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PROCEEDINGS


International Seminar
on Environment & Architecture

International Conference
on Engineering, Environment,
Economic, Safety & Health

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## 10th SENVAR
## 1st CONVEEESH

*26-27th October 2009*

SAM RATULANGI UNIVERSITY
FACULTY OF ENGINEERING
MANADO - INDONESIA
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# Welcome Speech
## Rector of Sam Ratulangi University, Manado

*Excellencies,*
*Keynote Speakers, Prominent Researcher, Professors, Graduate Students,*
*Distinguished Guests, Ladies and Gentlemen.*

Welcome to the International Seminar in Sustainaible Environment and Architecture (10th SENVAR), and International Conference on Engineering, Environment, Economic, Safety and Health (1st CONFEEESH).

I am very pleased to be here to attend the opening ceremony of this event, and it is a great honor for the Sam Ratulangi University to host this a back-to-back event. As a rector, let me give you a brief introduction about Sam Ratulangi University. This university consists of eleven faculties including Medicine, Engineering, Animal Science, Fisheries and Marine Sciences, Economics, Law, Social and Political Sciences, Letters, Mathematics and Natural Sciences, and Public Health. We run various academic programs for undergraduate and postgraduate level. We have several research centres, and one of them is the centre for environment.

In order to increase the quality, we set up several programs which one of them is to increase cooperation and collaboration with international universities and other related institutions. Currently we have some collaborations with institution abroad, and looking forward to having more cooperation and collaborations with others.

As we know, SENVAR has been hosted at both Indonesia and Malaysia for ten times, while CONFEEESH is the first conference that is originally initiated by faculty of engineering, Sam Ratulangi University. CONFEEESH is a platform for dissemination on knowledge of engineering for better life involving aspect of environment, economics, safety and health. Obviously, these two events provide a common platform for discourse, and are proudly organised together as both have similar objectives and obsession.

This event has successfully brought together experts and professional in diverse disciplines that are striving to give answer to engineering for better life. I believe that this even will be


an important forum for the exchange of information between different educational and research institutions, or between intellectual and industries.

I hope that this event would be fruitful in terms of sharing knowledge between us. I expect that the relationships established among participants during the conference will end up with more joint research projects and friendship among us.

This event is taking place with the support and coordination of many parties. Therefore, on behalf of Sam Ratulangi University I would like to sincerely thank to Organizing Committee. I would like also to express our gratitude to keynote speakers, presenters, all delegates and participants.

Thank you for visitting us in Manado Indonesia, I wish you all a successful seminar and an enjoying stay. May God bless us all.

**Prof. Dr. Donald A. Rumokoy, SH., MH.**
*Rector*


# Welcome Speech
## Dean of The Faculty of Engineering
## Sam Ratulangi University, Manado

I am very pleased to welcome all speakers and participants of the First International Conference on Engineering, Environment, Economic, Safety and Health (1st CONVEEESH) and the Tenth International Seminar on Environment and Architecture (10th SENVAR).

It is a great honor for us to organize and hold this very prestigious scientific event. As a leading Engineering Educational Institution in North Sulawesi Province, Faculty of Engineering Sam Ratulangi University always commits to be in the front line in the development of knowledge and technology. In facing the global challenge, this institution continues to improve itself by always developing and maintaining communication, networking and collaboration with various government and private institutions, profession organizations and other universities in country and overseas.

During 45 years since its establishment, Faculty of Engineering Sam Ratulangi University has produced more than 5000 graduates and currently has about 2500 students and 230 academic staffs distributed in four departments, Civil, Architecture, Electrical and Mechanical Engineering. This year, in the celebration of the 45th Anniversary of Faculty of Engineering Sam Ratulangi, we want to state again our commitment through a series of events with the theme 'Science and Engineering for Better Life', in which this International Conference and Seminar becomes one of the main programs.

I really appreciate the attendance of all speakers and participants from various institutions in country and overseas. I believe this conference and seminar will become a good forum for sharing information and experience, and with all your expertise I also believe that this forum could give significant contribution to the development of knowledge and technology that in turn could contribute to 'better life'.


Finally I would like to express my special thanks to the Organizing Committee, Technical Conference Chair and International Scientific Committee Members for all your hard work to make this event possible and my sincere thanks also to all speakers and participants, I hope you will have enjoyable conference and seminar. And for those who come from outside of Manado, I also hope you enjoy your stay here.

**Prof. Dr. Ir. Ellen J. Kumaat, MSc., DEA**
***Dean***


# PREFACE

Sustainable development is one the key issues for modern society and requiring new ideas to Advance the technologies and strategies currently in use. The main fields, which are the focus of many research efforts, are engineering, ecosystems, planning sustainability and many others. These and others aspects are the focus of the presentation and discussions that will be carrying out at the Conference.

The way in which our society exists, operates and develops is strongly influenced by the way in which sustainable development is applied and implemented. No function in sustainable development can be created without sufficient knowledge, and without sustainable development there can be no innovation on which the existence of modern society depends. However, this international Conference will focus on topics related to Sustainable Development in Engineering, Ecology, Ecosystems, Economics and Planning.

Editors


# *Preface*

## *CHAIRMAN*

It is a great honor that Faculty of Engineering, Sam Ratulangi University has been chosen as the host of a prestigious conference , First International Conference on Engineering, Environment, Economics, Safety and Health (1st CONVEEESH) in collaboration with Seminar on Environment Sustainable and Architectural (10th SENVAR), 2009.

As we are aware of globalization's impact that has resulted in very competitive business environment, which makes the fulfillment of customer sophisticated projects, products or services faces many challenges. With a great cooperation between CONVEEESH and SENVAR, we have successfully brought together experts and professionals in diverse disciplines who are striving to provide solution to global problems in term of energy consumption and its effect on sustainability and global climate. They do not only have an innate concern for environment but also for the human prosperity and the whole mankind.

We appreciate to receive more than 140 papers come from 14 countries which give contribution for this International events, which will be making our discussion more interesting and we hope these could give valuable contribution to various solutions for the environmental issues.

The organizing committee is also very grateful to invite 4 keynote speakers from Germany, Malaysia and Indonesia who have willingness to share their expertise and experiences with the participants.

I wish you a very pleasant stay in Manado and wish you all a meaningful and fruitful conference. Thank you.

**Prof. Dr.Ir.Sangkertadi, DEA**
*Chairman*

*Prof.Dr.Ir. Sangkertadi is architect and specialist in Building science at The Department of Architecture, Faculty of Engineering Sam Rtulangi University.*


# *Preface*

## *Co-chairman*

On behalf of the organizing committee, it is a pleasure to welcome all participants to the inaugural First International Conference on Engineering, Environment, Economics, Safety and Health (1st CONVEEESH) in collaboration with Seminar on Environment Sustainable and Architectural (10th SENVAR), 2009, hosted by the Faculty of Engineering, University of Sam Ratulangi in Manado, Indonesia at the celebration of 45th Anniversary of establishing the Faculty of Engineering. The aims of this International Conference are to exchange noble ideas and opinions on matters relevance to sustainable development and climate changes and to bring together engineers, environmental engineers and economists in both academic and industry to reflect upon the current status, the achievements and progresses in all main aspects of engineering, environmental, economics, safety and health and to share insights to the various attractive opportunities from a global perspectives.

I am looking forward to an active and productive exchange of views and information among all the participants gathered from a wide variety of associated disciplines. I am sure that your contribution will help to advance research in engineering, environmental, economics, safety and health in our countries in particular and the world in general.

It is a great opportunity indeed, to host the 1st International Conference on Engineering, Environmental, Economics, Safety and Health (CONVEEESH'09) Jointed Seminar on Environment Sustainable and Architectural (10th SENVAR) in Manado, Indonesia, which featuring 4 keynote papers by professors and experts, on various issues related to the conference's themes and more the 170 research-based papers drawing from various scientist, researchers and students in different fields. I would like to express our appreciation to paper presenters and the session chairpersons for their contribution. I also wish to extend our thanks to the Vice


Chancellor of University of Sam Ratulangi, and the Dean of the Faculty of Engineering for gracing this event. Our appreciation also goes to corporate and individual sponsors for their support. Last but not least, I would like to thank the members of the organizing committee and other individuals for their commitment to make this event a success.

Thank you very much.

**Dr. Abdelnaser Omran Al-Amroni**

Co - Chairman

***Dr. Abdelnaser Omran*** *is specialist in field of environmental engineering and management at the School of Housing, Building and Planning, Universiti Sains Malaysia.* ***He*** *is an avid writer, contributed many publication in environmental sciences, construction and project management.*

# CONTENTS

# GROUP ISSUES B

# The Role of Old Urban Structure In Preventing The Old Historical Area From Fire Disaster

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***Abstract***

*This paper presents a study on potentials of old buildings in historical areas of Palembang in accommodating the effort of fire protection environmental system. The historical setting was a riverside development of Musi River. It has a high building density with a declining living quality, thus was considered by the municipality as a slump. The crowded condition turns it to be high risk from the fire hazard. The study was begun by exploring the existing conditions of old buildings including their current use and physical characteristics. Then it sorted government policy and perception of people on fire prevention effort through field survey and in-depth interview. Two types of analyses were conducted: architecture and fire protection. In the architectural analysis, it discussed the urban structure, building and landscape, while the fire protection analysis utilized the SWOT analysis, hazard mapping analysis, and evacuation analysis. The results show that some of old urban elements in the slump have potentials to be developed as elements for supporting environmental fire protection system. It also shows that community squares between the old buildings were potential for assembling point or as preparation point for active and passive protections. The study recommends that streets should be widened in order to give access for fire engine or fireman. And, narrow pathways which cannot be the accessed by the fire engine should be redesigned and equipped with fire hydrants. The study also suggests that the squares should be supported by greenery as natural firewall. Finally, the residents in the community must be trained in order to increase their awareness of fire hazards and its procedure to overcome the fire.*

***Key words:*** *fire protections system, green barrier, greenery, historical area*

## 1. INTRODUCTION

In many cities in Indonesia, riverside area is one of the earliest settlements and thus becomes historical area. As the city population increases and new development emerges, the urban spatial structure has been changed. In Palembang, the urban structure change at old city area gave little attention to the value of traditional buildings, leaving them being abandoned. Old building areas in Palembang are characterized as high density, narrow path, lack of wide open space, made from combustible building materials, therefore, making these areas hazardous to fire. This study investigates the potency of old urban structure at Palembang historical areas in accommodating the effort of fire protection for historical buildings, and further for environmental system.

## 2. METHODS

This study aims to reveal some supported connection between the effort of fire safety to protect the historical buildings and the urban structure at the historical area. The study is conducted on three study areas, the Kampung AL Munawar, Kampung Kapiten and Kampung China 10 Ulu. Each area was selected to represent the old urban structure at the riverside area. Kampung Al Munawar and Kampung Kapiten represented the inner side of riverside area; meanwhile the Kampung 10 Ulu represented the waterfront side of riverside area. The two areas were explored by observing the historical building orientation to get the old urban structure, and analyzing the current use and physical condition to see how the urban structure change contribute to the fire hazard potency. In the architectural analysis, the study explored the old urban

structure, building arrangement, orientation, and while for the fire protection the analyses were fire risk analysis and hazard mapping. The paper produced several design guidelines for the use of urban structure at historical area, design of assembling point and refuge area, circulation path as access for fire engine and landscape design for fire hazard protection.

# 3. RESULTS AND DISCUSSION

## Characteristic of fire hazard

Generally there are two aspects that should be considered in effort to prevent and overcome fire hazard, flame and smoke. These two elements create fire hazards. According to Wahadamaputera 2008[1] , smoke has similar hazard level compare to flame. Smoke is the initial sign of fire hazard. Smoke can reduce sight level and furthermore it will hamper the evacuation effort when fire occurs. Smoke in its moving has higher level of speed if we compare to human speed. According to Asmaningprojo (2008) [2], Flame is produced by a chain of chemical reaction among combustible materials, oxygen and heat. Up to level of flash over, the chain reaction produces the heat and explodes into a flame, and then spread up to other place or combustible materials. In order to eliminate the flame, Darmono 2008 [3] suggests that fire can be overcome by removing one of three elements of fire triangle: combustible material, applied heat and oxygen). Thus, the effort of fire control must be done by removing one of these elements.

The flame and smoke have different way in spreading. Usually smoke will spread up by filling in the open or undivided area such corridor, stairs, lift; in spite of this area is the important path for evacuation. Flame can be spread vertically and horizontally. Horizontally the flame will be spread up because of the burn up of the room under the flame, vertical divider (wall), ceiling and air conditioning ducting. Vertically, the flame can be spread by passing the vertical core (such stairs room, lift shaft, escalator, or void) and opening at wall. Flame can be spread up internally and externally as mentioned by Darmono. Internally, the spread of fire mostly can be caused by heat radiation at external building cover. Externally the fire can be spread up by several factors such the distance between buildings, the size and location of opening at wall, and combustible material located near by the fire location.

## Fire Protection System

There are two general systems in fire protection system, active and passive. The active system means the facilities in building which are used to overcome fire hazard. The passive system means the facilities in building which are used to protect the building before the fire hazard occur. These systems can be applied both in as single system in a building and also as complex system in a certain environment, consisting of buildings and the surroundings.

There are two safety aspects in dealing with fire hazard, building safety and fire safety environment area (FSEA). Simanjuntak (2008) [4] mentioned that building safety is the key factor for successful building operation, thus collaboration between the users and building is achievable. Safety in building must be applied in every steps of building development, from pre-design phase, construction, operation and maintenance. Related to fire hazard, this safety should be achieved and applied comprehensively, including prevention, detection and overall building systems in dealing with first emergency situation. The Fire Safety Environment Area is a tool for fire severity and security system in macro scale (urban and environment level) and micro scale (building level). In macro scale, the policy in FSEA consists of the statement of the fire risk management area, the need of supported force of firefighter, the organization, human resources development and standard operational procedures. In micro scale, fire safety system is conducted by the availability of fire protection system in building. The availability of fire safety system in building design is known as Performance Based Fire Safety Design. Similar with the macro scale, the

[1] Wahadamaputera 2008, *Aspek Evakuasi Kebakaran dalam Eksplorasi desain arsitektur.*
[2] Asmaningprojo, 2008 *Konsep Arsitektural Permukiman Yang Mampu Mencegah Dan Menanggulangi Kebakaran Dalam Rangka Mewujudkan Pembangunan Yang Berkelanjutan.*
[3] Darmono, R, 2008, *Design Principle Of Passive Fire Protection To Controlling Fire And Life Safety In Building Design,*
[4] Simanjuntak, Manlian RA, *Konsep dan Strategi Fire risk Management dalam mendukung Pembangunan ang Berkelanjutan,* 2008

adjustment of this level of performance was marked by the availability of fire safety facility in building, organization in fire risk management, human resources development and standard operationalprocedures.

Concerning the comprehensive strategy to overcome the fire hazard, Simanjuntak also mentioned a strategy concept by Fitzgerald (2004)[5] known as Fire Risk Management Strategy. The concept consists of some aspects which are considered in creating and maintaining the comprehensive effort in order to create sustainable development, particularly in macro scale. In formulating the strategy, the concept considered the characteristics of risk, including human safety, property protection, operational continuity, neighboring property and environment. In order to create a sustainable effort in development, the fire risk management strategy has several phases as follows:

- Understanding the problem, related to building function, sources of risks, and the objective of safety management.
- Identifying building feature in order to get the genuine character of buildings and surroundings, then the need treatment to overcome the risks
- Performance evaluation, including the deep understanding of fire behavior, building structure reaction to fire hazard and also the spread of smoke in or among building
- Characteristics risk, including the understanding of the risk of fire hazard in building, and its impact on the livelihood of building occupants, the destruction of buildings, operational and impact on environment.
- Structure risk management program, including the risk identification, risk management, analysis of hazard situation, before, when and after the fire hazard.
- Evaluation EB prevention, related to the maintenance and inspection the preparedness of building to prevent the fire spread.
- Develop emergency preparedness plan to safe the people, assets, future building potency.
- Structure decision Analysis, starting from identification of qualitative and quantitative adjustment, scale priority, conclusion and documentation
- Decision making in applying the strategy.

## Fire Risk Analysis

Fire risk should be analyzed, from the tendency of fire, the potential fire sources, and potency of damage. The tendency of fire is influenced by the fire history, land use, population density, building density, and inhabitant's readiness. The damage potency is shown by the number of death, assets losses, and economic activity stagnancy. Fire risk analysis is done to get the accurate information about the hazard potency so the safe and rescue decision can be conducted systematically and properly. The result from this analysis is hazard mapping which shows the zoning of hazard and weight of attack for each location.

## Urban Elements at Palembang Historical Area

Krier (1975) [6] categorized urban open spaces into square and street. The square is produced by grouping some buildings or massive form such houses that create the space. The street is a product of the spread of a settlements or a group of linier buildings. Furthermore, Lynch (1960)[7] mentioned that some urban elements can be perceived by the people to build a certain image of the city. The path, edges, district, nodes and landmark can be perceptible object in urban that has social meaning in urban area related to its function, history, and even its name.

Palembang Historical Areas are located at the old settlement, at Musi riverside. The history can be traced by the existence of some old buildings which are located riverside settlement. Mostly the old buildings are more than 100 years old and their existences are mixed with the new settlements. The historical buildings were functioned as house for a family. The increasing number of population, made the surrounding filled by new houses. Mostly, the historical buildings are pillar houses, and they were owned

[5] Robert W Fitzgerald (2004) *Building Fire Performance Analysis*, John wiley & Sons, ltd p.396 As cited in Simanjuntak (2008),

[6] Krien, Rob,(1975) *Typological and Morpholigical Elements of the Concept of Urban Square*, as reprinted in Time saver Standard for Urban Design, Mc Graw Hill, 2003

[7] Lynch, Kevin (1960), *The Image Of The City*, as reprinted in Time saver Standard for Urban Design, Mc Graw Hill, 2003

by the prestigious family such community leader, big-scale trader, religious leaders or kingdom's officers. This condition might be the reason of why the historical buildings have some open spaces and are linked to relatively wide street.[8]

Generally, location of open space in Musi river settlement is located at strategic positions such as a junction and gate area (Sarwadi, 1998)[9]. He mentioned two types of neighborhood common space; space inside the settlements and the space at the edge of settlement. The inside spaces have varied form: linear, terrace and rectangular. The other common spaces can be located at the edge of settlement, in water area and main entrance-landed area.

Based on the observation, the study classified the old urban structure into two main structures: inner and waterfront. The inner urban structure was a complex of historical buildings which located at landed area, relatively near to the land, represented by Kampong Arab Al Munawar settlement in 13 Ulu District and Kampung Kapiten in 7 Ulu District. The old urban structures were dominated by an open space at the center of complex (Figure 1). The old buildings were oriented to this space. Located at the center of complex, the space was linked to the street at landed area and water at a boat pier. Based on the interview, the space was used to accommodate the family event or gathering related to marriage ond other abual ceremony such Islamic Celebration day at Kampong Arab and Lunar New Year celebration at Kampong Kapiten. Sometimes, the space at Kampong Kapiten was also used for Islamic celebration day as the Kapiten (Chinese Leader) have Muslim servants[10]. The main building, the Kapiten's house was oriented to the river, while the other buildings oriented to the space (Figure 2). As the time goes by, the new buildings were built at the empty space, outside the complex[11]. At Kampung Arab 13 Ulu, the complex was relatively similar. The complex was located at landed area, which dominated by square as building orientation. The main building, known as Rumah Tinggi, built by Habib Al Munawar, the famous religious leader in Sriwijaya Sultanate Era. The other old buildings were oriented to the square. Unlike at Kampung Kapiten, the main house was not oriented to the river. Its orientation was to the square, back to back the river.

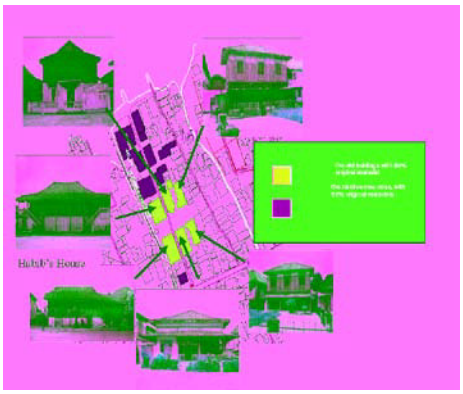

**Figure1.** Figure Ground of Kampung Al Munawar

[8] The general typology of houses at Musi river settlement were pillar house (rumah panggung) and raft houses (rumah rakit). The new settlements filled the space around the old buildings and made a new urban structure. Almost the paths (as alleyway) were narrow, approximately 1.00 to 1.20 meters in width and made by concrete and wooden. Only street of old buildings complex had wider dimension.

[9] Sarwadi, Ahmad , *Study on Living Space Typology of Urban Riverside Settlement for Improvement Planning. Case study in Palembang, Musi river Indonesia*, Master Thesis, Dept of Global Environment Engineering, Graduated School of Engineering, Kyoto University, 1998

[10] The Kapiten was a Leader for Chinese community, selected and installed by Dutch Government in era of Ducth colonization. Kampung Kapiten was a complex of house where the Kapiten family and the servants were stayed.

[11] Febriati, Widya F, 2007, *Analisa Potensi Pariwisata pada Kampung Kapiten Palembang (The analysis on Kampung Kapiten's Tourism Potency),* Seminar Ilmiah Fakutas Teknik Univeritas Sriwijaya

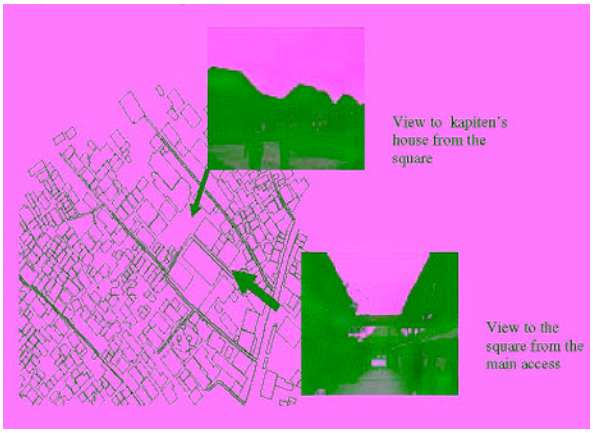


**Figure 2.**Figure Ground of Kampung Kapiten

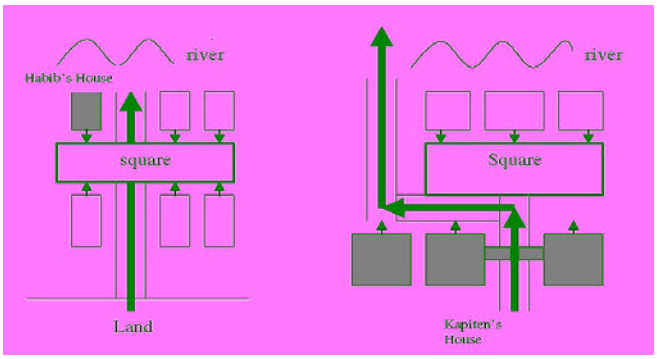


**Figure 3.** The urban structure at inner area, Al Munawar's urban structure at left side, and the Kapiten's at right side. See the different orientation between the Habib's house and Kapiten's House as main buildings.

The old urban structure at waterfront area was represented by Pecinan 10 Ulu, a complex of historical buildings which is located at near water area (Figure 4). As owned by Chinese trader, the houses have open space in front of the buildings. The form of the space was rectangular, paralleled to the river length. The square served two functions, as a place for accommodating big ceremonial event such family gathering, marriage, and a place for accommodating loading area. The first function was located at near the house, while the second one was located at near the water. Having this arrangement, the open space was relatively bigger and longer than the old urban structure at inner area.[12]

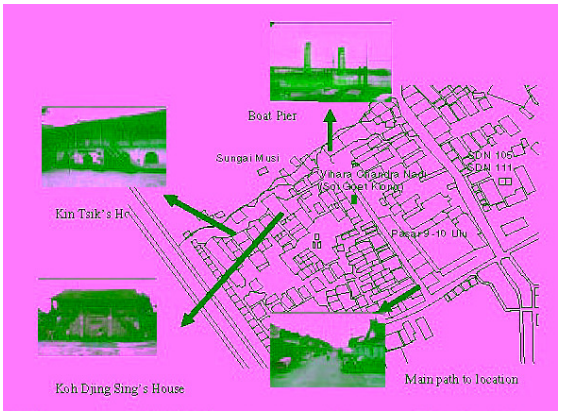


**Figure 4**. The figure ground of old urban structure at Kampung China 10 Ulu

[12] Some of Chinese big trader owned the houses located near to the river. The dimension of the house reflects the social status of the trader in the past time. Usually, the big-scale trader owned the bigger house. Smaller-scale Chinese trader owned the pillar houses in smaller houses, some of these did not have landed open house in front of the houses. The front side of the house was faced the river, directly to the water.

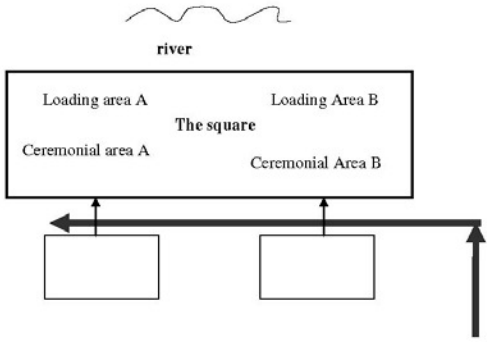


**Figure 5.** Urban structure at waterfront area of Musi River

## Fire Risk Analysis

Generally, based on fire history in Palembang, the settlements have high risk of fire hazard, with electrical shock problem as the main causal factor. [13] The risk of fire hazard is influenced by several aspects: the industrial buildings, public buildings, the potency of ire spread, population density, and the frequency of fire hazard. The fire risk analysis comes out for fire hazard mapping in Palembang as shown in Figure 6. The observed area of study were noticed by code 14 (7 Ulu), 17 (9/10 Ulu) and 19 (AL Munawar). The inner old urban structure located at Kampung Kapiten in 7 Ulu was categorized as high risk area while the other inner old urban structure at al Munawar was low risk area. In addition, the waterfront urban structure at Pecinan 10 Ulu was categorized as moderate risk area.

Palembang Fire Management Area consists of two main areas; Ulu FMA and Ilir FMA. The three observed areas were part of fire management at Ulu Area. Based on Palembang Fire Safety Master Plan, the observed areas were served by the 3-4 Ulu fire station. The location of 3-4 Ulu fire station and its service scope san be seen in dark purple color as shown in Figure7.

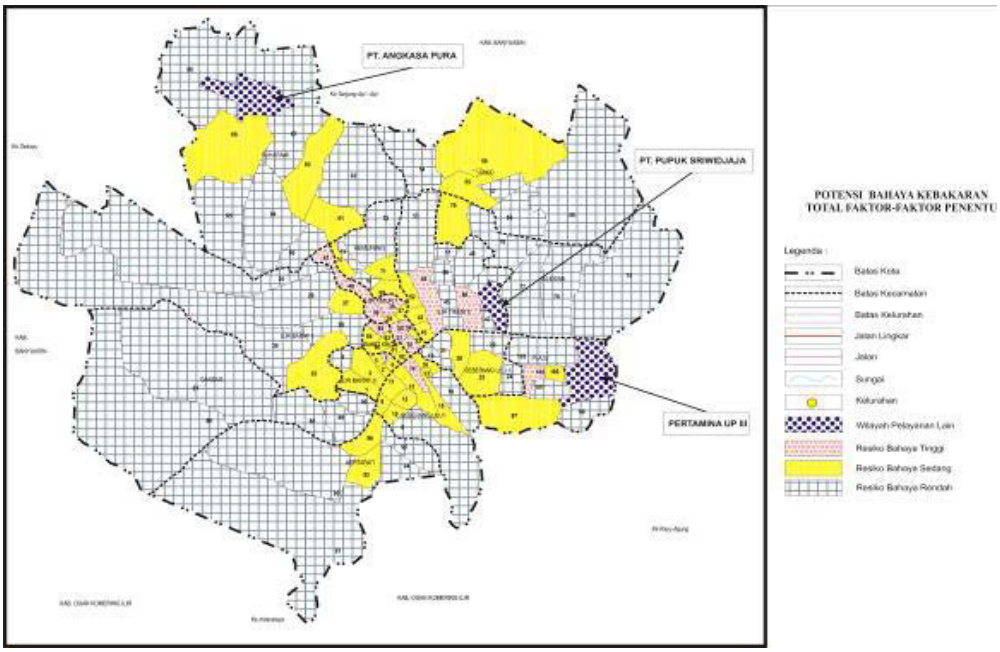


**Figure 6.** Palembang Fire Hazard Mapping
*Source: Palembang Fire safety Master Plan, 2006*

[13] Palembang Fire Safety Master Plan (2007)

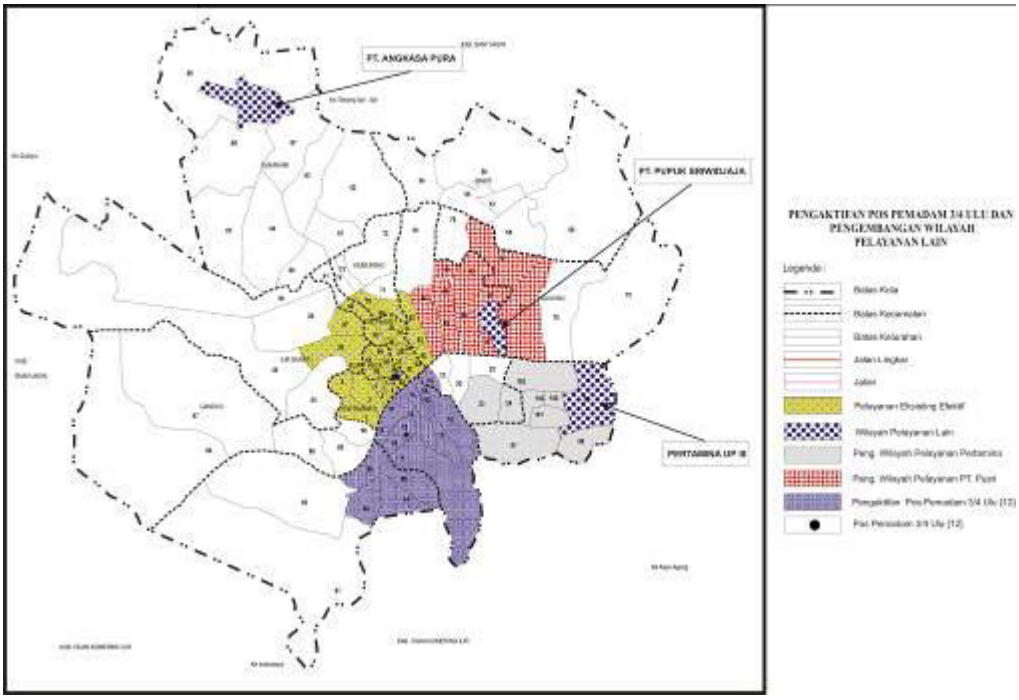


**Figure 7.** Serving Scope of Four Fire Stations in Palembang
*Source: Palembang Fire safety Master Plan, 2006*

## The reliability of historical area in fire fighting

The fire safety effort at historical area must be supported by the service ability of fire station to reach the historical area, provide the man power and utilize the supported facility for fire control. As the successful fire control or extinguishment is determined by the first 10 minutes efforts, the study analyzed the reliability in fire control (Table 1). The table shows that the environment ability for fire extinguishment could not depend on the service from fire station only. The accessibility to the historical area was still bothered by the unclearness of fire engine track to reach the closest water sources or water shuttle. There was no simulation or training on fire control for inhabitants participation organized by people living at the historical area. This can lead the first 10 minutes of fireman to unsuccessful fire control, thus to the damage on historical buildings or kill the residents.

**Table 1.** The Reliability of Historical Area

| Factor | | Existing condition | Description |
|---|---|---|---|
| Accessibility | Speed of fire engine through the closest street (K.H Azhari st) | 19 km / hour | |
| | Clearance to historical area | low | The main accesses to the historical area were crowded, as market and high density settlement area located near the main entrance of location. |
| | Track to the historical building | Main path was quite wide, mostly 3-4 m in width | The high density of settlement decrease the speed of fire engine to reach the building site |
| Water supply | Water sources | Musi River and Kedukan River | S. Kedukan for Kampung Kapiten, 7 Ulu Disrict, 750 m<br>S. Musi for Kampung China 10 Ulu District, 300 m<br>S. Musi for Al Munawar, 150 m |
| | Hydrant | Available | Bad condition |
| | Water shuttle | Not available | |
| Organization | Inhabitants participation | Not Available | |
| | Fireman Organization | Fire force by goverment | 3-4 Ulu fire station at 3-4 Ulu district. |

In order to provide the environment ability to overcome and control the fire severity in the first 10 minutes, the elements of old urban structure can be used to eliminate the inability. Table 2 shows the potency of elements of urban structure at observed historical area.

**Table 2.** The Role of Old Urban Elements to Control the Fire Severity

| Urban elements | Function or requirement | |
|---|---|---|
| | Inner urban structure | Waterfront urban structure |
| Street, path, | ▪ The main street to historical area must be connect to the square,<br>▪ As main access for fire fighter to the historical area, but it must be wide and clearance<br>▪ Location for hydrant along the main entry access.<br>▪ Complementary access should be maintained as evacuation track | |
| Square | ▪ As place for water shuttle or hydrant. The square location was relative in the middle position between water and land.<br>▪ As place for temporary shelter or refuge area for evacuation | ▪ As place for waterfront fire station to provide water supply intake from river and boat pier for landing the rescue from river<br>▪ As place for temporary shelter or refuge area for evacuation |
| Landscape | The complex of historical building must be completed by greenery, such trees for land area, or hanging greenery for pillar house at water area. The greenery can be used as firewall, which can reduce the speed of fire spread across to the settlement around the historical building, visa versa. | |

## 4. CONCLUSION

The study comes out with several design guidelines at historical area as follows:

- Old urban structure elements were potential to reduce the fire hazard damage. The street was widest path at riverfront settlement and the square was big, so these two open spaces are worth urban elements in the high density settlement.
- The elements can be used as location for placing the fire safety environment system such hydrant, water shuttle, water-fire station and also assembling point or refuge area for evacuation
- In order to reduce the speed of fire speed from/to the historical buildings, the landscape should be designed, particularly use the greenery as firewall.
- Human resources should be well trained and well managed, both for fire man and inhabitants
- The effort of fire control or extinguishment should be done by the readiness of fire man and inhabitants to take the right control steps in first 10 minutes. The comprehensive environmental fire safety system can support this by utilizing the good organizing human resources and fire protection facilities at elements of urban at historical area.

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