each variable for drywall success in Singapore and the United States.

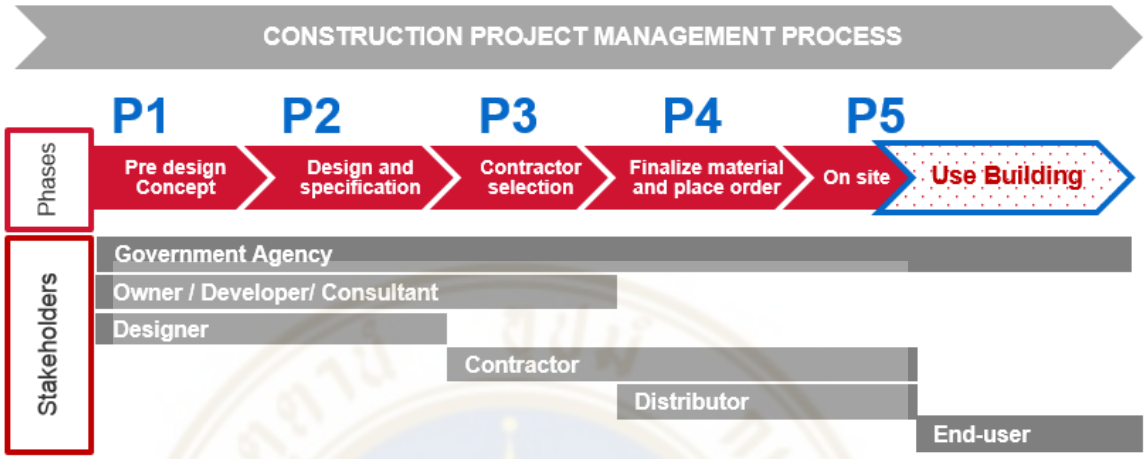


Figure 5.1 Constrction process and Stakeholder

As the chart shows that government agency which enforces the building or environment regulation is the key stakeholder in every phase. And Thailand faces a lack of such kind of agencies and regulations which concern about peoples.

Safetyness and wellbeing. I propose three suggestions in order to expand drywall market in Thailand. First thing providing drywall benefit awareness to government agencies and push them launch the regulation. The regulation context must concern sustainability, safty and wellbeing of people in the country in which drywall is an answer for such requirements. A regulation example is Vietnam. Vietnam has regulation to support unburned material like drywall because material like bricks production process burn a lot of wood which is not good to their environment.

Secondly, to promote drywall performance and economy and sustainability benefits to early stage stakeholders such as project owner, developer and designer. Also providing installation training for contractors and installers to develop drywall installation skillset and professional service in Thailand.

Lastly, to encourage end users to have direct experience with drywall by raising number of project reference both of non residential and residential sector. CSR marketing also helps to improve an awareness of drywall as well, for example, drywall

donation to school and public sector. Another recommendation is to do a marketing communicationb, for instance, to do a public relationship to end users about a benefit from drywall which will effect to their wellbeing, having a radio spot about gypsum production and drywall installation generated low dust and emission of Carbon dioxides which is sourced of air pollution as PM 2.5.

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