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Maximizing Productivity Using Spatial Organization Strategies In Rubberwood Processing Factories In Nigeria

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ABSTRACT
Rubberwood processing is usually considered as a simple manufacturing process, (i.e. cutting down a tree, sawing, and generating lumber), is in fact a highly technical and sophisticated industry that must be constantly monitored. In the past, old Rubber tree after latex stage were burnt, but today most of these older trees are being treated and sawn into lumber instead of being burned, which has resulted in economic value and substantial increases in lumber availability. The functionality of the rubberwood factory and how these spaces relate is dependent on how the spaces flow into themselves. The main purpose of spatial organization is to plan an interior space in order to create functional efficiency in a space layout. This study is centered on using spatial organization strategies to achieve maximum productivity in rubberwood processing factories. This point to the fact that with proper articulation of activities through more effective spatial design, designing suitably related activity spaces would be actualized thereby resulting into effective and maximum industrial production. Encompassing two case studies regarding rubberwood processing factory, this study aims to understand how interrelated space planning enhances spatial arrangements to achieve maximum industrial production. This paper recommends spatial organization principles that should be adhered, to ensure optimization of space in order to achieve maximum productivity in rubberwood processing factory.
Keywords: Rubberwood, Spatial Organization, productivity

INTRODUCTION

Wood processing can be describe as the various types of procedures used to utilize raw wood or log in order to create lumber or supplies that serve as the raw materials for the manufacture of various wood-based goods. Wood as an indispensable engineering material has served man from time immemorial. It was one of the earliest discovered materials endowed by nature with its source renewable and with lowest tooling cost (Owoyemi, 2006). Early craftsmen relied on it as the material to meet most of their needs. It is used today for various forms of construction work.

Rubber wood plantations are considerable and widespread in the mid-west and south east regions of Nigeria. Most of the plantations within Nigeria were established in the beginning of the 20th century as a response to the booming rubber market (Aigbodion, 2017).

Rubber trees are grown in plantations for the purpose of harnessing rubber latex. The economic life span of rubber trees ranges from 25 to 30 years (i.e., The trees produce latex up until they are roughly 20 years old, between the ages of 20-25 the trees start to decline in their latex production and by the age of 30 most trees stop producing quality latex), thereafter, the trees are felled and replanted to maintain high latex production (Coulen et al., 2017). However, there is a growing interest in technical applications of rubber wood for furniture factories, energy generation (as firewood and charcoal), and in pulp and paper industry. In recent decades, rubberwood has become an important timber for wood products, particularly in the furniture manufacturing 27 sector, due to its attractive features, cream color, and good working properties. There are limited technical applications of rubber wood in African countries especially the major rubber producers such as Côte d'Ivoire, Nigeria, Liberia and Cameroon. In these countries, the wood is often burnt off or used as firewood and charcoal for heat generation by the locals, but this could generate substantial revenue if properly harnessed (Aigbodion, 2017). In Nigeria these trees are cut down, used as firewood or to make charcoal, thereby emitting large amounts of carbon dioxide into the atmosphere (Aigbodion, 2017).

Within the last two decades, rubberwood has evolved from being relatively unknown to one highly sought after as a principal raw material by the furniture industry, both in Malaysia and abroad. As such, the trees, originally planted for latex, have gained much importance contributing to the competitiveness of local wood and wood based industries. Production of sawn timber from rubber trees has been studied by a number of researchers (Lopez. et al. 1980, Ho & Choo 1982, Gan et al. 1985).

Rubberwood which is gotten from rubber tree has traditionally been used for fuel wood and charcoal in rubber processing, steel industries, tobacco curing and brick manufacturing. Most rubberwood has been burned at the clearing site, except in the wood-scarce countries of South Asia (Hashim, 2001). Malaysia has the most diversified rubberwood industry with various types of wood-based panel plants and furniture mills. Ready and low-cost availability, light color, easy machining and staining properties have all contributed to the establishment of rubberwood as an important wood product (Hong, 1996).

Today, aside from the traditional uses, rubberwood is used primarily for furniture, furniture parts and wood-based panels. Rubberwood stumpage prices have generally been very low or negative when compared to other wood species, due largely to the fact that rubberwood is an agricultural by-product. Poor quality logs, distance to processing facilities, seasonality and rubberwood traders' opportunism has contributed to these low prices. The price differential between rubberwood logs/sawnwood and other species is narrower, but the former is still cheaper in many places (Goldthorpe, 1993).

The rubberwood processing industry has also been suffering from low production rates (15-35 percent), partly due to the use of poor technology and lack of proper spatial planning during design stage by Architect (Denig and Wengert, 2010). A rubberwood processing factory that is designed with keen consideration on proper spatial organization and relationship will help to maximize industrial productivity. Nowadays, architects not only focus on designing the facade composition and the geometry of the floor plan; they also take into consideration subjects such as the organization within and around a structure (Franklin, 2006). The essence of architecture is space. Architects are responsible for the creation of space with the relevant characteristics in functional, aesthetical and structural qualities – as in the Vitruvian triad: utilitas, venustas and firmitas (Vitruvius, 1960).

Gellerman, (2008) puts it thus, that architects add to buildings the qualities that make them not only aesthetical but also practical and functional. Suvanajata (2001), says that, Space also includes activities or functions; that is to say, every activities or functions of human beings require a space. Most of the time an activity becomes the main feature, which identifies a space. This is why space is never just a simple shape and volume and the main reason why space making is the essential parameter of architecture.

Aim of study

The primary aim of this study is centered on how to use spatial organization strategies to ensure maximum industrial productivity in rubberwood processing factories.

RESEARCH METHOD

A qualitative research approach was employed, with this, comprehensive data and insights were gathered. The relevant literature on spatial organization strategies, its contribution towards maximum industrial productivity, and its use in a variety of contexts was thoroughly reviewed. The theoretical framework of the study was developed by analyzing books, reports, academic papers, research articles, and other resources. Case studies of some existing rubberwood processing factories in Nigeria and Malaysia were also carried out, to assess their level of compliance to the principles of spatial organization. The case studies featured; on-site visits, interviews with factory workers, factory production manager, and documentation of findings.

FINDINGS

Case studies were undertaken at the following rubberwood processing factories:

i. **Enghuat Rubberwood processing factory, Akamkpa, Calabar:** This factory is located at Akamkpa, calabar in cross river state.The factory is the first and larged scaled integrated Rubberwood processing factory in Nigeria. It comprises of planned timber felling, wood preservation and machining, with annual output of 15,000 cubic metres of high rubber wood in all sizes. Enghuat rubber wood processing factory covers an area of 30 acres and is situated close to the raw material (rubber tree plantation), and has advanced-imported production line and equipments and employs specialists in the wood processing field from china who supervise log cutting, high pressure preservative treatment and kiln drying. The factory consist of four (4) sections namely:- the administrative section, the production section(operations), maintenance workshop section, recreational section. Secondly, on approaching the factory, the first port of call is the administrative building. The administrative section is separated from the factory building. The factory building (production area), the engineering department and the maintenance workshop are zoned and grouped in close proximity, together with other factory supporting facilities. Also the log yard is located close to the log sawing area. The inherent zig zag production process in industrial designs gave rise to a zig-zag form adopted in the design of the factory. There is proper and sequential spatial interation between facilities and production line, which in turn encourages effective and efficient industrial production.

ii.

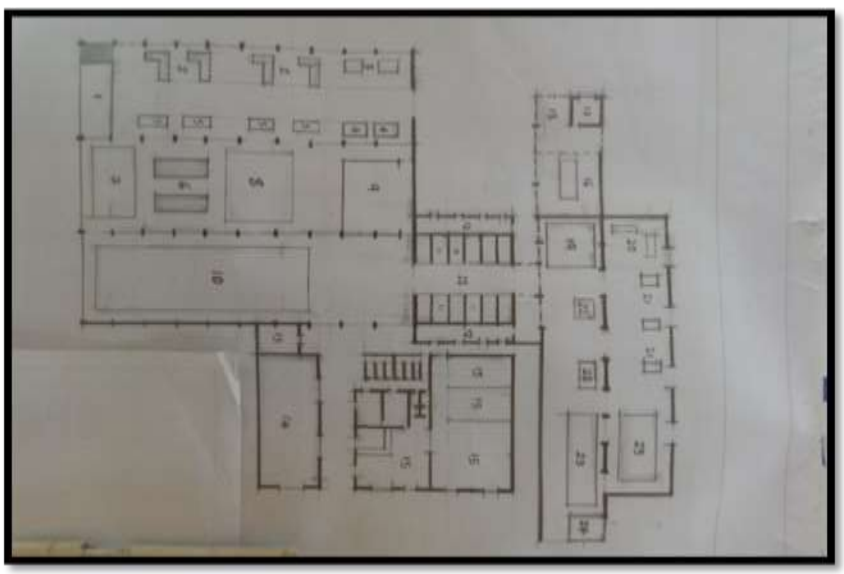

Plate 1: Factory floor plan of Enghuat Rubberwood processing factory, Akamkpa, Calabar
Source: Researcher’s field work, 2022

Plate 2: view showing factory interior with arrangement of machines in Enghuat Rubberwood processing factory, Akamkpa, Calabar
Source: Researcher's field work, 2022

iii. Ban Huat Rubberwood processing factory at Kedah, Malaysia: The factory is located at Kedah in Malaysia and covers an area of 60,000m^2 and has about 600 employees working at the factory. The factory has a rubber tree plantation right round its boundary. It is a manufacturer of rubber wood timber made from treated rubber wood which has gone through kiln-drying process. The factory production capacity of rubberwood timber is approxi. 30,000 cubic metre annually. Related functions are properly grouped together and the production line is well planned using l-shape production line. The factory consists of the following sections namely: - the administrative section, the production section (operations), maintenance workshop section, log yard. Also, the administrative building is connected to the factory building. The factory building and the maintenance workshop are in close proximity.

Plate 3: Site Arial view of Ban Huat Rubberwood processing factory at Kedah, Malaysia
Source: google earth, 2022

It was observed that the rubberwood processing factories visited have some applications of the principles of spatial design patterns and organization, as can be seen in the plates above. The facilities on site were spatially planned and articulated; including the arrangement of machines use for production, According to Francis D.K. Ching, (1979), spatial organization in architecture is fundamental in creating a composition as it brings together different shapes and forms and provides a cohesive structure to the design. Spatial Organization is a way to tie the spaces together to create a collective and organized whole. This can be done both on the micro-level (i.e. by relationship patterns) with the floor plan zoning and at the macro level (i.e, by spatial types) on the site (Sailer & Penn, 2010). The factory hall of the rubberwood processing facilities visited has patterns of spatial organization. Though, the surrounding site facilities were not properly zoned thereby leading to poor management of material handling which result into low production. For instance, the log yard is far from the log sawing area and the engineering department, who are supposed to supervise production process, is separated from factory building. A connecting covered walk way between the factory building and the engineering department should have solved the issue of poor space planning and zoning. Given these observations, it can be deduced that the design of these facilities did not consider spatial organization patterns in totality (i.e, micro-level and macro level on site) and these in turn resulted to low production.

Concept of Spatial Organization

Organizing spaces in architecture is an essential task that affects the whole building usage. The manner in which these spaces are arranged can clarify their relative importance and functional or symbolic role in the organization of a building (Francis D.K. Ching, 1979). Therefore, the preliminary study of the main functions for which a factory is be built, the spaces that meet these functions and their relationship with each other are the first basis for achieving maximum industrial productivity. Architects, says Yi-Luen Do (2001), define boundaries and select specific features and relations to attract attention, and create their design on the spatial situation. Moreover, they achieve coherence that guides subsequent movements in the spatial formation through space relations (Do, 2001).

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Alexander Christopher (2008) presents architectural spatial design of buildings, which is proven by a system, which contain proportions, actions, and relations. This attempt of Alexander identifies the spatial organization or pattern of space which represent living and working factors in the spatial settings for human livings and work. Similarly, Ching (1979) has classified the methods of space organizations; his work is a great contribution to the geometric categories of space organization and its principles remain fundamental in architecture spatial organization.

The following section lays out the basic ways we can arrange and organize the spaces of a building. In a typical building program, there are usually requirements for various kinds of spaces (Francis D.K. Ching, 1979).

There may be requirements for spaces that:

- have specific functions or require specific forms
- are flexible in use and can be freely manipulated
- are singular and unique in their function or significance to the building organization
- have similar functions and can be grouped into a functional cluster or repeated in a linear sequence
- require exterior exposure for light, ventilation, outlook, or access to outdoor spaces
- must be segregated for privacy
- must be easily accessible

Ching (1979) draws attention to the importance of space relations within buildings. Buildings are usually composed of several spaces, which are related to each other by functions, proximities and circulation paths. He further outlines the basic ways in which spaces could be related and arranged into a coherent pattern and how any two spaces can relate to each other, likewise, these spatial patterns can be used to plan spaces in rubberwood processing factory in order to achieve maximum industrial productivity.

Below are certain patterns that can be adopted to attain optimal spatial organization in order to achieve maximum industrial productivity

- Space within a space
- Interlocking spaces
- Adjacent spaces
- Space linked by a common space

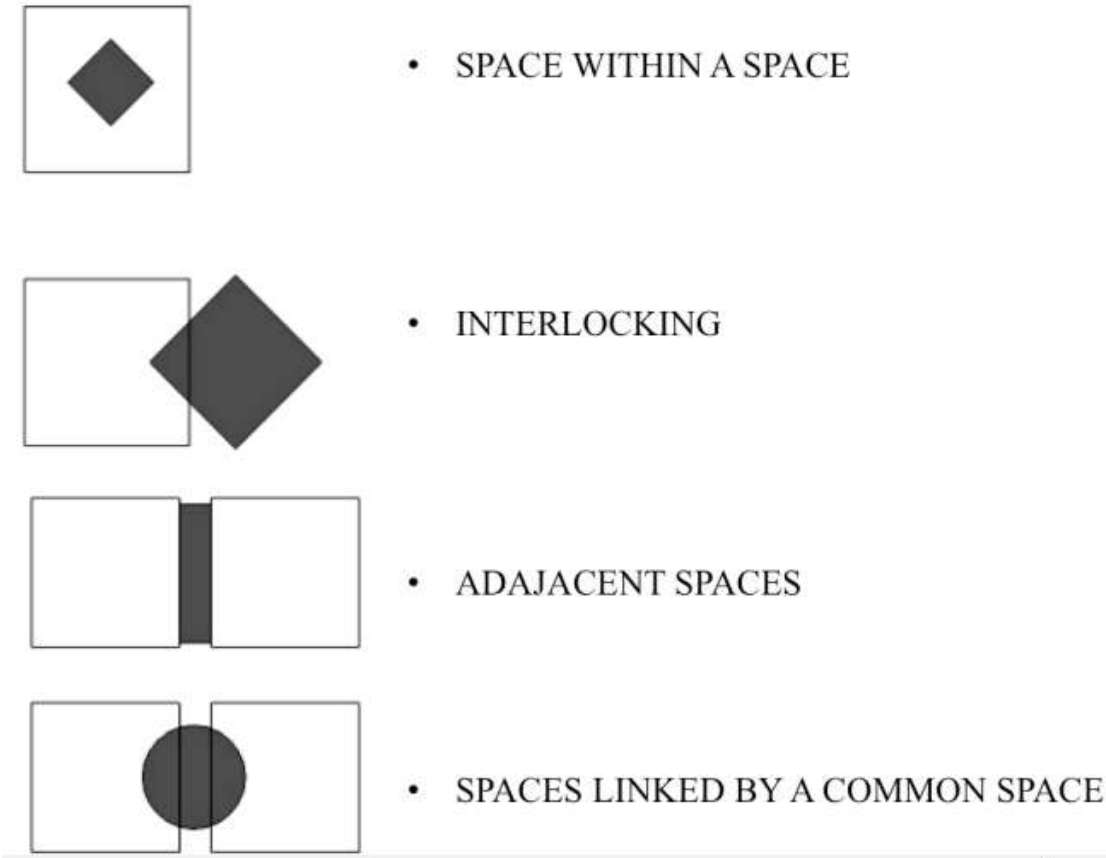

Plate 4. Four Categories of Basic spatial patterns
Source: (Ching 1979, p. 195)

Space within a Space: space within a space is one of the form-giving characteristics of spatial relations. Ching (1979), explains it as a large space that contains within its volume a smaller space. This larger space has a role of envelope for the smaller space, which exists within it. The larger space in this kind of spatial relations has the role of three dimensional field for the smaller space. This type of spatial pattern is applied in the design of rubberwood processing factory, whereby an open hall housing machines that are been arranged to follow a particular production line, thereby ensuring a continuous production flow.

Interlocking Spaces: Ching (1979), describes the Interlocking spatial relation as two spaces, which have common parts shared in both spaces; these two spaces interlock with this common spatial zone.

Adjacent Spaces: Ching (1979), describes adjacent spaces as space relations that connect two spaces together beside each other. The level of visual and spatial continuity depends on the nature of the plan.

Spaces Linked by a Common Space: this is the fourth basic spatial relation. This kind of spatial organization connects two separate distanced spaces together by adding another space in-between. The relation between these two spaces depends on the nature of the third space (Ching, 1979).

The basic space relations discussed above drive the process of design – being the main concern of architectural design process (Schön, 2007). Space is more an idea rather than a portrayed concept. When one puts this idea into words, one almost loses it (Hertzberger, 2010). Machines with any imaginable number and possible spatial settings are essential to supporting the future possible use of a factory (Frank & Lepori 2007).

Organization of Space, according to Ola Nylander (2012), spatial organization provides the opportunity for users to stake out territory, within public space is the most important aspect of it. Also, within the spatial organization of space not only the functional aspect of space has been serving but also it makes a great contribution to perception of the space as a part of a whole spatial organization in a structure. In

Ando's (2010) conception of this rationalization of design, he argues that behind the promotion of the universalization of architecture is the idea that functionality equals economic rationality. The function-based qualities are essential in defining space not only as a functional feature but also as a meaning of architecture. Functional requirements are the main considerations in functional designs (Wright, 2008)

Integration of Spatial Organization Strategies in rubberwood processing Factory to maximize production

For a factor design to be spatially planned it must have properly and sequential planned spaces and activity zoned according to their functions and organized. From the scope of this study, major concentration will be on the following spatial organization strategies.

- Citing rubberwood factory close to the source of rubber tree plantation which is the raw material for rubberwood.
- proper zoning of facilities in relation to their functions
- proper and orderly arrangement of machines to easy flow of material handling
- use of wide lobbies within the production area, so as to enhance unobstructed and free movement between people, machines and material
- provision of mezzanine floor for supervision in production area
- close proximity of log yard to log sawing machines

CONCLUSION

To conclude, the study has showed the need to design a Rubberwood processing factory which is well spatially planned in order to achieve maximum and increased industrial productivity. All the features analyzed in this study, if adopted will help tackle the problem of low production and maximize productivity in rubberwood factory. The study also shows that considering spatial organization in wood factory design will go a long way in achieving increased productivity in rubberwood processing factory.

RECOMMENDATIONS

Spatial organization and planning is essential for achieving maximum and increased productivity in factories. It is therefore recommended that as applicable to factory design such as rubberwood processing factory, considerations should be given to spatial patterns and strategies for achieving maximum and increased productivity in wood factory during design stage. Also, Architects should be space usage oriented as a culture and should base their spatial design and allocation based on the production process, production line and material handling within the interior spaces and around the factory site, rather than abstract concept which is the norm.

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