LIFE IN BUILDINGS

A study on how to increase the potentials of social interaction in markets based on use-space-design relation

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Abstract

Due to industrialization, cities grew with migration; a process that has been ongoing ever since and characterizes globalized contemporary cities. More and more strangers came to cities transforming the traditional patterns of social relations and everyday encounters in public space. Citizens adapt to social roles and socially acceptable patterns of behavior, trying to give a good impression as well as keep the appropriate distance to others. Much more public life and co-presence now is about spectating than about participating, and that makes social interaction in public space transform from close encounter and verbal interaction to simple co-awareness, fleetingly verbal encounter, distant visual encounter and short mutuality of gazes. This social segregation is not only seen in open public space but also in public buildings. This side effect can be seen clearly through the change of the consumption behavior. In the past, markets played an important role in the public system; there, people not only exchanged goods, but also information and personal news. Nowadays, people have more efficient ways to exchange information and do not need to go to markets for news anymore. The social role of markets as places for social interaction has decayed. Traditional markets were largely replaced by unmanned supermarkets, while on-line shopping has decreased their necessity even more.

It is obvious that the traditional markets cannot fit contemporary society. However, the necessity for social interaction in public space is ever-growing. In that case, the intention of co-presence and co-awareness could be the key issues. By prolonging or increasing co-presence and co-awareness, the potential of encounter and social interaction could be increased. As architects, we need to build knowledge on the new spatial patterns of social interaction and apply this knowledge in future public building design, so as to support, enhance and generate them.

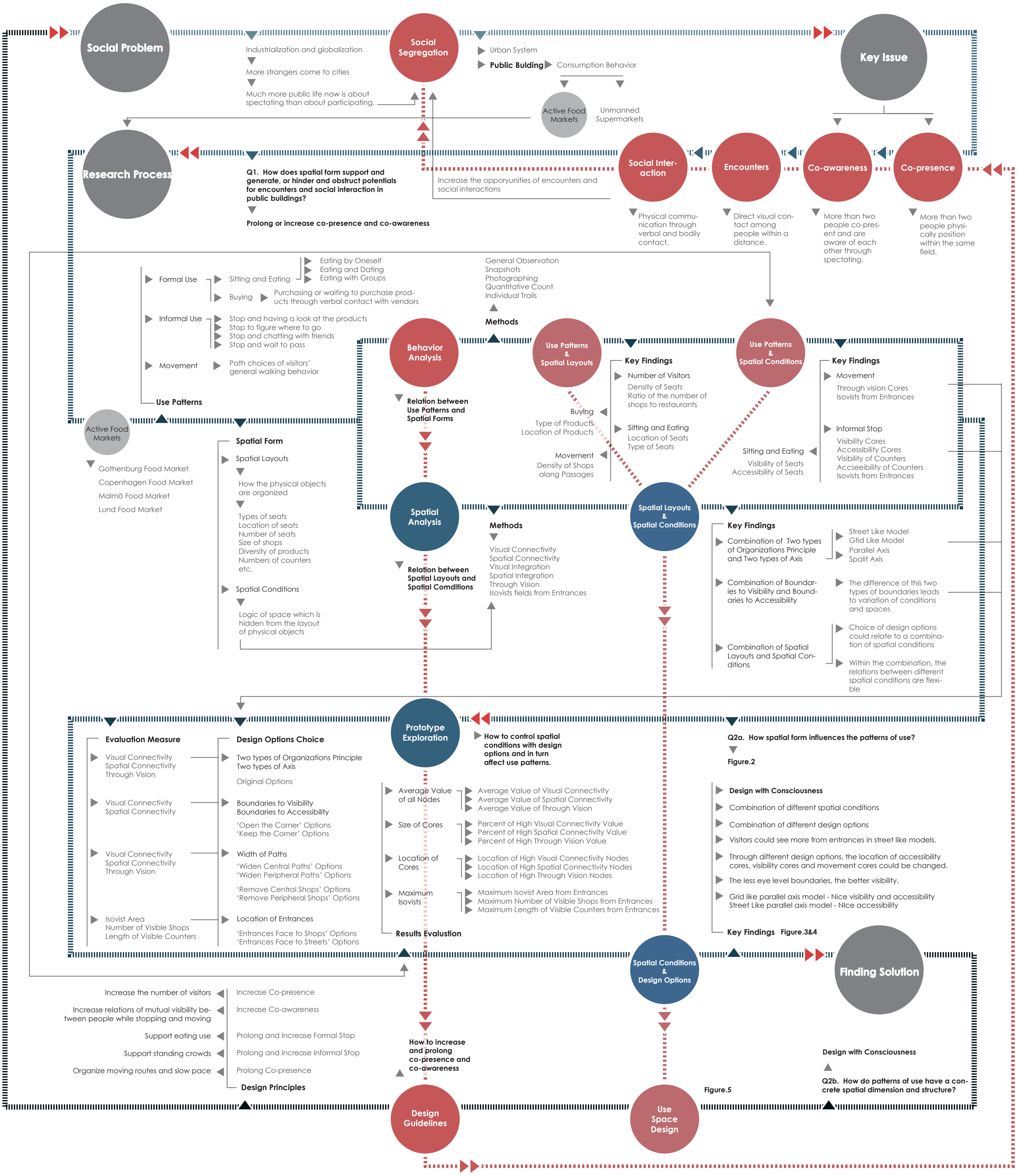
This thesis focuses on how spatial form, which consists of 'spatial layouts' and 'spatial conditions', influences the formal and informal use of commercial spaces like markets, the patterns of co-presence and co-awareness and the organized or unorganized social activities that take place there. The case studies of this thesis are four typical Nordic markets in Gothenburg, Copenhagen, Lund and Malmö. By analyzing A) the patterns of visibility and movement constructed through spatial form, it studies how these spatial layouts are related to spatial conditions. And by analyzing B) the patterns of use by behavior-mapping, the objective of this study is to reveal the relation between use patterns and spatial layouts and spatial conditions of co-presence and co-awareness. However, the question is not only how spatial form influences the patterns of use, but also how patterns of use have a concrete spatial dimension and structure. In addition, the aim of the research is to introduce general design knowledge to both professional architects and normal citizens like vendors, markets managers and even customers. Professional analysis diagrams and conclusions should be translated into more readable design guidelines. Hence, C) the explorative design prototypes are developed to understand how to control specific spatial conditions through design options based on the findings from previous spatial and behavior analysis. The related research can help us deepen our understanding on the changeable patterns of social interaction in space and in turn to affect the social interaction through different design options.

As the end project, usability based design guidelines will be introduced in order to answer the question: How to increase the potentials for encounters and social interaction in food markets? This part could contribute to general design process about how to basically shape spaces and, what is the most important, how to design with consciousness. In addition, the whole research process can function as a research guideline for future similar studies.

Keyword: Market, Space Syntax, Behavior Mapping, Co-presence, Co-awareness

Content

Outline



Social Problem
Industrialization and globalization
More strangers come to cities
Much more public life now is about spectating than about participating.
Social Segregation
Urban System
Public Bulding
Consumption Behavior
Active Food Markets
Unmanned Supermarkets
Key Issue
Research Process
Q1. How does spatial form support and generate, or hinder and obstruct potentials for encounters and social interaction in public buildings?
Prolong or increase co-presence and co-awareness
Increase the opporyunities of encounters and social interactions
Social Inter-action
Encounters
Co-awareness
Co-presence
Physical commu-nication through verbal and bodily contact.
Direct visual con-tact among people within a distance.
More than two people co-pres-ent and are aware of each other through spectating.
More than two people physi-cally position within the same field.
Formal Use
Sitting and Eating
Eating by Oneself
Eating and Dating
Eating with Groups
Buying
Purchasing or waiting to purchase prod-ucts through verbal contact with vendors
Informal Use
Stop and having a look at the products
Stop to figure where to go
Stop and chatting with friends
Stop and wait to pass
Movement
Path choices of visitors' general walking behavior
Use Patterns
General Observation
Snapshots
Photographing
Quantitative Count
Individual Trails
Methods
Behavior Analysis
Relation between Use Patterns and Spatial Forms
Use Patterns & Spatial Layouts
Key Findings
Number of Visitors
Density of Seats
Ratio of the number of shops to restaurants
Buying
Type of Products
Location of Products
Sitting and Eating
Location of Seats
Type of Seats
Movement
Density of Shops along Passages
Use Patterns & Spatial Conditions
Key Findings
Movement
Through vision Cores
Isovists from Entrances
Informal Stop
Visibility Cores
Accessibility Cores
Visibility of Counters
Accseeibility of Counters
Isovists from Entrances
Sitting and Eating
Visibility of Seats
Accessibility of Seats
Active Food Markets
Gothenburg Food Market
Copenhagen Food Market
Malmö Food Market
Lund Food Market
Spatial Form
Spatial Layouts
How the physical objects are organized
Types of seats
Location of seats
Number of seats
Size of shops
Diversity of products
Numbers of counters
etc.
Spatial Conditions
Logic of space which is hidden from the layout of physical objects
Spatial Analysis
Relation between Spatial Layouts and Spatial Comditions
Methods
Visual Connectivity
Spatial Connectivity
Visual Integration
Spatial Integration
Through Vision
Isovists fields from Entrances
Spatial Layouts & Spatial Conditions
Key Findings
Combination of Two types of Organizations Principle and Two types of Axis
Street Like Model
Grid Like Model
Parallel Axis
Spalit Axis
Combination of Boundar-ies to Visibility and Bound-aries to Accessibility
The difference of this two types of boundaries leads to variation of conditions and spaces
Choice of design options could relate to a combina-tion of spatial conditions
Combination of Spatial Layouts and Spatial Con-ditions
Within the combination, the relations between different spatial conditions are flexi-ble
Evaluation Measure
Visual Connectivity
Spatial Connectivity
Through Vision
Visual Connectivity
Spatial Connectivity
Visual Connectivity
Spatial Connectivity
Through Vision
Isovist Area
Number of Visible Shops
Length of Visible Counters
Design Options Choice
Two types of Organizations Principle
Two types of Axis
Original Options
Boundaries to Visibility
Boundaries to Accessibility
'Open the Corner' Options
'Keep the Corner' Options
Width of Paths
'Widen Central Paths' Options
'Widen Peripheral Paths' Options
'Remove Central Shops' Options
'Remove Peripheral Shops' Options
Location of Entrances
'Entrances Face to Shops' Options
'Entrances Face to Streets' Options
Prototype Exploration
How to control spatial conditions with design options and in turn affect use patterns.
Average Value of all Nodes
Average Value of Visual Connectivity
Average Value of Spatial Connectivity
Average Value of Through Vision
Size of Cores
Percent of High Visual Connectivity Value
Percent of High Spatial Connectivity Value
Percent of High Through Vision Value
Location of Cores
Location of High Visual Connectivity Nodes
Location of High Spatial Connectivity Nodes
Location of High Through Vision Nodes
Maximum Isovists
Maximum Isovist Area from Entrances
Maximum Number of Visible Shops from Entrances
Maximum Length of Visible Counters from Entrances
Results Evalustion
Q2a. How spatial form influences the patterns of use?
Figure.2
Design with Consciousness
Combination of different spatial conditions
Combination of different design options
Visitors could see more from entrances in street like models.
Through different design options, the location of accessibility cores, visibility cores and movement cores could be changed.
The less eye level boundaries, the better visibility.
Grid like parallel axis model - Nice visibility and accessibility
Street Like parallel axis model - NIce accessibility
Key Findings Figure.3&4
Spatial Conditions & Design Options
Finding Solution
Increase the number of visitors
Increase relations of mutual visibility be-tween people while stopping and moving
Support eating use
Support standing crowds
Organize moving routes and slow pace
Increase Co-presence
Increase Co-awareness
Prolong and Increase Formal Stop
Prolong and Increase Informal Stop
Prolong Co-presence
Design Principles
How to increase and prolong co-presence and co-awareness
Design Guidelines
Figure.5
Use Space Design
Design with Consciousness
Q2b. How do patterns of use have a con-crete spatial dimension and structure?

1 INTRODUCTION

The first part starts with the overview of social problems in our daily life – ***social segregation***. It is not just a social problem, but a spatial problem at both urban level and architecture level. The thesis focuses on architecture level, trying to find a way to improve social segregation. Hence, co-presence and co-awareness could become the ***key issues***. The first part introduces the detail formulations of theoretical and methodological foundation, delimitation, working approach based on the main argument.

1.1 Life in Buildings. The case of markets

As the support of public life, public open spaces such as urban streets, squares and parks have drawn extensive attention from researchers from different fields. However, compared with public open spaces, the role of public buildings is less studied and highlighted. Public buildings are often ignored in studies of urban public spaces or are treated as destinations and ends of the whole system of urban public spaces (Hillier, 2004). However, life in buildings should be regarded as important as life between buildings. The role of public buildings as places for potential social interaction, physical co-presence and co-awareness, is crucial not least in a time when the abundance of offered on-line processes lower the need for physical interactions.

What is co-presence and co-awareness? The definition could be different under the different context. However, according to Goffman (1961), Collins (2004), Legeby (2013) and Marcus (2015), I share the sociological concept from the spatial dimension. The definition of co-presence is that more than two people physically position within the same field. In turn, co-awareness can be defined as being co-presence with the perception of other people. In other words, co-awareness is the situation that more than two people co-present and are aware of each other through spectating. Moreover, encounter is possible by prolonging the co-presence and co-awareness and defined as the direct visual contact among people within a distance. Social interaction is more about physical communication through verbal and bodily contact.

Wherever I lived, I found that the most visited public place was the market – traditional food market, farm market, holiday market etc. In traditional markets, bargains between vendors and residents are on-going, throughout the whole market, during day and night and filled with joy! Invisible laws seem to exist in each corner of the seemingly chaotic market, that is, the tacit understanding among people and spatial environment. Vendors seem to make efficient use of the limited space in accordance to their wishes. There is a multitude of activities happening in these markets, which go far beyond its specific 'commercial' function; making it a very lively and eventful, active social place.

However, these traditional markets do not fit contemporary urban societies, nor their patterns of use can be copied or imitated. Cities have grown immensely with migration; an ongoing process that characterizes globalized contemporary urban societies. More and more strangers came to cities transforming the existing patterns of social relations and everyday encounters in public space. Citizens adapt to social roles and socially acceptable patterns of behavior, trying to give a good impression as well as keep the appropriate distance to others. Much more public life now is about spectating than about participating, and that makes social interaction in public space transform from close encounter and verbal interaction to simple co-awareness, fleetingly verbal encounter, distant visual encounter and short mutuality of gazes. This social segregation is not only seen in open public space but also in public buildings. This side effect can be seen clearly through the change of the consumption behavior. In the past, markets played an important role in the public system; there, people not only exchanged goods, but also information and personal news. Nowadays, people have more efficient ways to exchange information, such as from the internet and do not need to go to markets for news anymore. The social role of markets as

Figure 1. The unmanned supermarkets in our daily life.

places for social interaction has decayed. Traditional markets were largely replaced by unmanned supermarkets, while on-line shopping has decreased their necessity even more.

Nevertheless, the necessity for co-presence and social interaction in public space is always crucial and ever-growing, especially in globalized societies and open communities. As architects, we need to build knowledge on the new spatial patterns of social interaction, co-presence and co-awareness and apply this knowledge in future public building design, so as to support, enhance and generate them. How does spatial form support and generate - or hinder and obstruct - potentials for co-awareness and social interaction in public buildings? Or going back to the case of traditional markets, how is this common understanding of space between vendors and customers is generated, which in turn makes markets not only a relatively well-functioning commercial space, but also a dense, diverse and active social place?

Designing spaces is often equal to design the use of spaces and to suppose how the life of those who use it will be affected. Space affords a number of uses, while restricting others (Markus 2015, 2108) However, architects are not the sole directors of people's life. Our design proposals might intent to better their lives, but can also become too instrumental and deterministic by forcing people to follow certain rules and patterns of behavior imposed by the designed environment and its intended use. That is the reason why we need to understand deeply the relationship of spatial form and patterns of use before the design process; and idea that relates to the balance between bottom-up and top-down design practices.

The case studies of this thesis are four typical Nordic food markets in Gothenburg, Copenhagen, Lund and Malmö. This thesis focuses on how spatial form, which consists of 'spatial layout' and 'spatial condition', influences the formal and informal use of commercial spaces like markets, the patterns of co-presence and co-awareness and the organized or unorganized social activities that take place there. By analyzing A) the patterns of visibility and movement constructed through spatial form, it studies how these spatial layouts are related to spatial conditions. And by analyzing B) the patterns of use by behavior-mapping, the objective of this study is to reveal the relation between use patterns and spatial layouts and spatial conditions. However, the question is not only how spatial form influences the patterns of use, but also how patterns of use have a concrete spatial dimension and structure. In addition, the aim of the research is to introduce general design knowledge to both professional architects and normal citizens like vendors, markets managers and even customers. Professional analysis diagrams and conclusions should be translated into more readable design guidelines. Hence, C) the explorative design prototypes are developed to understand how to control specific spatial conditions through design options based on the findings from previous spatial and behavior analysis. The related research can help us deepen our understanding on the changeable patterns of social interaction in space and in turn to affect the social interaction through different design options.

The aim of the research is to answer the main question: ***how to increase the potentials of social interaction in markets based on use-space-design relation?*** As the end-product, usability based design guidelines that consciously interrelate spatial forms and patterns of use are set up. This thesis tries to introduces more readable knowledge about how to design co-presence and co-awareness potentials in space to intensify social contact. In other words, this thesis tries to introduce how to design with consciousness to those who want to design their own shops or other commercial areas even though they don't have professional knowledge. The design guidelines could be referred at the start of the design process about how to basically shape spaces. In addition, the whole research process can function as a research guideline for future similar studies.

1.2 Main Question

As presented in the Introduction, the main question of the thesis is: ***how to increase the potentials of social interaction in markets based on use-space-design relation?***

The thesis as presented in the Introduction is focused on the space of markets, particularly food markets and their spatial design. It is specified as follows: How can we design markets as social places where people not only buy and sell, but engage different people to interact with each other?

The questions above are related to a broader fundamental issue; the relation of spatial form and human behavior in public buildings: How does spatial form influence human behaviors and interactions in public buildings? The question is not only how spatial form influences the patterns of use, but also how do patterns of use have a concrete spatial dimension and structure.

Before continuing detail description, the definition of 'spatial form' need to be presented. In this thesis, spatial form consists of 'spatial layout' and 'spatial condition'. The primary mean of spatial layout is about how the physical objects are organized. It relates to the size and shape of the building, functions of physical objects, number of physical objects and the location of physical objects. Spatial layouts can be analyzed directly based on the plans. For examples: types of seats; location of seats; size of shops; diversity of products; numbers of counters etc. Spatial condition, on the other hand, is defined as the logic of space which is hidden from the layout of physical objects. It is more about understanding how people perceive the space created by physical objects. Through analysis, some invisible spatial properties like centrality of visibility and accessibility, potential of movement and stop etc. could be performed. Spatial condition can be analyzed based on Space Syntax theory and Visibility Graph Analysis. In this thesis, the means of spatial conditions are limited as the patterns of visual and spatial connectivity, visual and spatial integration, through vision and isovists from entrances. The detail explanations will be presented before the spatial analysis section.

The objective of the study is twofold: a) ***explore the relation between spatial form and patterns of use, co-presence and co-awareness, taking the case of food markets*** and b) ***develop explorative design prototypes to increase co-presence and co-awareness potentials in space, with an aim to intensify social contact.*** The a) study could answer the 'use-space' part of the main question while the b) study could answer the 'design' part of the main question.

The aim would be to make food markets again places of encounters and social interactions, as were the traditional markets, but now in the context of the contemporary society. How can the understanding of the mutual relationship between spatial form, behavior and patterns of co-presence inform the design of commercial places which go beyond their specific commercial use to become engaging and lively social places?

Figure2. Social life in the Copenhagen Food Market.

1.3 Theoretical and Methodological Background

For the theoretical part, my topic is based on the mutual relation of social events, social use and spatial form both from a general field such as sociology and a professional field like space syntax.

According to Goffman (1959), when an individual participates social life with other people, he or she will try to guide the impression to others by his or her manner and behavior. Meanwhile, others also try to form the information about the individual. I think this phenomenon can be translated as the invisible laws of social interaction and is the underlying support of social activities and urban function. The evolution and development of the social interaction reflects back the different urban and architecture space.

Furthermore, space syntax theory also introduced a unique perspective to think about the relation between social interaction and spatial form. By limiting the spatial elements, the morphological language started from human behavior (how people see and move in spaces) and focused on the description of social logic of space (how spaces connect with other spaces). Hillier (2004) mentioned that the definition of 'architecture' should be more than 'building' and that is architecture adds configurational ideas to building and makes building to be a cultural and social object. In other words, spatial configuration is a method to transmit common cultural tendencies through spatial form. From a spatial dimension, the key of the morphology language, or in his words, spatial configuration, is the logic of the physical space that is influenced by the relative position and the relation of the space (see Fig.3). In addition, the configurational logic has the potential to contribute to social life. And in return, social behavior is the start point when we consider to build environment as an organized system.

For the methodological part, I will use visibility analysis, together with the analysis of spatial configuration and location of markets.

The visibility analysis is based on the isovist and isovist field theory from Benedikt (1979) who tried to describe the space from the individual view as how individual perceive the space that was created by different kinds of boundary. This theory showed the relevance of architectural analysis because it focused on how much space can be seen from one point in the building. After that, Turner (2001) rebuilt the theory system that combined the theory form Hillier and Benedikt. By constructing all the visible points in the human scale grid, the visibility condition of the building can be described through a mathematical way.

The analysis of location and spatial configurations is important to understand and abstract the key spatial properties of the markets and the relations with their use. Visibility analysis, together with spatial analysis, is important because the attraction of the customer's gaze is a key factor that drives the placement and the organization of all shops. It is something that all traders, no matter if they are placed in an organized or unorganized market, intuitively know and use. They all try to have the greatest exposure to the customer's gaze, to be seen from many places and to be in a 'central place' and this is how they choose their spot. Also, the spatial relations, the visual interaction and co-visibility between people is the foundation of any social interaction. So, spatial and visual analysis will also be the tools to study the elusive distribution of use.

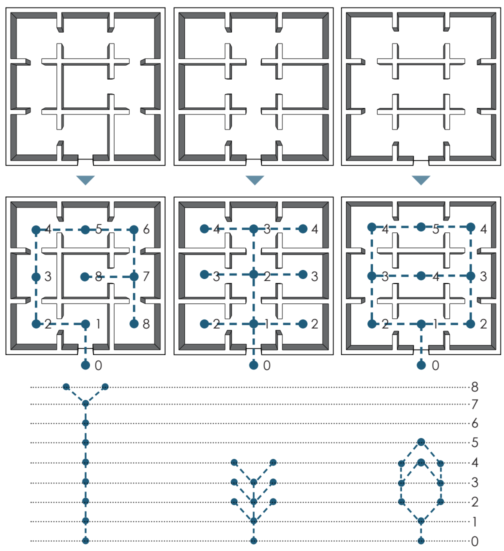


Figure3. How similar spaces could create different configuration of space (Hillier 2004).

1.4 Delimitation

A limitation of my study is that there are a multitude of reasons that affect the patterns of use in each market that go beyond the spatial environment (e.g. personal agendas, time limitations, economic reasons, and special preferences). My method of observation and behavior mapping focus on visitors' movement patterns (tracking), time spending, type of interaction in space (e.g. shopping, dining) and social context (e.g. alone or with company). No questioners or interviews are used.

In addition, different spatial characters can shift our attention, orientate, guide and affect how we behave and use space (e.g. colors, visual aids, signs, advertisements). Here, we focus on the fundamental spatial and visual relations, created by architectural boundaries in visibility and accessibility, which guide movement and afford visual interaction.

Even more general, my study focuses on a specific type of markets and in a specific geographical, cultural and social environment. The findings of this study could be much different if for example the context was non-European.

1.5 Working Approach

The whole working process consists of nine steps. First of all, through the 1) daily experience and 2) literature study, I set up the subject of the thesis, the research question, as well as the working method – spatial analysis and behavior observation. Originally, general field research is conducted in different types of markets in Gothenburg to select the final case studies (e.g. flea markets, food markets, department stores, shopping malls). After that, I decide to focus on food markets, as the main case study and 3) four food markets are selected in four Nordic cities. The 4) field research and behavior observation are conducted on weekends from the January to March. In parallel 5) spatial analysis is applied, focusing on the organizational structure, the spatial and visual relations. All the analytical and observational data are then 6) correlatively analyzed to draw conclusions on the relation between spatial forms and patterns of use, and extract the spatial conditions that relate to different spatial organizations. Then, 7) a series of different spatial prototypes are produced. Spatial and visual analysis are again used, this time to 8) evaluate the different spatial prototypes. The end-product of my research is 9) a set of design guidelines that can create organized markets which enhance co-awareness and co-presence, creating increased potentials for encounters and social interactions that go beyond the specific commercial function, to support the social role of the market as a public space. Moreover, the whole research process will also be concluded as a research guideline for me to study the same topic on other types of buildings and in other cities.

The layout of the booklet follows the structure of the working process, where the different steps are described in respective chapters.

1	Problem Description	• Public System: Public Open Space & Public Building • Social Interaction: Walking & Watching • Social Segregation: Co-presence & Co-awareness & Encounter & Social Interaction	• Photography • Sketches
2	Theory Background	• Bill Hillier: Space is the Machine • Jan Gehl: Life between buildings • M L Benedikt: To Take Hold of Space: Isovists and Isovists Field	• Sketches • Notes
3	Case Study	• Gothenburg Food Market • Copenhagen Food Market • Lund Food Market • Malmö Food Market	• Visiting • Photography • Sketches
4	Spatial Analysis	• Spatial Analysis: Spatial Connectivity & Spatial Integration & Through Vision • Visual Analysis: Visual Connectivity & Visual Integration • Isovist Analysis: Isovist Field from Entrances	• Depthmap • Diagrams • Illustrations • Excel
5	Behavior Analysis	• Behavior Mapping: General Observation & Snapshots & Photographing & Quantitative Count & Individual Trails • Overlapping Analysis • Statistical Correlation Analysis	• Diagrams • Illustrations • Sketches • Excel
6	Correlation Analysis	• Relation between Spatial Layouts & Spatial Conditions • Relation between Patterns of Use & Spatial Conditions • Relation between Patterns of Use & Spatial Layouts	• Drawings • Illustrations • Excel
7	Prototype Explorations	• Shape Explorations & Structure Axis Explorations • Two Boundaries Explorations • Paths Explorations • Entrances Explorations	• Drawings • Model Making • Grasshopper
8	Prototype Evaluation	• Spatial Analysis: Spatial Connectivity & Through Vision • Visual Analysis: Visual Connectivity • Isovist Analysis • Data Collection and Analysis	• Depthmap • Diagrams • Illustrations • Excel
9	Conclusion	• Use - Space - Design relation • Design with Consciousness • Usability Based Design Guidelines of Pragmatic Design Options	• Diagrams • Illustrations

Table 1. Outline of the thesis.

2 CASE STUDIES

The case studies start with the general investigation of all type of commercial buildings in Gothenburg. During that time, the unique characteristic of food markets is highlighted. Hence, the spatial analysis and behavior analysis are focused on four food markets.

The aim of spatial analysis is to understand the configurational language of the markets: how the different spatial elements are organized? How different spaces are linked? etc. By overlapping the spatial analysis and behavior mapping, the hidden logic of how people behavior in spaces could be revealed: where customers prefer to stop and eat? where customers prefer to move to? etc. The similarities and differences among the four food markets are discussed. Based on the spatial analysis and behavior analysis, the question that how spatial form influences the patterns of use could be answered.

RESEARCH PROCESS

2.1 Urban Context

In this study, Gothenburg and other Nordic cities are chosen as the urban context. Because of the weather conditions, the social role of interior closed markets is more important in Nordic cities compared, for example, to Mediterranean cities. Interior markets seem to function well in terms of the 'sell and buy' interaction. However, they seem to lack a creation of a more active social place. Markets not only serve as platforms where people conduct trades or buy things, but also are an important part of urban public space, just like squares and parks for different kind of social activities. It is of great importance to also consider the role of these places as public spaces, especially in northern cities. However, they are often ignored in urban studies or are treated as mere destinations and ends of the whole system of urban public spaces (Hillier, 2004).

2.2 Preliminary study

General Types of Market

The general definition of 'market' is a regular gathering of people for the purchase and sale of provisions, livestock, and other commodities. In this thesis, the market will be defined as a public commercial space that people sell and buy goods mainly through the verbal contact. In light of this, department stores, farmer markets, food markets and flea markets etc. are included into the general market definition. However, supermarkets and the convenience stores are not included in this category. Furthermore, the temporary open market like festival market will not be discussed. Therefore, there are three major markets being explored, including flea market, food market and department store, are found in Gothenburg center area and are observed as the start point in order to gain the general knowledge of the spatial form and pattern of use.

A summary of this preliminary study is given in the following tables

SMYRNA SECOND HAND (Flea Market)

NORDSTAN (Department Store)

ARKADAN GALLERY (Department Store)

KOMMERSEN LOPPMARKNAD (Flea Market)

FESKEKÖRKA (Food Market)

STORA SALUHALLEN (Food Market)

Figure 4. The location of the six selected markets in Gothenburg.

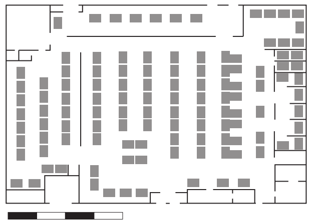
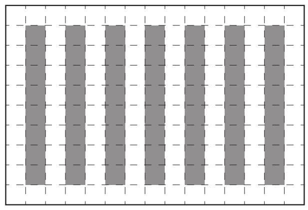
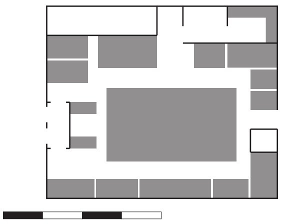
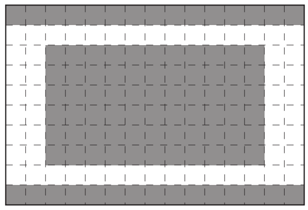
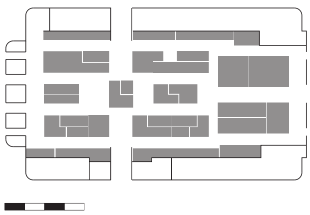
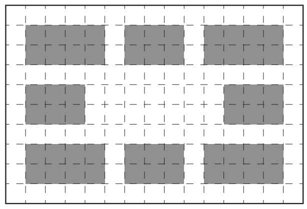
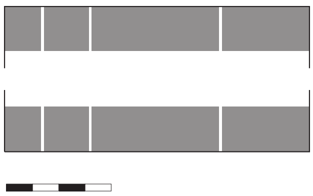
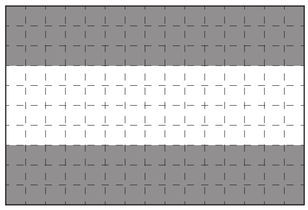
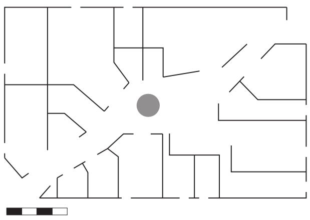
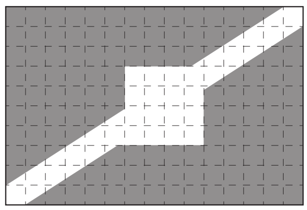
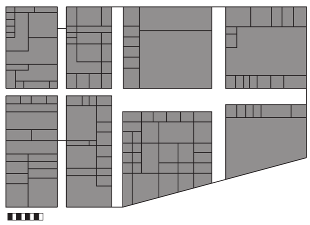
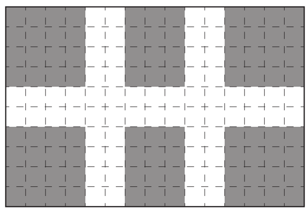
	Using Situation	Ground Floor Plan	Spatial Form
KOMMERSEN LOP-PMARKNAD (Flea Market)		 0 20	
SMYRNA SECOND HAND (Flea Market)		 0 20	
STORA SALUHALLEN (Food Market)		 0 20	
FESKEKÖRKA (Food Market)		 0 20	
ARKADAN GALLERY (Department Store)		 0 20	
NORDSTAN (Department Store)		 0 40	

Table 2. The spatial organization and pictures of the six selected markets.

General observations of preliminary study

After the general field research and observation, it is found that the general qualities of the markets differ from each other in terms of the spatial organization, function, products, scale and distribution. These differences affect the density and type of use for the visitors.

For example, the group of customers in the two flea markets is different in terms of age. In the Smyrna second-hand market, perhaps because of the high quality of products and the well-organized selling hall, young people are seen more than in the Kommersen Flea Market. However, the intimate atmosphere that is created by the limited selling space in the Kommersen Flea Market created a unique experience and engages visitors to communicate with each other and also visit it again.

Another example is the impact of the location to the informal use of the markets. The pedestrian flows peak in Arkaden Gallery during 16:00-18:00 because it serves as a shortcut for people who just get off work and walk from the bus station to another street. On the contrary, the Feskekörka (Fish market) is quite off-center and not part of naturally occurring passages. Although the spatial organization allows through movement, it functions more as a destination than a passing-through or drop-in space.

Nordstan, on the other hand, because of its spatial organization, scale and location, has a high intensity of use and public interaction. The large scale department store are consisted of eight former city blocks and the street-like distribution of common spaces. It creates indoor pedestrian streets with different groups of people, both local and immigrants, gathering at different corners. These indoor spaces function complementary to the open square of Brunnsparken. The large scale and street-like organizations allow a variety of formal and informal activities like performances, protests, informal trade to take place, or even sheltering of homeless people during winter.

Food markets are chosen as the coming case study type. Food markets show the unique quality that provide the platform not only for people to sell and buy, where people stand or walk for short time, but also for people to eat, where people sit and share certain space for a longer time. The interrelation of these two formal activities organized in food markets show a high potential for co-presence and co-awareness, thus serving as a fruitful case study for the specific research agenda.

2.3 General Introduction of Food Markets

There are four food markets being chosen as the subjects for the further observation. They have similar size and number of shops. Besides, all of them are located at downtown area, sitting very close to the central station. Moreover, they are available by both public transportation and car driving with a large parking square and also used as the open marketplace during the summer. Furthermore, they are all familiar by the citizens as the daily lunch destination and famous as the tourist attractions. All of them belong to interior permanent markets that open both weekday and weekend at a regular time.

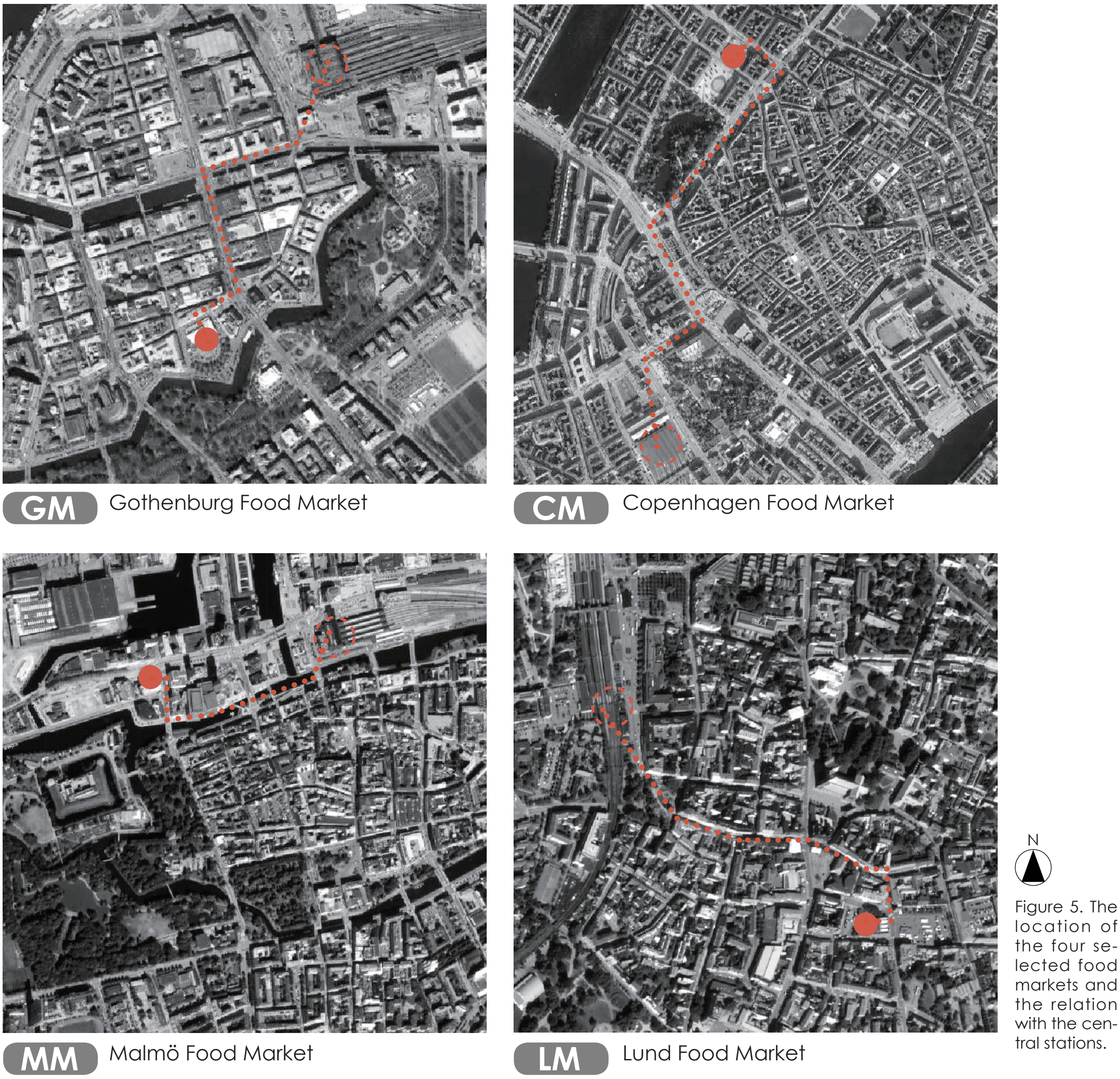


Figure 5. The location of the four selected food markets and the relation with the central stations.

Gothenburg Food Market

GM

Opening hours: Monday - Friday: 09:00-18:00; Saturday: 09:00-17:00
Area: Footprint: 2720sqm., Levels: 1 (plus basement storerooms and offices)
The food market area: 1990sqm. The restaurants and retails area: 730sqm.

The food market area:

P

- Shops

Number of shops: 31
Number of retail shops: 23
Total area of retails: 561.4sqm.
Average area of retails: 24.2sqm.
Diversity of products: Chocolate & dessert & bread: 5; fruit & vegetable: 1; meat & cured: 10; cheese: 2; tea: 2; seafood: 1; take away food: 1; other: 3
Number of restaurants: 8
Total area of restaurants (including sitting area): 328sqm.
Average area of restaurants (including sitting area): 41sqm.
Diversity of products: coffee: 1; food: 7

- Eating seats and areas：

S

Number of seats: 184
Number of seats along the counters (bar seats): 71
Number of seats in eating areas: 113

Figure 6. The picture of the food market in Gothenburg.

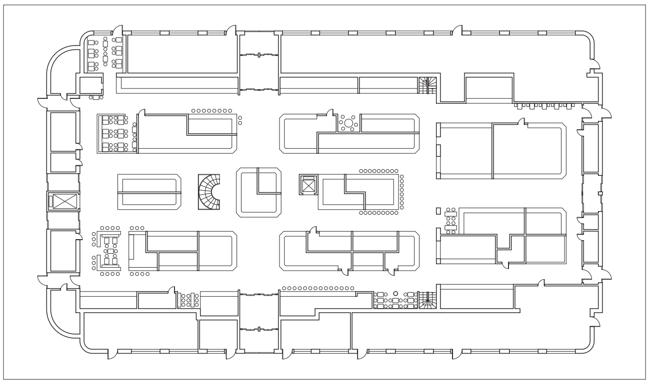


Figure 7. The ground floor plan of the food market in Gothenburg. N

- Customers

Number of customer co-presence during lunch time (Saturday 12:00 – 14:00): 380
Number of customer co-presence during other time (Saturday 15:00 – 17:00): 230

- General Information:

1. Since 1848, the open space of the food market has been the open city marketplace for meat, butter, cheese and flour; 40 years later the hall was built. The food market is very well-known to both locals and tourists.
2. The food market is located at the most central square of Gothenburg, Kungsportsplatsen, and is accessed by both public transportation and car.
3. There are nine entrances in total. Two of them are main entrances which are located at the north and south side. The east entrances of the market are close to bus station while the south entrance is close to a parking square and a canal.
4. The market is constituted in two parts, including independent shops, which are organized at the north and south side of the market with independent entrances and are not available from the market hall, and the food market hall, which also provides diverse shops for both buying and eating. This investigation only focuses on the food market hall.

Copenhagen Food Market

CM

Opening hours: Monday - Thursday: 10:00-19:00; Friday: 10:00-20:00; Saturday: 10:00-18:00; Sunday: 11:00-17:00
Area: Footprint: 4237sqm., Levels: 1 (plus basement storerooms and offices)
The food market area: 1350sqm for each. The open marketplace area: 1113sqm. The independent restaurants area: 424sqm.

The food market area: P

- Shops

Number of shops: 28
Number of retail shops: 20
Total area of retails: 430sqm.
Average area of retails: 21.5sqm.
Diversity of products: meat & cured: 8; cheese: 2; wine: 3; seafood: 2; take away food: 1; kitchen-ware: 2; other: 2
Number of restaurants: 10
Total area of restaurants (including sitting area): 368.6sqm.
Average area of restaurants (including sitting area): 36.9sqm.
Diversity of products: coffee: 1; food: 9

- Eating seats and areas： S

Number of seats: 196
Number of seats along the counters (bar seats): 108
Number seats in eating areas: 88

Figure 8. The picture of the food market in Copenhagen.

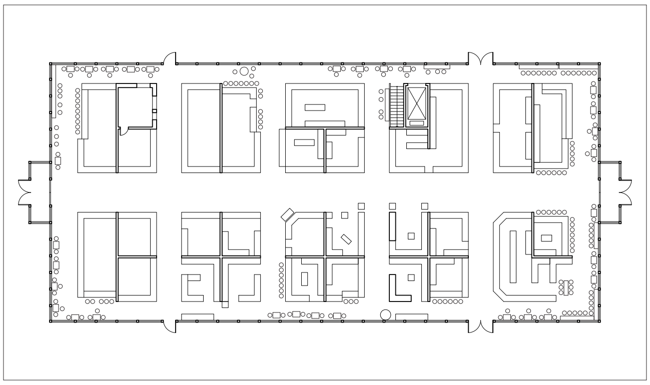


Figure 9. The ground floor plan of the food market in Copenhagen.

N

- Customers

Number of customer co-presence during lunch time (Saturday 12:00 – 14:00): 370
Number of customer co-presence during other time (Saturday 15:00 – 17:00): 210

- General Information:

1. Since 1889, a green square was established here and it became the platform for citizens and farmers to sell goods and vegetables. Even though the food market was built around 120 years later, it was regarded as the continuation of the tradition that people went to the “platform” purchasing fresh food. Nowadays, this market is one of the most popular food markets not only in Denmark but also in the whole Nordic area.
2. The food market is located at the northwest part of the central Copenhagen and is accessible by both public transportation and car.
3. The whole market block consists of two market halls, one independent restaurant building, an open market and independent public toilet building. Only the market hall part will be studied in this paper.
4. There are six entrances in total. Two of them are main entrances which are placed at the north and south sides. The north entrance is close to the bus station. The two entrances at the east side link to the open market and the second market hall.

Malmö Food Market

MM

Opening hours: Monday - Thursday: 10:00-19:00; Friday: 10:00-21:00; Saturday: 10:00-17:00; Sunday: 11:00-16:00
Area: Footprint: 2215sqm., Levels: 1 (but with loft as common eating area)
The food market area: 1320sqm. The open square area: 895sqm.

Figure 10. The picture of the food market in Malmö.

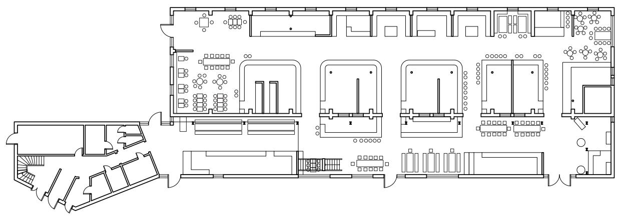


Figure 11. The ground floor plan of the food market in Malmö.

N

The food market area:

- Shops P

Number of shops: 17
Number of retail shops: 11
Total area of retails: 289.5sqm.
Average area of retails: 26.3sqm.
Diversity of products: chocolate & dessert & bread: 2; fruit & vegetable: 1; meat & cured: 1; cheese: 1; tea: 1; seafood: 1; take away food: 1; flower: 1; other: 2
Number of restaurants: 8
Total area of restaurants (including sitting area): 471.5sqm.
Average area of restaurants (including sitting area): 58.9sqm.
Diversity of products: coffee: 1; food: 7

- Eating seats and areas： S

Number of seats: 361(84 seats are placed at the loft)
Number of seats along the counters (bar seats): 44
Number of seats at eating areas: 317 (84 seats are placed at loft)

- Customers

Number of customer co-presence during lunch time (Saturday 12:00 – 14:00): 390
Number of customer co-presence during other time (Saturday 15:00 – 17:00): 150

- General Information:

1. The site of the food market was a freight depot and stayed empty ever since the last train left in 1955. It was no more than a roofless shell at 2013. Afterwards, two siblings bought it and invited a well-known local architect to renovate it as a food market.
2. The food market is located at north part of the central Malmö and is accessible by both public transportation and car.
3. The designer added a similar volume onto the existing brick building and reduced the built area and hence to create more paths and selling area.
4. There are five entrances altogether. A special roof was created at the main entrance. The south entrances can open to the square during the summer.

Lund Food Market

LM

Opening hours: Monday - Wednesday: 10:00-18:00; Thursday - Friday: 10:00-29:00; Saturday: 09:30-17:00
Scale: Footprint: 2004sqm., Levels: 2 (the second is Systembolaget)
The old food market area: 900sqm. The additional restaurants area: 1104sqm.

Figure 12. The picture of the food market in Lund.

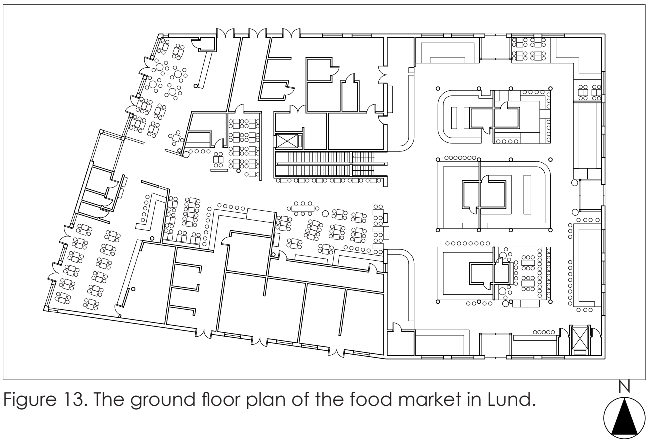


Figure 13. The ground floor plan of the food market in Lund.

The food market area: P

- Shops

Number of shops: 18
Number of retail shops: 9
Total area of retails: 286sq.
Average area of retails: 31.8sq.
Diversity of products: chocolate & dessert & bread: 2; meat & cured: 2; cheese: 1; seafood: 1; take away food: 2; other: 1
Number of restaurants: 10
Total area of restaurants (including sitting area): 736.8sq.
Average area of restaurants (including sitting area): 73.7sq.
Diversity of products: coffee: 1; food: 9

- Eating seats and areas： S

Number of seats: 402
Number of seats along the counters (bar seats): 88
Number of seats in eating areas: 314

- Customers

Number of customer co-presence during lunch time (Saturday 12:00 – 14:00): 450
Number of customer co-presence during other time (Saturday 15:00 – 17:00): 180

- General Information:

1. The food market was first opened at 1909 with a large main hall and two smaller hallways for cheese and fish. After 2009, it was renovated and the designer added the new restaurant section separated by large glass pieces to the older original market.
2. The food market is located at the central Lund and is accessible by both public transportation and car.
3. The whole market consists of the original food market hall, the new restaurant section at the ground floor and a wine store at the second floor. Only the ground floor will be studied in this paper. It is a big market. However, as there is no basement for storage and kitchens, these occupy a large area of the ground floor.
4. There are four entrances in total. Three of them are located at the original market hall and one, the west entrance, was set at the addition part towards the bus station. The east entrance is close to the city square.

2.4 Types of Spaces - Spatial Analysis

2.4.1 Analysis Method

- **Terminology and measures introduction:**

In this section, the spatial measures used to analyze the spatial form of the markets will be introduced. The spatial analysis is related to Space Syntax theory and analytical tools, as is described in the theoretical and methodological framework. It is focused on the visual and spatial connectivity, visual and spatial integration, 'through vision' measure and isovists fields from entrances. The main purpose of the spatial analysis is to understand how boundaries to visibility (the dark gray blocks in Fig.14) and accessibility created by architecture and objects affect how people see and move in space, and also how people see each other in space. Additionally, the aim is to understand the invisible morphology language that refers to how people perceive space through design, but is often ignored by designers. The software used for analysis is DepthmapX. The grid is 50x50cm (see Fig.14). The terminology and measures will be explained below:

- **Isovist field:**

An isovist is a set of all points visible from a given vantage point in space and with respect to an environment. The shape and size of an isovist is liable to change with position (Benedikt 1979). The isovist field is the polygon prescribing the area which is visible from the specific point of observation in space (see Fig.15). Again, the polygon changes as the observation point change. The area which is visible from an observation point is defined by visual boundaries present at space. As we move, visual boundaries come in and out of our visual field, occluding or revealing parts of the environment. The isovist is related to the ecological approach to environmental perception as introduced by Gibson (Gibson 1986) and to his theory of affordances (see Fig.16).

For this study, I generate isovist fields from the entrances of the markets, so as to highlight the parts of space and the shops, restaurants and eating areas that are visible from the entrance. This set of isovist from entrances illustrates what people can see as soon as they get in the market hall. This first glimpse could define how and where people would then move. Also, from that point they could have a first look at the people who were already in.

- **Spatial and visual connectivity:**

Visibility Graph Analysis (VGA) (Turner et al 2001, 2004) was used to analyze visual and spatial connectivity. Visibility graph is the graph of mutually visible locations in a spatial layout. The VGA can be applied to two levels, eye level for what people can see, and knee level for how people can move. It is a critical way to understand spatial layouts (Turner et al 2001).

In simple words, the analysis starts with a defined grid of nodes is space. It then calculates from every node, the amount of other nodes that are directly visible or accessible. When all nodes have been calculated, the

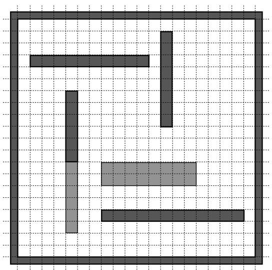


Figure 14. The 2D plan of a hypothetical space which is divided into human scale grid. The light gray walls are lower than eye level while the dark gray walls are higher than eye level.

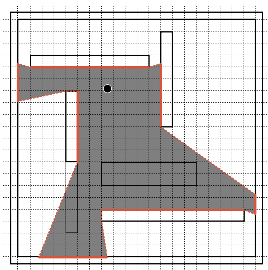


Figure 15. The isovist polygon (the visible area) from a generating location (the black point). The visual boundaries (the red lines) in 2D plan.

I

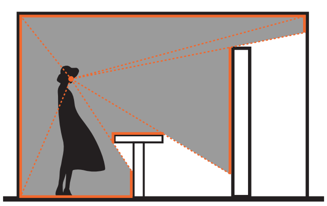


Figure 16. How the visual boundaries (the red lines) and view sight (the imaginary lines) are shaped by boundaries to visibility and accessibility from the eye level based on Gibson's theory.

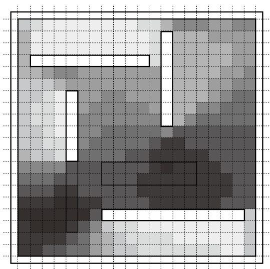


Figure 17a. The visual connectivity values of the hypothetical space. The color range from dark gray to light gray stands for the value range from high to low.

V

results show which nodes are more accessible or visible. Thus it highlights the areas that are more accessible or/and visually connected. Areas of highest spatial accessibility and highest visual connectivity do not always coincide or overlap. We have to study both as well as their interplay to understand how space directs our movement and shapes our views.

In this case, the spatial connectivity analysis (see Fig.17a) takes into account all boundaries to accessibility (walls, counters, tables, seats etc.). The visual connectivity analysis (see Fig.17b) takes into account only visual boundaries (walls and high shelves). Everything lower than the eye-level or glass walls which people can see-through were not taken into account. The analysis results of the two models shows the great difference of the spatial conditions that are created by the two types of boundaries even in the same market hall.

- **Spatial and visual integration:**

As with spatial and visual connectivity, Visibility Graph Analysis (VGA) (Turner et al 2001, 2004) was used to analyze visual and spatial integration. Integration in general is a measure of centrality. It does not only take into account the direct relations of visibility and accessibility between nodes in space (connectivity), but also the indirect relations.

It measures topological distance between nodes and the analysis results highlight spatial and visual centrality. Visual integration (see Fig.18a) measures visual distance from all spaces to all others (Hillier 1996, 2007). In simple words, it measures how many times does one have to turn starting from one's location to see all the other locations. Spatial Integration (see Fig.18b) measures respectively, how many times does one have to turn starting from one's location to access all other locations.

Hence, the most spatially integrated locations are best accessible from the whole system while the most segregated locations are more isolated and disconnected. Respectively, the most visually integrated locations are the more visually prominent and offer large or panoramic views of the interior space, while the visually segregated are more 'hidden' and offer narrow views of the interior space.

- **Through vision:**

Through Vision is the measure that in a way combines accessibility and visibility. It reflects on the space syntax theory that people move to where they can see. Through vision is simply the summation of the number of lines of visibility passing through a location. It is a function of movement potentials in a layout and it relates well with observed movement counts (Turner 2007). The long corridors with long fields of view show high 'through' value, matching also the high intensity of movement flows. It could be used to predict how people would move in the market hall (see Fig.19).

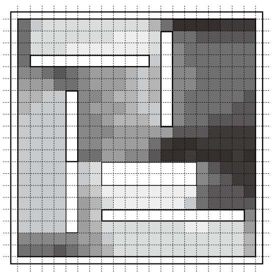


Figure 17b. The spatial connectivity values of the hypothetical space. The color range from dark gray to light gray stands for the value range from high to low.

A

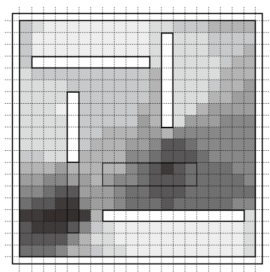


Figure 18a. The visual integration values of the hypothetical space. The color range from dark gray to light gray stands for the value range from high to low.

V

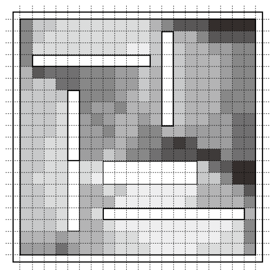


Figure 18b. The spatial integration values of the hypothetical space. The color range from dark gray to light gray stands for the value range from high to low.

A

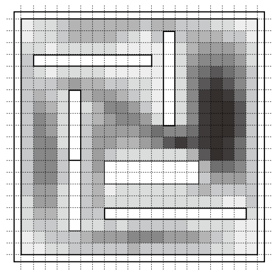


Figure 19. The through vision values of the hypothetical space. The color range from dark gray to light gray stands for the value range from high to low.

T

2.4.2 Gothenburg Food Market

GM

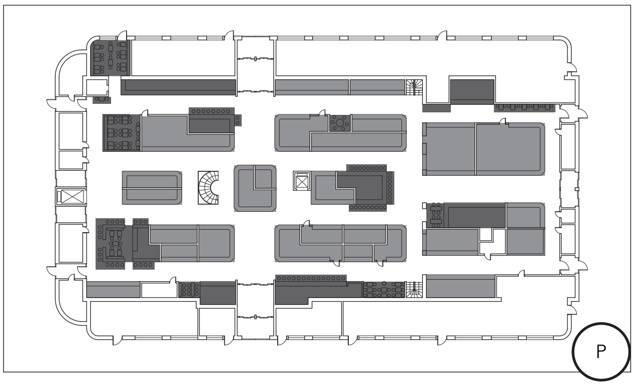


Figure 20. The proportion of the function in the Gothenburg Food Market.

Shops for Selling and buying

Restaurants and Seats for Eating

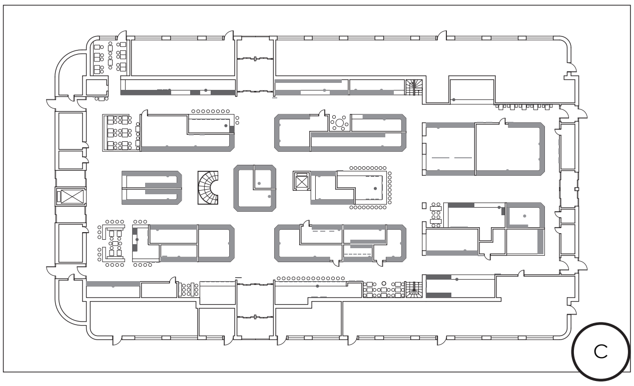


Figure 21. The distribution of the two types of interfaces in the Gothenburg Food Market.

Interface for Shops

Interface for Restaurants

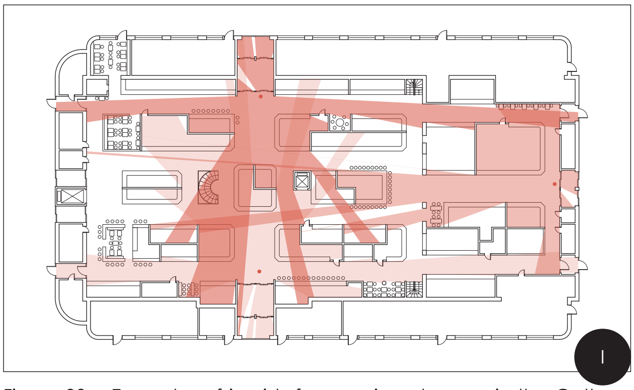


Figure 22a. Examples of isovists from main entrances in the Gothenburg Food Market.

The isovists from main entrances

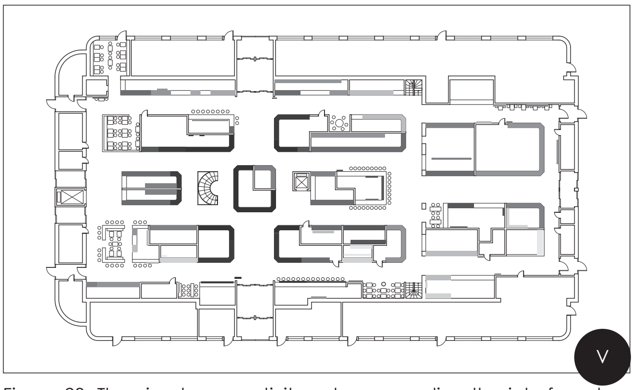


Figure 23. The visual connectivity values regarding the interface layout of the Gothenburg Food Market.

60 2400

Visual Connectivity Value Range*

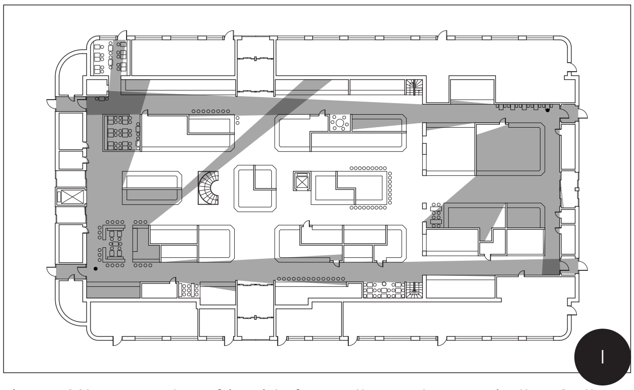


Figure 22b. Examples of isovists from other entrances in the Gothenburg Food Market.

The isovists from other entrances

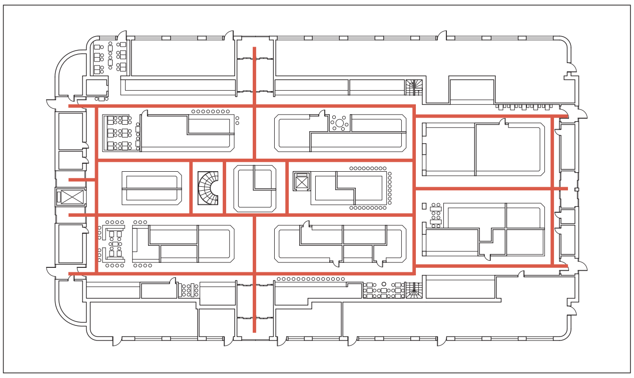


Figure 24. The organization axis of the Gothenburg Food Market.

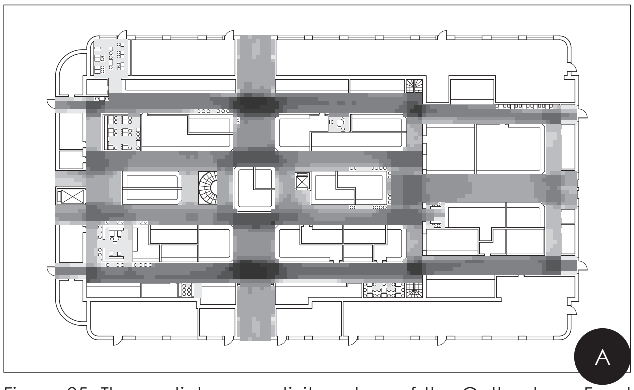


Figure 25. The spatial connectivity values of the Gothenburg Food Market.

1 1000

Spatial Connectivity Value Range*

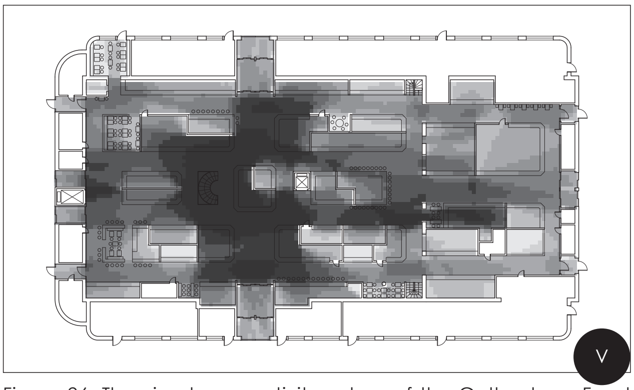


Figure 26. The visual connectivity values of the Gothenburg Food Market.

60 2400

Visual Connectivity Value Range*

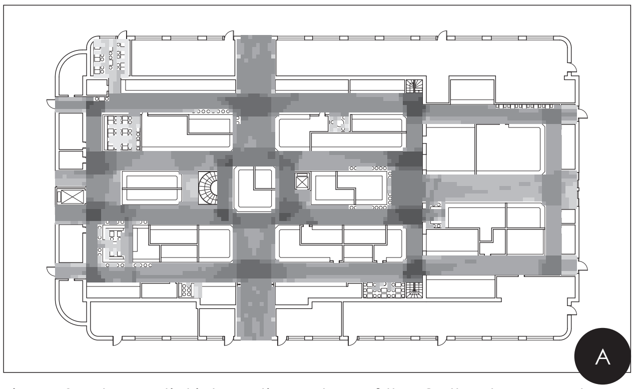


Figure 27. The spatial integration values of the Gothenburg Food Market.

3 12

Spatial Integration Value Range*

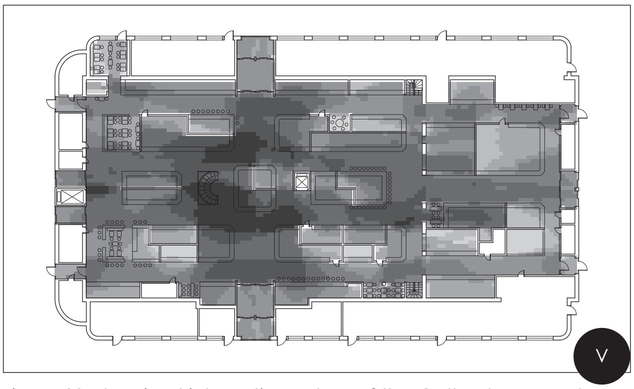


Figure 28. The visual integration values of the Gothenburg Food Market.

5 18

Visual Integration Value Range*

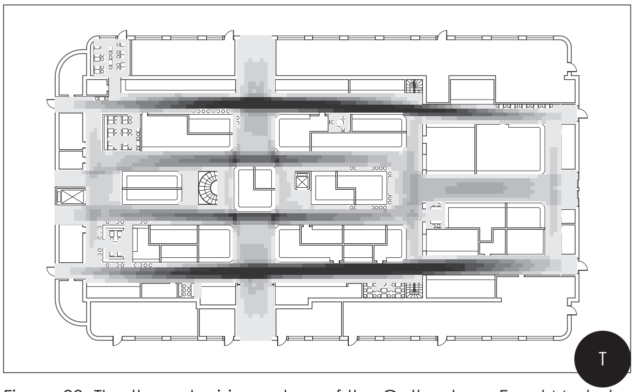


Figure 29. The through vision values of the Gothenburg Food Market.

1 40000

Through Vision Value Range*

* In order to make the comparative analysis among four markets, it is worthy to note that:

1. The color range of visual connectivity is same for four markets.
2. The color range of spatial connectivity is same for four markets.
3. The color range of visual integration is same for four markets.
4. The color range of spatial integration is same for four markets.
5. The color range of through vision is same for four markets.

In that case, all the values could be analyzed on a higher level: comparing the similarities and differences among four markets. Hence, in some figures, there are not dark gray nodes but it does not mean that there are not integrated or well connected nodes. It means that the highest value of nodes in some markets can not reach the general highest value. In other words, visibility or accessibility of the markets without dark gray nodes is in a way not as good as other markets with numbers of dark gray nodes.

2.4.3 Copenhagen Food Market

Figure 30. The proportion of the function in the Copenhagen Food Market.

Shops for Selling and buying

Restaurants and Seats for Eating

Figure 31. The distribution of the two types of interfaces in the Copenhagen Food Market.

Interface for Shops

Interface for Restaurants

Figure 32a. Examples of isovists from main entrances in the Copenhagen Food Market.

The isovists from main entrances

Figure 33. The visual connectivity values regarding the interface layout of the Copenhagen Food Market.

60 2400

Visual Connectivity Value Range*

Figure 32b. Examples of isovists from other entrances in the Copenhagen Food Market.

The isovists from other entrances

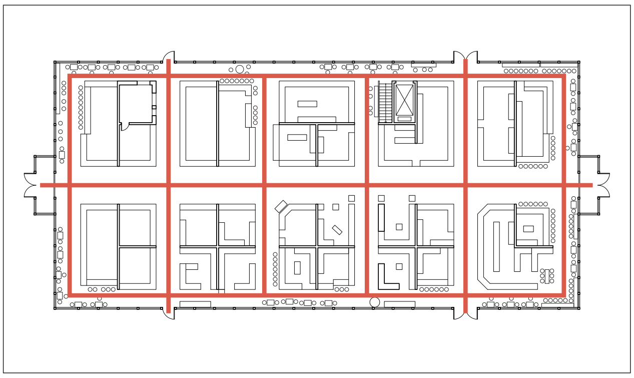


Figure 34. The organization axis of the Copenhagen Food Market.

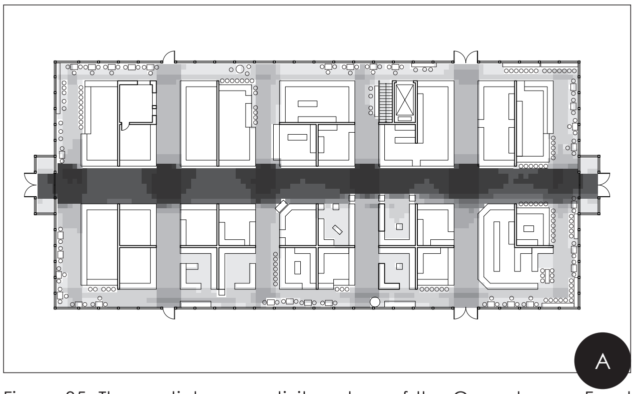


Figure 35. The spatial connectivity values of the Copenhagen Food Market.

1 1000

Spatial Connectivity Value Range*

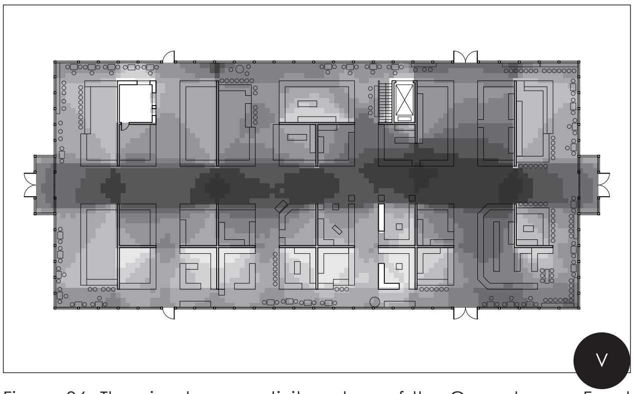


Figure 36. The visual connectivity values of the Copenhagen Food Market.

60 2400

Visual Connectivity Value Range*

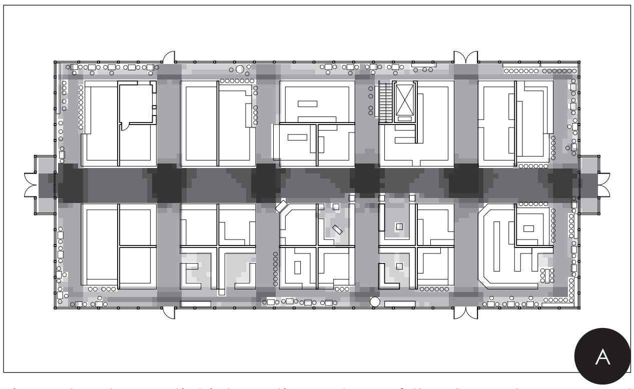


Figure 37. The spatial integration values of the Copenhagen Food Market.

3 12

Spatial Integration Value Range*

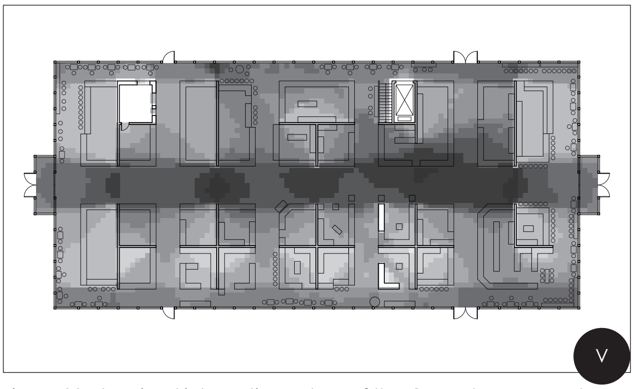


Figure 38. The visual integration values of the Copenhagen Food Market.

5 18

Visual Integration Value Range*

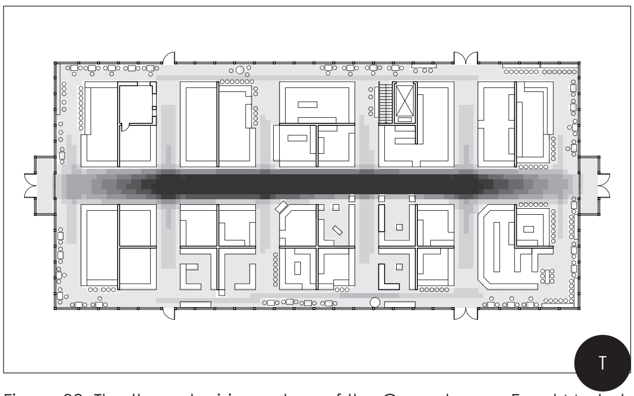


Figure 39. The through vision values of the Copenhagen Food Market.

1 40000

Through Vision Value Range*

* In order to make the comparative analysis among four markets, it is worthy to note that:

1. The color range of visual connectivity is same for four markets.
2. The color range of spatial connectivity is same for four markets.
3. The color range of visual integration is same for four markets.
4. The color range of spatial integration is same for four markets.
5. The color range of through vision is same for four markets.

In that case, all the values could be analyzed on a higher level: comparing the similarities and differences among four markets. Hence, in some figures, there are not dark gray nodes but it does not mean that there are not integrated or well connected nodes. It means that the highest value of nodes in some markets can not reach the general highest value. In other words, visibility or accessibility of the markets without dark gray nodes is in a way not as good as other markets with numbers of dark gray nodes.

2.4.4 Malmö Food Market

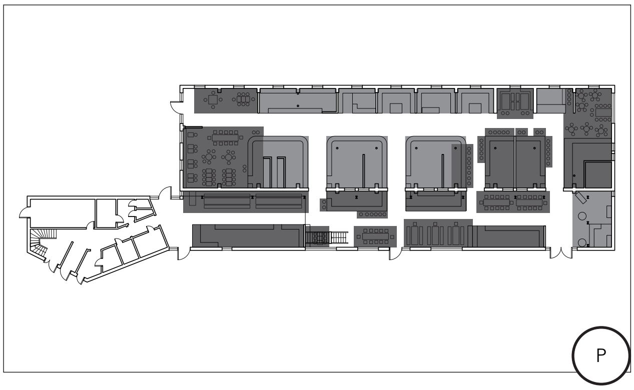


Figure 40. The proportion of the function in the Malmö Food Market.

Shops for Selling and buying

Restaurants and Seats for Eating

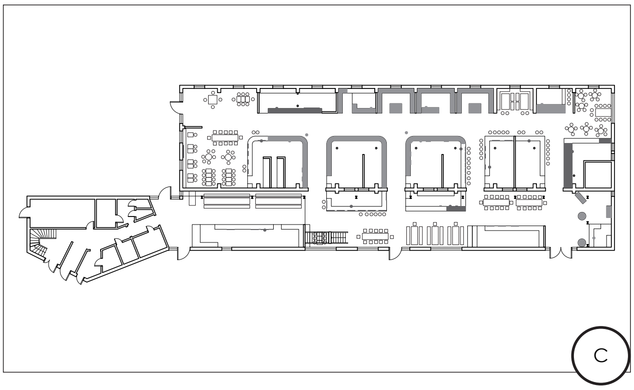


Figure 41. The distribution of the two types of interfaces in the Malmö Food Market.

Interface for Shops

Interface for Restaurants

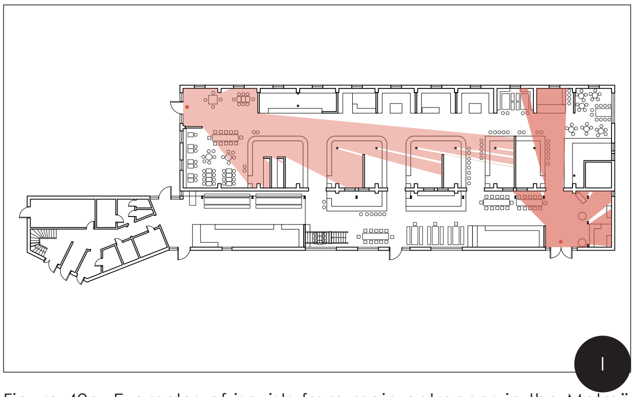


Figure 42a. Examples of isovists from main entrances in the Malmö Food Market.

The isovists from main entrances

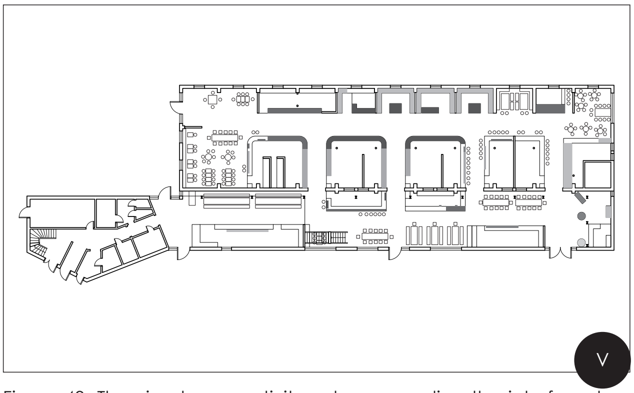


Figure 43. The visual connectivity values regarding the interface layout of the Malmö Food Market.

60 2400

Visual Connectivity Value Range*

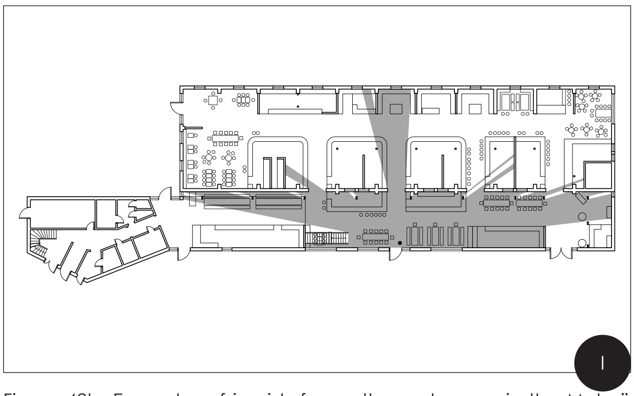


Figure 42b. Examples of isovists from other entrances in the Malmö Food Market.

The isovists from other entrances

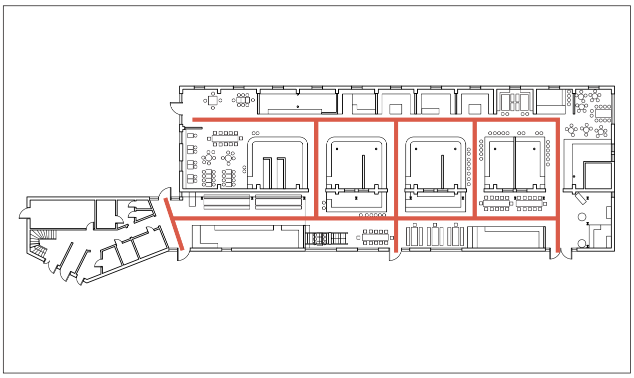


Figure 44. The organization axis of the Malmö Food Market.

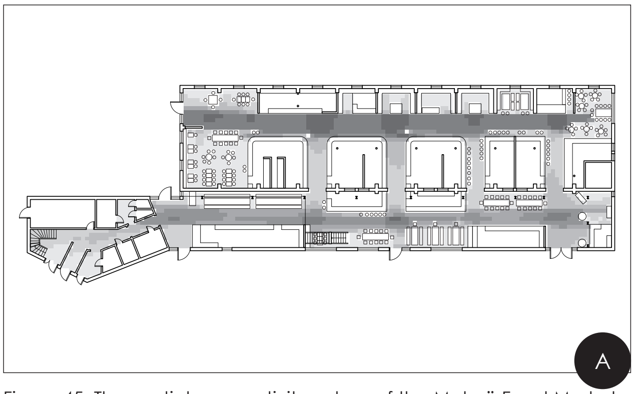


Figure 45. The spatial connectivity values of the Malmö Food Market.

1 1000

Spatial Connectivity Value Range*

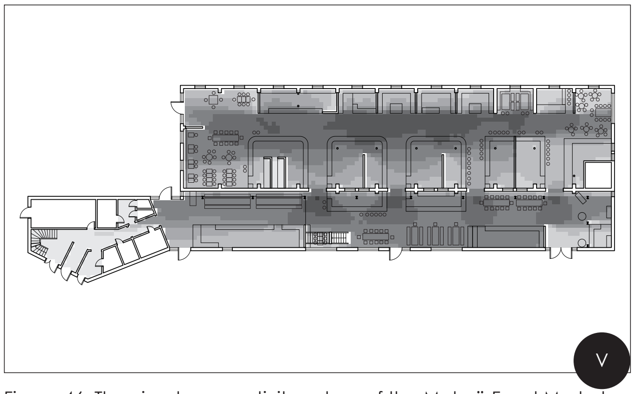


Figure 46. The visual connectivity values of the Malmö Food Market.

60 2400

Visual Connectivity Value Range*

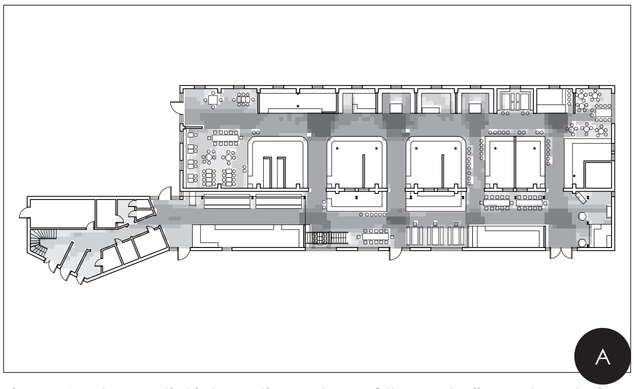


Figure 47. The spatial integration values of the Malmö Food Market.

3 12

Spatial Integration Value Range*

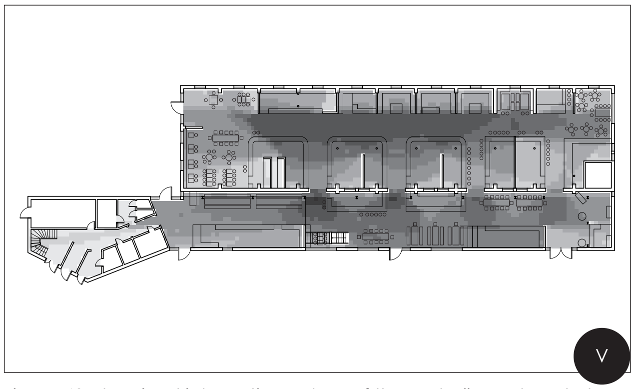


Figure 48. The visual integration values of the Malmö Food Market.

5 18

Visual Integration Value Range*

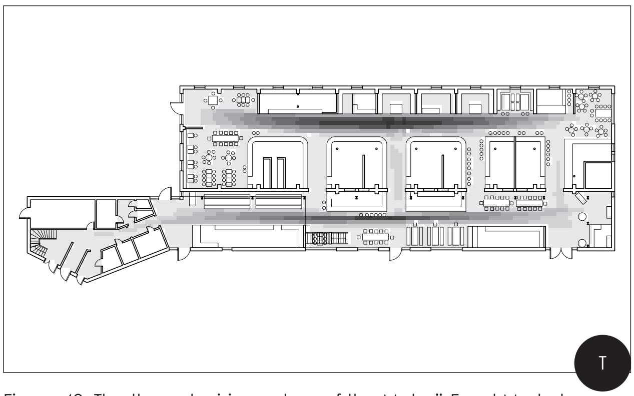


Figure 49. The through vision values of the Malmö Food Market.

1 40000

Through Vision Value Range*

* In order to make the comparative analysis among four markets, it is worthy to note that:

1. The color range of visual connectivity is same for four markets.
2. The color range of spatial connectivity is same for four markets.
3. The color range of visual integration is same for four markets.
4. The color range of spatial integration is same for four markets.
5. The color range of through vision is same for four markets.

In that case, all the values could be analyzed on a higher level: comparing the similarities and differences among four markets. Hence, in some figures, there are not dark gray nodes but it does not mean that there are not integrated or well connected nodes. It means that the highest value of nodes in some markets can not reach the general highest value. In other words, visibility or accessibility of the markets without dark gray nodes is in a way not as good as other markets with numbers of dark gray nodes.

2.4.5 Lund Food Market

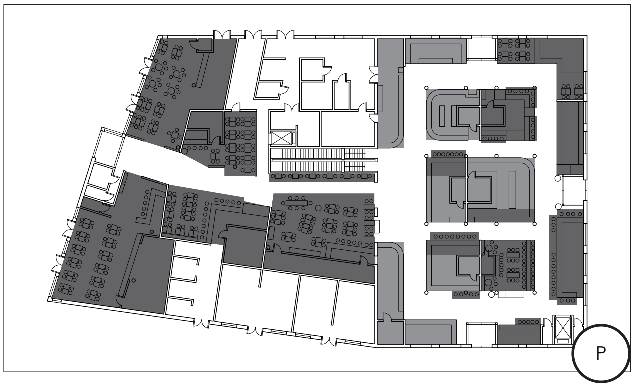


Figure 50. The proportion of the function in the Lund Food Market.

Shops for Selling and buying

Restaurants and Seats for Eating

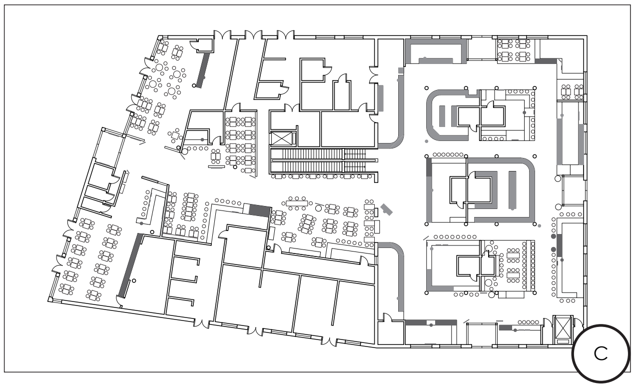


Figure 51. The distribution of the two types of interfaces in the Lund Food Market.

Interface for Shops

Interface for Restaurants

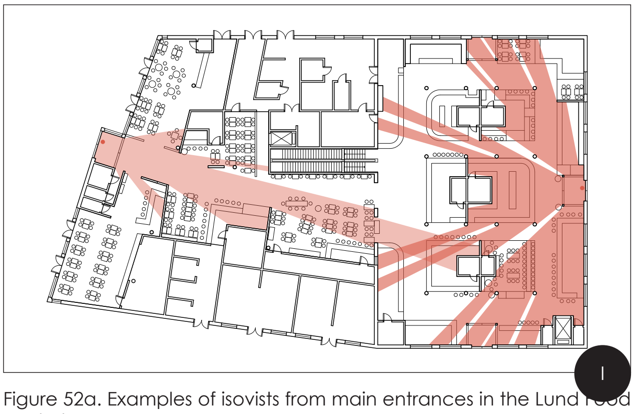


Figure 52a. Examples of isovists from main entrances in the Lund Food Market.

The isovists from main entrances

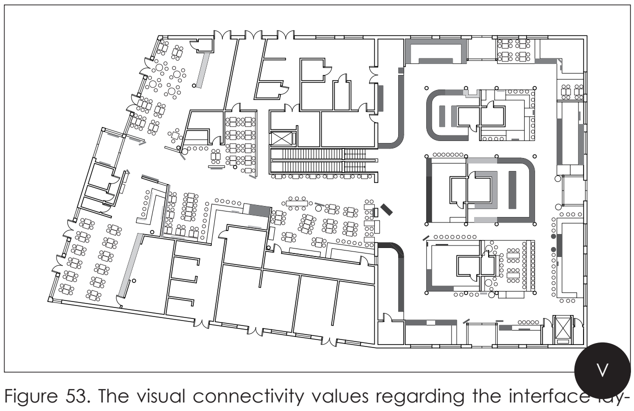


Figure 53. The visual connectivity values regarding the interface layout of the Lund Food Market.

60 2400

Visual Connectivity Value Range*

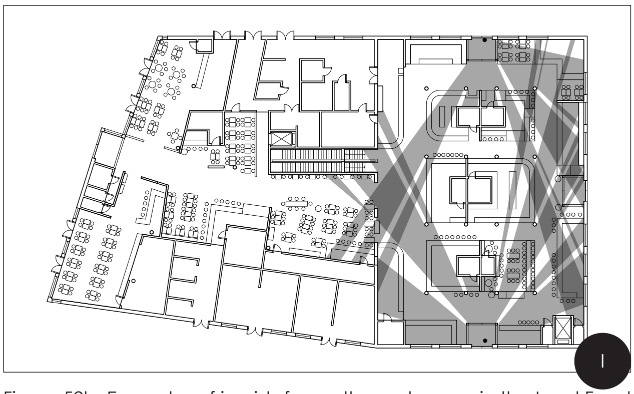


Figure 52b. Examples of isovists from other entrances in the Lund Food Market.

The isovists from other entrances

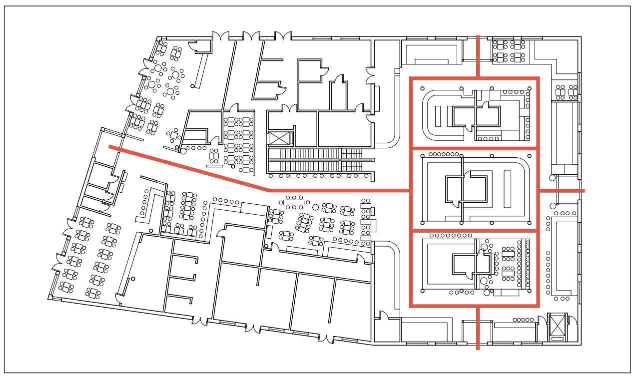


Figure 54. The organization axis of the Lund Food Market.

Figure 55. The spatial connectivity values of the Lund Food Market.

1 1000

Spatial Connectivity Value Range*

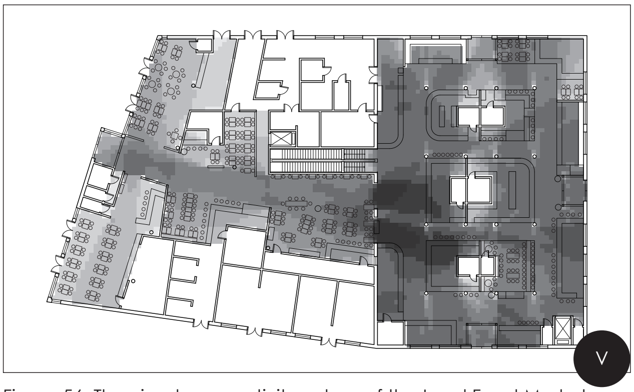


Figure 56. The visual connectivity values of the Lund Food Market.

60 2400

Visual Connectivity Value Range*

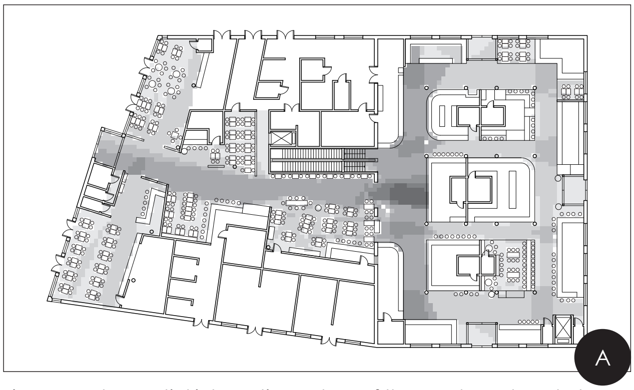


Figure 57. The spatial integration values of the Lund Food Market.

3 12

Spatial Integration Value Range*

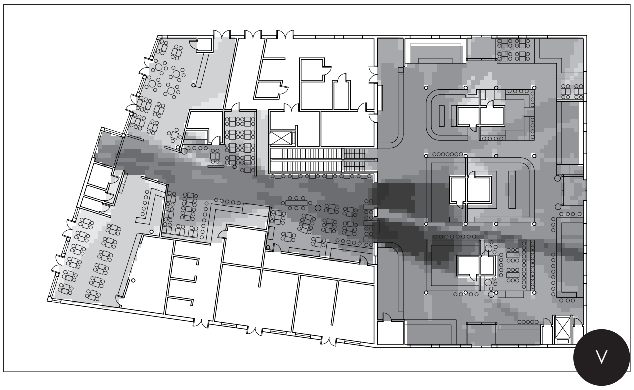


Figure 58. The visual integration values of the Lund Food Market.

5 18

Visual Integration Value Range*

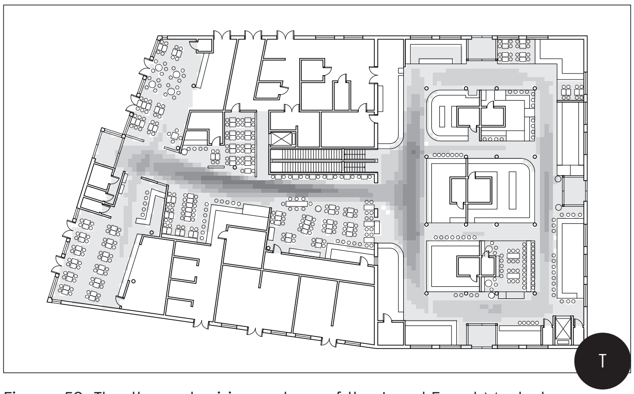


Figure 59. The through vision values of the Lund Food Market.

1 40000

Through Vision Value Range*

* In order to make the comparative analysis among four markets, it is worthy to note that:

1. The color range of visual connectivity is same for four markets.
2. The color range of spatial connectivity is same for four markets.
3. The color range of visual integration is same for four markets.
4. The color range of spatial integration is same for four markets.
5. The color range of through vision is same for four markets.

In that case, all the values could be analyzed on a higher level: comparing the similarities and differences among four markets. Hence, in some figures, there are not dark gray nodes but it does not mean that there are not integrated or well connected nodes. It means that the highest value of nodes in some markets can not reach the general highest value. In other words, visibility or accessibility of the markets without dark gray nodes is in a way not as good as other markets with numbers of dark gray nodes.

2.5 Findings

Relation between Spatial Layouts and Spatial Conditions

What need to be stressed first is that red or orange nodes of high value do not equal to nodes of good quality. For example, high visual connectivity or high spatial connectivity could be negative if people require privacy. In other words, the high or low value of nodes is meaningless unless we discuss it based on the pre-defined goals and see if it could achieve the goals. In this thesis, as mentioned above, the goal is to increase and prolong co-presence and co-awareness. In that case, high value is positive to reach co-presence and co-awareness.

- **Two types of organization principle plus two types of axis are observed as the basic structure of market halls.**

The street like model, in Copenhagen Food Market and Malmö Food Market, provides long main passages with two sides shops in the middle of the rectangle market halls. More shops are organized along long sides. Conversely, the grid like model, in Gothenburg Food Market and Lund Food Market, does not provide the geometric main passages because the similar length or width of most passages.

The parallel axis, in Copenhagen Food Market (see Fig.34) and Malmö Food Market (see Fig.44), contributes to long and continue passages that extend across the whole market halls. While the split axis, especially in Gothenburg Food Market (see Fig.24), contributes to the situation that one passage is split in two passages by shops. In that case, the visual lines are long in parallel axis markets but short in split axis markets. The longer the line the more likely it is to strike shop interfaces at an open angle; the shorter the line, the more likely it is to strike shop interfaces at a right angle. Hence, visitors could have totally different visual perception in the two different types of axis markets.
Two types of organization principle plus two types of axis (see Fig.60) are used as the basic models in the following prototype exploration.

- **The different layouts of boundaries to visibility and boundaries to accessibility lead to the similar accessible conditions but different visual conditions of sitting areas among the four markets**

The data collection and analysis produce that the averagely accessible connectivity of all seats is relatively low in the four markets. However, the layouts and visual conditions of sitting areas varies from markets to markets.
In Gothenburg Food Market, sitting areas are placed separately at the end of passages, but most of them can be seen directly from entrances. Besides, most seats with tables are surrounded by glass dividing walls with one or two entrances. It is the simplest option to reduce the accessibility of sitting areas by creating dividing walls with limited entrances.
In Copenhagen Food Market, sitting areas are placed at the peripheral passages along the glass walls. The seats offer a good view of outside environment but are hidden from the main passage and main stream.
In Malmö Food Market, common sitting areas are heavily distributed along one passage close to the main entrance while other sitting areas are placed at the end of other passages. This option turns the wide passage

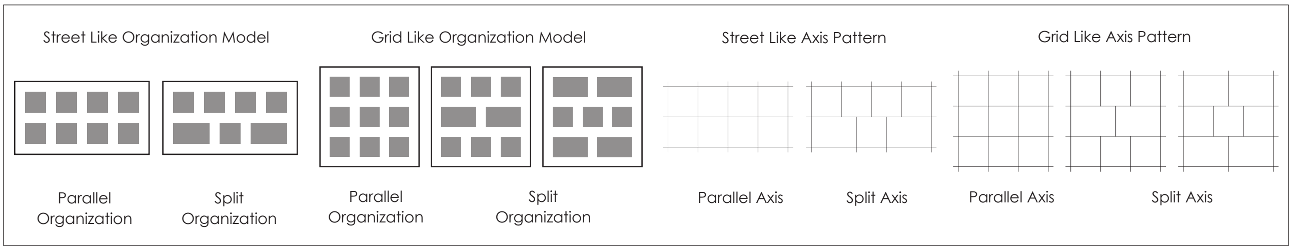


Figure 60. Two types of organization principle plus two types of axis.

into the end of the accessible system by placing seats together and narrowing the width of the passage. In that case, although most sitting areas are not easily accessible, some sitting areas can be seen directly from entrances but others are more private.
In Lund Food Market, sitting area are placed along the main passage with limited entrances. The central passage branches into less accessible sitting area. The eating visitors have nice view of the central passage without being disturbed by passing visitors.

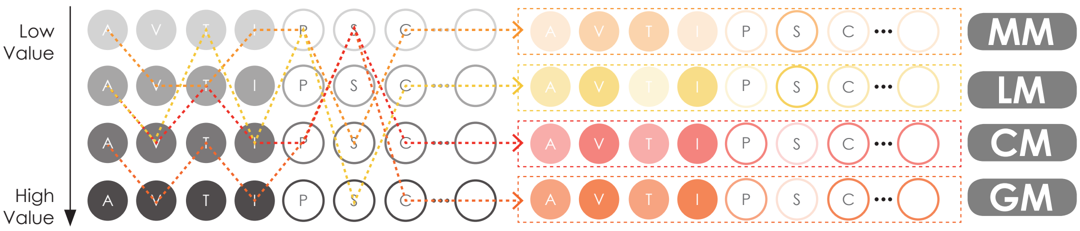
The reason to point this out is to emphasize that on the one hand, different spatial layouts could lead to the similar spatial conditions. It is important to know that the relation between spatial layouts and spatial conditions is not a single relation and there is not only one recipe to achieve specific goal. On the other hand, the spatial conditions should be understood as the result of a combination of boundaries to visibility and accessibility. The difference of this two types of boundaries leads to variation of conditions and spaces. Thurs, it is important for architects to be aware of the meaning of each design options which could have an effect on spatial conditions and then indirectly influence social behavior.

- **The visual connectivity image and spatial connectivity image shows significant similarities regarding the location of high value nodes in Copenhagen Food Market but unexpected differences in Gothenburg Food Market due to the different layouts of boundaries to visibility and boundaries to accessibility.**

In Copenhagen Food Market, the nodes of high visual connectivity value are overlapped with the nodes of high spatial connectivity value at the central passage (see Fig.35 and Fig.36). On the contrary, in Gothenburg Food Market, the nodes of high visual connectivity value are located at the center of the market while the nodes of high spatial connectivity value are only located at crossroads (see Fig.25 and Fig.26). In simple words, the centrality of visibility and accessibility is overlapped in Copenhagen Food Market but totally separated in Gothenburg Food Market. The relation between layouts of boundaries to visibility and accessibility and spatial conditions need to be discussed. This finding leads to the following prototype exploration on the two boundaries in order to get deeper understanding about how spatial conditions could change when the layouts of boundaries to visibility and accessibility change.

- **Spatial conditions and spatial layouts should be discussed as a combination**.

On the one hand, when architects choose different design options to achieve specific spatial conditions, it is important to be aware that we cannot design a single condition. Instead, the choice of design options could relate to a combination of visibility, accessibility, isovist area etc (see Fig.99). On the other hand, within the combination, the relations between different spatial conditions are flexible. In simper words, for example, four different combinations of spatial conditions and spatial layouts are observed in the four markets (see Fig.100). In that case, according to different demands of use, there are many possible combinations. Hence, during design process, we need to be aware that low value of one single condition does not mean terrible space or less visitors.



A - Accessibility,
V - Visibility,
T - Through Vision,
I - Isovist Area,
P - Diversity of Products,
S - Number of Seats,
C - Length of Counters

Figure 100. The different spatial conditions and spatial layouts combine with each other and produce different combinations in the four markets.

- **The bar seats tend to have better visibility and accessibility.**

In Gothenburg Food Market (see Fig.61 and Fig.62) and Lund Food Market, depending on the data collection and analysis, most bar seats are placed at the space of highly visual connectivity value while seats with tables are mainly placed at the relatively less visible space. Adding to this, bar seats tends to be easily accessible in the system in the four markets – as a higher proportion of bar seats can be observed at the well accessible space.

- It seems that in Gothenburg Food Market (see Fig.63a and Fig.63b) and Copenhagen Food Market (see Fig.64a and Fig.64b) the nodes of higher visual and accessible connectivity are left for counters instead of seats. However, in Malmö Food Market and Lund Food Market, there are not apparently visual and accessible advantages of counters.

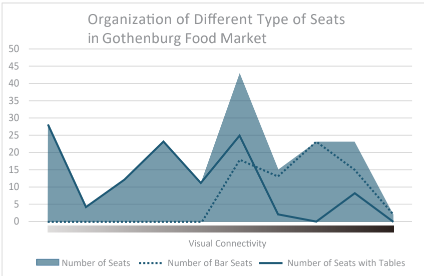


Figure 61. Correlation between visual connectivity and the organization of bar seats and seats with tables in Gothenburg Food Market.

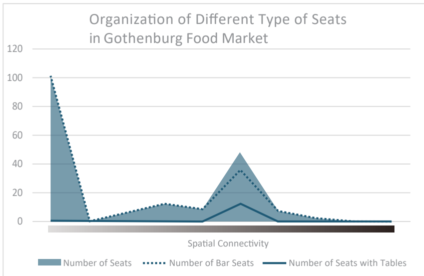


Figure 62. Correlation between spatial connectivity and the organization of bar seats and seats with tables in Gothenburg Food Market.

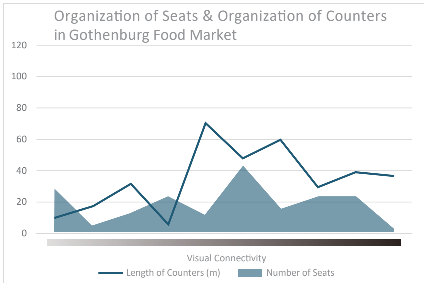


Figure 63a. Correlation between organization of seats and counters regarding visual connectivity in Gothenburg Food Market.

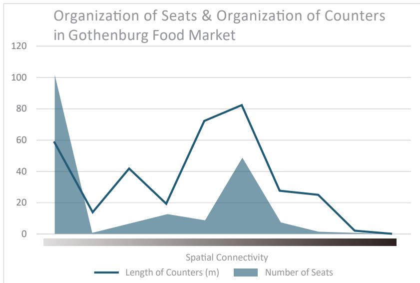


Figure 63b. Correlation between organization of seats and counters regarding spatial connectivity in Gothenburg Food Market.

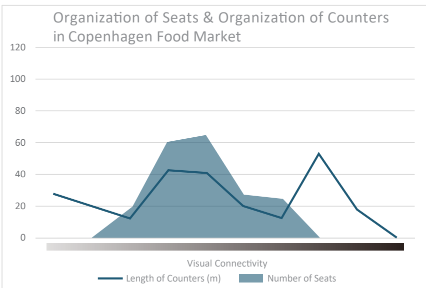


Figure 64a. Correlation between organization of seats and counters regarding visual connectivity in Copenhagen Food Market.

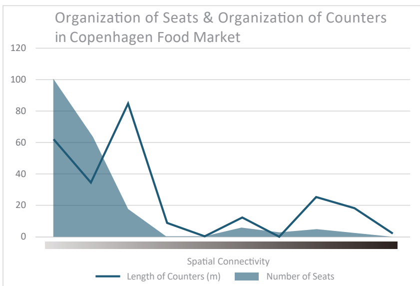


Figure 64b. Correlation between organization of seats and counters regarding spatial connectivity in Copenhagen Food Market.

2.6 Types of Use - Behavior Mapping

2.6.1 Observation Method

In this section, in order to construct the real description of the physical use of the market space, the observation focuses on measuring the occupancy behavior and movement behavior.

The investigation in the four markets are from January to March 2018 because the cold weather provides good opportunities to observe indoor lives. The non-participant observation is divided into two sections: peak time, from 11:00 to 14:00, when the majority of customers visit the markets for lunch; and other time, from 14:00 to 17:00, when most customers finish their lunch and stroll to buy products. The observation are both at weekdays and weekends. However, the behavior mapping and analysis mainly focus on the weekends because the high visiting flows show more room for investigations. The observation methods will be presented below:

- **General observation**

The purpose of general observation is to gain more information about the markets (history, environment, owner, construction etc.). The regular visits helps to experience the markets and its context, thus to form the deeper understanding of how to set the markets observation areas and photographing points.

- **Snapshots**

Snapshot represents how visitors locate and act in the markets at specific time. It includes not only the information where people are, but also detail descriptions that where people are sitting, where people are standing and are they individuals or with groups. Adding to this, the actions of visitors are noted down as if they are buying products or queuing to buy, if they are standing and chatting with friends, if they are stopping to have a look at products etc. The snapshots are taken twice a day at the lunch time and the other time.

- **Photographing**

The panoramic images at the crossroads show the moments how people organize themselves and the relation among different groups of visitors. It also contributes to quantitative count. Besides, the detail distribution like the number and position of seats, type of interfaces and how vendors organized their products are also recorded in this step.

- **Quantitative count**

Quantitative count consists of the number of sitting people and standing people at specific time, the visiting flow as passing by pre-defined gates and the amount of visitors in pre-defined observation areas.

- **Individual trails**

Individual trail is a good way to understand how people move in the markets. The whole movement are noted down when visitors get into till they leave the market hall, with additional information about where they pause, if they buy products, if they are individuals or with groups etc.

- Relation analysis methods

Overlapping analysis
Data collection and analysis
Comparative analysis: the analysis consists of the internal comparison within each market and comparison among the four markets.

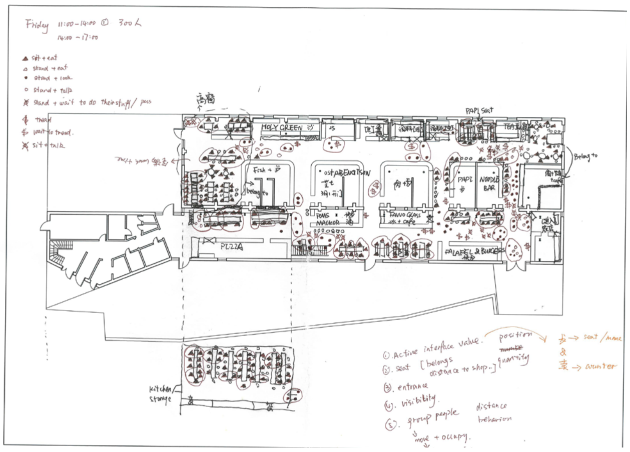


Figure 65a. Some symbols used for manual mapping and an example of behavior map as recorded during observation in Malmö Food Market.

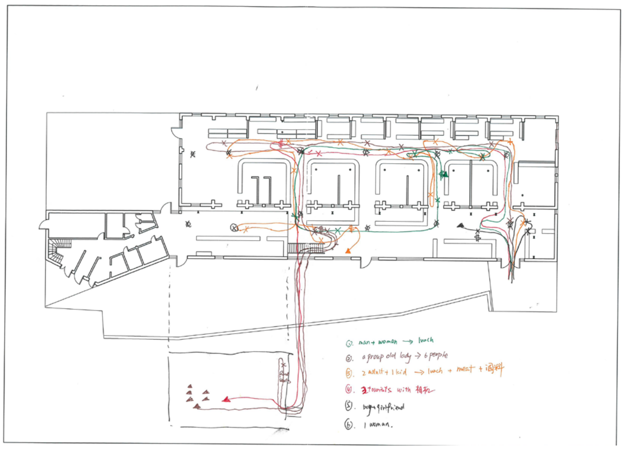


Figure 65b. Some symbols used for manual mapping and an example of individual trails as recorded during observation in Malmö Food Market.

2.6.2 Patterns of Use

The observation mainly concerns about the occupancies and movements in the four market halls. As the additional information, if visitors are individuals or with groups are also noted down. Several formal and informal patterns of use are observed:

- Formal Use: Eating and Buying Behavior

Eating: visitors sit on seats for a relatively long while
Eating by oneself: individual diners sit by oneself for a long time, often are absorbed in the cellphone.
Eating and dating: two visitors dine in an intimate atmosphere.
Eating with groups: more than three visitors sit together. The situation that eating with family especially with children and old persons are also included in this category. Sometimes they buy food from different shops but eat together.

Buying: visitors stop in front of specific counters to purchase or wait to purchase products through verbal contact with vendors.

- Informal Use: visitors stand for a while without buying behavior

Stop and having a look at the products
Stop to figure where to go
Stop and chatting with friends
Stop and wait to pass

- Movement: general walking behavior.

Only the path choices of visitors are analyzed in the following section. The walking behavior will not be categorized by for example the pauses and activity types as visitors go, as well as if they are individuals or with groups.

Figure 66.The panorama photo of the spatial use situation in the Gothenburg Food Market.

GM

Figure 67. The panorama photo of the spatial use situation in the Copenhagen Food Market.

CM

Figure 68. The panorama photo of the spatial use situation in the Malmö Food Market.

MM

Figure 69. The panorama photo of the spatial use situation in the Lund Food Market.

LM

2.6.3 Gothenburg Food Market

GM

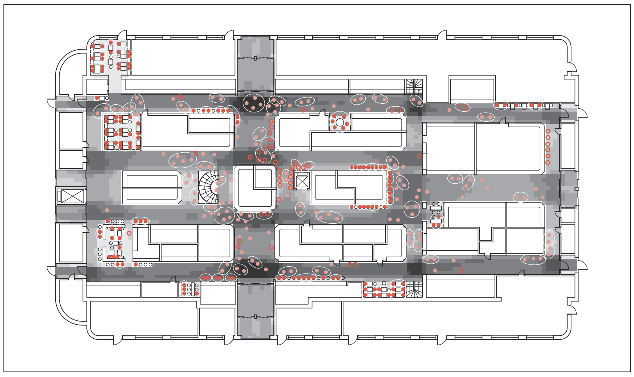


Figure 70. Spatial connectivity value combined with occupancy positions in the Gothenburg Food Market.

1 1000

Value Range*

Standing
Buying
Sitting
Group

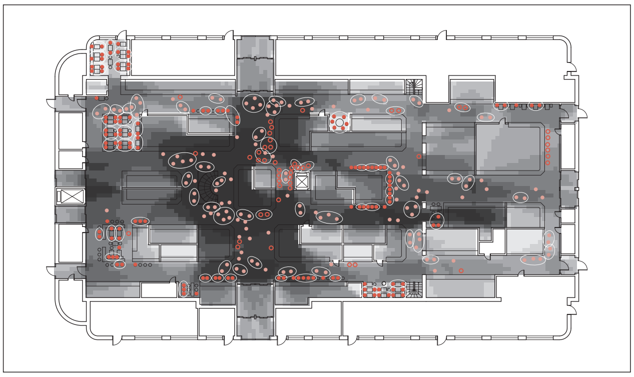


Figure 71. Visual connectivity value combined with occupancy positions in the Gothenburg Food Market.

60 2400

Value Range*

Standing
Buying
Sitting
Group

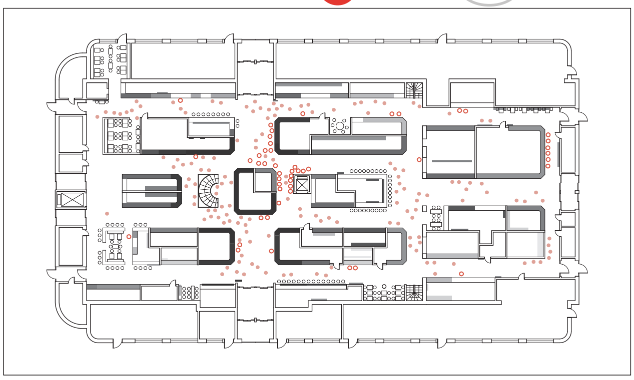


Figure 72. The interface connectivity values combined with the shopping people positions and the standing people positions in the Gothenburg Food Market.

60 2400

Value Range*

Standing
Buying

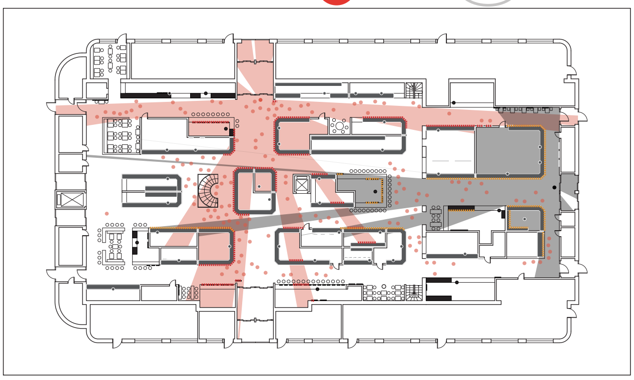


Figure 73. Isovists from entrance combined with the standing people positions in the Gothenburg Food Market.

Length of counters from entrance (red polygon)

Length of counters from entrance (gray polygon)

Standing

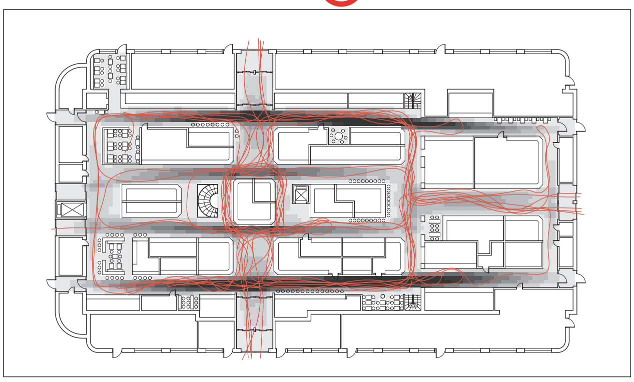


Figure 74. Through vision value combined with movement routes in the Gothenburg Food Market.

1 40000

Value Range*

* In order to make the comparative analysis among four markets, it is worthy to note that:

1. The color range of visual connectivity is same for four markets.
2. The color range of spatial connectivity is same for four markets.
3. The color range of visual integration is same for four markets.
4. The color range of spatial integration is same for four markets.
5. The color range of through vision is same for four markets.

In that case, all the values could be analyzed on a higher level: comparing the similarities and differences among four markets. Hence, in some figures, there are not dark gray nodes but it does not mean that there are not integrated or well connected nodes. It means that the highest value of nodes in some markets can not reach the general highest value. In other words, visibility or accessibility of the markets without dark gray nodes is in a way not as good as other markets with numbers of dark gray nodes.

2.6.4 Copenhagen Food Market

CM

Figure 75. Spatial connectivity value combined with occupancy positions in the Copenhagen Food Market.

1 1000 Value Range*

Standing Buying Sitting Group

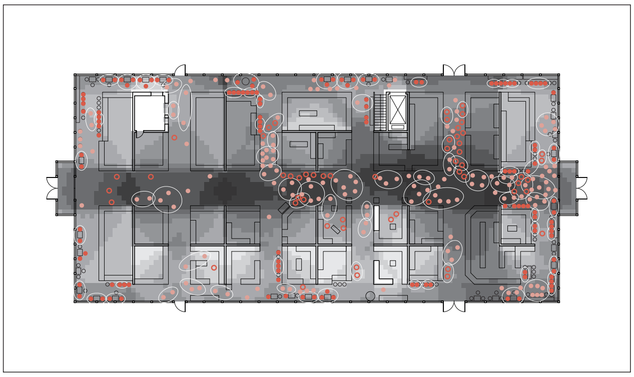


Figure 76. Visual connectivity value combined with occupancy positions in the Copenhagen Food Market.

60 2400 Value Range*

Standing Buying Sitting Group

Figure 77. The interface connectivity values combined with the shopping people positions and the standing people positions in the Copenhagen Food Market.

60 2400 Value Range*

Standing Buying

Figure 78. Isovists from entrance combined with the standing people positions in the Copenhagen Food Market.

Length of counters from entrance (red polygon)

Length of counters from entrance (gray polygon)

Standing

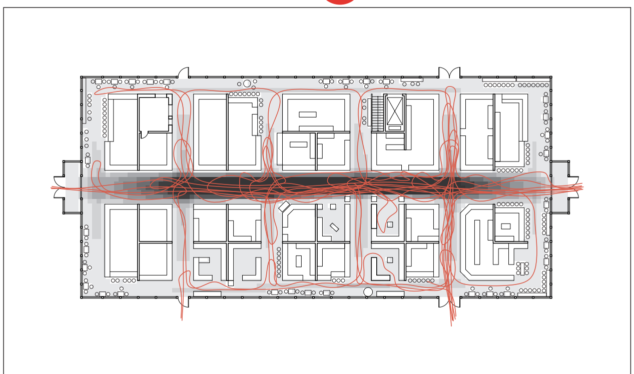


Figure 79. Through Vision value combined with movement routes in the Copenhagen Food Market.

1 40000 Value Range*

* In order to make the comparative analysis among four markets, it is worthy to note that:

1. The color range of visual connectivity is same for four markets.
2. The color range of spatial connectivity is same for four markets.
3. The color range of visual integration is same for four markets.
4. The color range of spatial integration is same for four markets.
5. The color range of through vision is same for four markets.

In that case, all the values could be analyzed on a higher level: comparing the similarities and differences among four markets. Hence, in some figures, there are not dark gray nodes but it does not mean that there are not integrated or well connected nodes. It means that the highest value of nodes in some markets can not reach the general highest value. In other words, visibility or accessibility of the markets without dark gray nodes is in a way not as good as other markets with numbers of dark gray nodes.

2.6.5 Malmö Food Market

MM

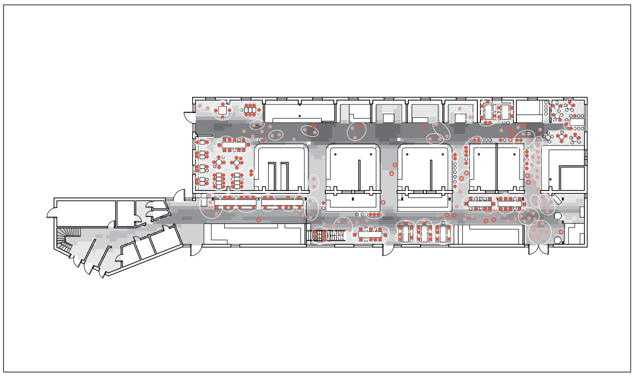


Figure 80. Spatial connectivity value combined with occupancy positions in the Malmö Food Market.

1 1000 Value Range*

Standing Buying Sitting Group

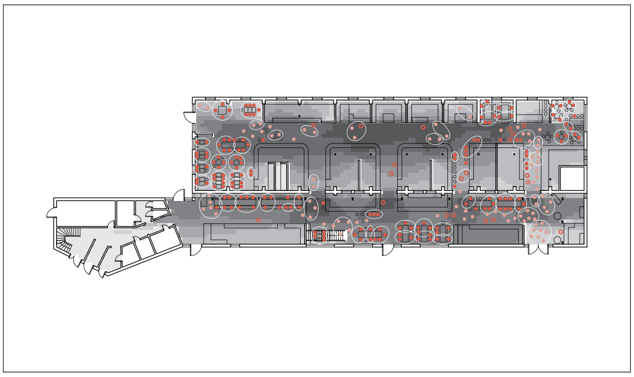


Figure 81. Visual connectivity value combined with occupancy positions in the Malmö Food Market.

60 2400 Value Range*

Standing Buying Sitting Group

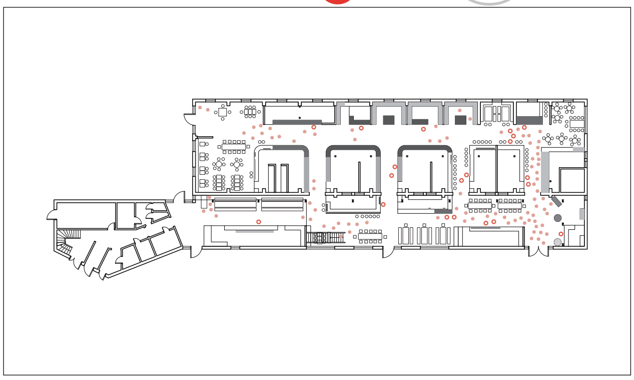


Figure 82. The interface connectivity values combined with the shopping people positions and the standing people positions in the Malmö Food Market.

60 2400 Value Range*

Standing Buying

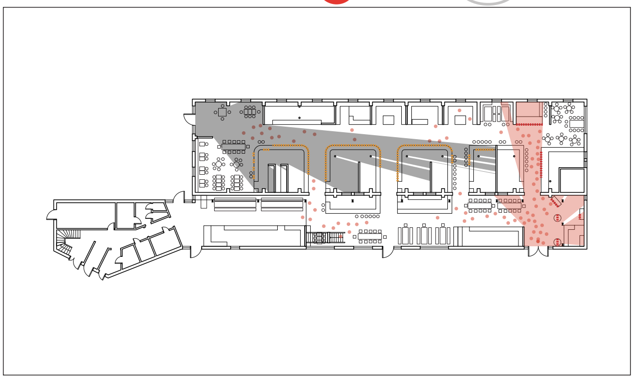


Figure 83. Isovists from entrance combined with the standing people positions in the Malmö Food Market.

Length of counters from entrance (red polygon)

Length of counters from entrance (gray polygon)

Standing

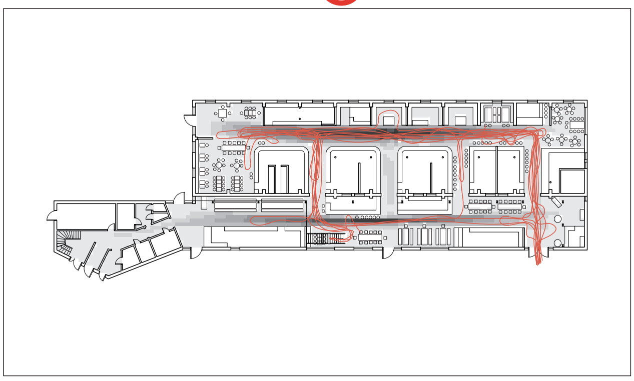


Figure 84. Through Vision value combined with movement routes in the Malmö Food Market.

1 40000 Value Range*

* In order to make the comparative analysis among four markets, it is worthy to note that:

1. The color range of visual connectivity is same for four markets.
2. The color range of spatial connectivity is same for four markets.
3. The color range of visual integration is same for four markets.
4. The color range of spatial integration is same for four markets.
5. The color range of through vision is same for four markets.

In that case, all the values could be analyzed on a higher level: comparing the similarities and differences among four markets. Hence, in some figures, there are not dark gray nodes but it does not mean that there are not integrated or well connected nodes. It means that the highest value of nodes in some markets can not reach the general highest value. In other words, visibility or accessibility of the markets without dark gray nodes is in a way not as good as other markets with numbers of dark gray nodes.

2.6.7 Lund Food Market

LM

Figure 85. Spatial connectivity value combined with occupancy positions in the Lund Food Market.

1 1000

Value Range*

Standing Buying

Sitting Group

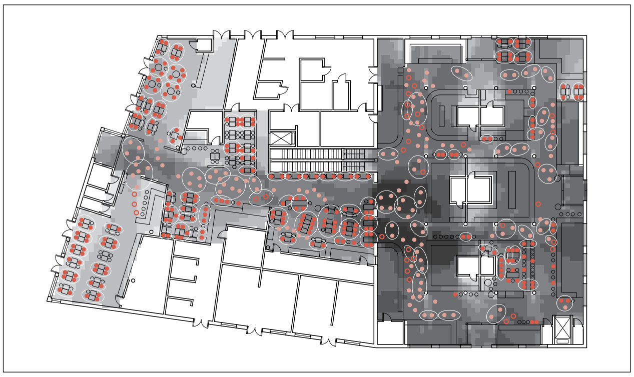


Figure 86. Visual connectivity value combined with occupancy positions in the Lund Food Market.

60 2400

Value Range*

Standing Buying

Sitting Group

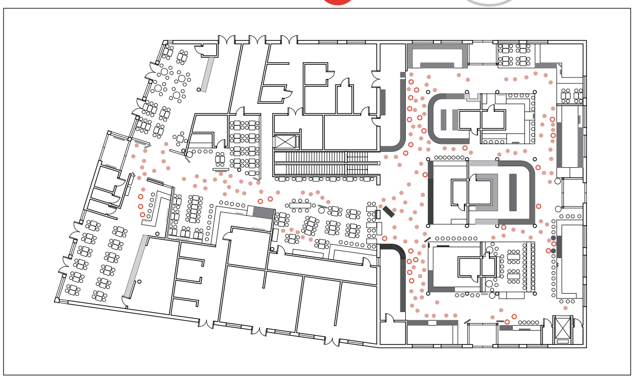


Figure 87. The interface connectivity values combined with the shopping people positions and the standing people positions in the Lund Food Market.

60 2400

Value Range*

Standing

Buying

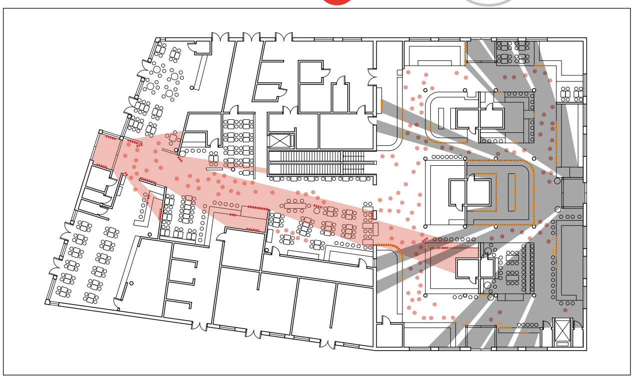


Figure 88. Isovists from entrance combined with the standing people positions in the Lund Food Market.

Length of counters from entrance (red polygon)

Length of counters from entrance (gray polygon)

Standing

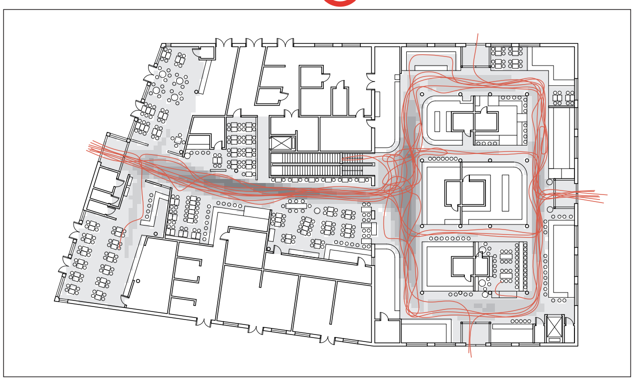


Figure 89. Through Vision value combined with movement routes in the Lund Food Market.

1 40000

Value Range*

* In order to make the comparative analysis among four markets, it is worthy to note that:

1. The color range of visual connectivity is same for four markets.
2. The color range of spatial connectivity is same for four markets.
3. The color range of visual integration is same for four markets.
4. The color range of spatial integration is same for four markets.
5. The color range of through vision is same for four markets.

In that case, all the values could be analyzed on a higher level: comparing the similarities and differences among four markets. Hence, in some figures, there are not dark gray nodes but it does not mean that there are not integrated or well connected nodes. It means that the highest value of nodes in some markets can not reach the general highest value. In other words, visibility or accessibility of the markets without dark gray nodes is in a way not as good as other markets with numbers of dark gray nodes.

2.7 Findings

Relation between Patterns of Use and Spatial Forms

- **The analysis provides the strongest relation between through vision and movement.**

The through vision value has significant impact on movement. More visitors are observed walking at the passages of high through vision value.

- **It seems that the density of shops along passages has an effect on movement.**

There is a tendency that passages with more shops could attract more movement. According to the individual trail observation, more visitors stroll down the passages with more shops and although sometimes they make a turn, they walk back in a short while. For instance, the central passage with two sides shops in the middle of the Copenhagen Food Market hall leads to more movement compared with peripheral passages with only one side shops (see Fig.90).

- **The Isovists from entrances tends to affect the choice of routes.**

The first view from entrances influences how and where people choose to move. More visitors are observed to walk directly to the passages which they can see from entrances. It is not difficult to understand this relation because the first glimpse is always important and could shape visitors' behavior. What kind of shops or function are placed at entrances is also important. For example, in Malmö Food Market, sitting areas directly faced to main entrance. Visitors would not choose sitting areas as the start of the route and most of them walked to another passage with shops (see Fig.91).

- **Visiting flow apparently relates to density of seats and ratio of the number of shops to number of restaurants (see Fig.92a and Fig.92b).**

More seats and restaurants tend to attract more customers during the lunch time. The number of restaurants is more than the number of shops in Malmö Food Market and Lund Food Market (see Fig.92b that the ratio of shops to restaurants is lower than 0.5) while in Gothenburg Food Market and Copenhagen Food Market the number of shops is more than restaurants. There are significant differences between number of visitors at lunch time and other time in Malmö Food Market and Lund Food Market. Adding to this, in Malmö Food Market, the high density of seats and restaurants leads to the peak visiting flow during the lunch time (see Fig.92c). However, in Gothenburg Food Market, more retails and shops tend to keep the high visiting flows all the day (see Fig.92d).

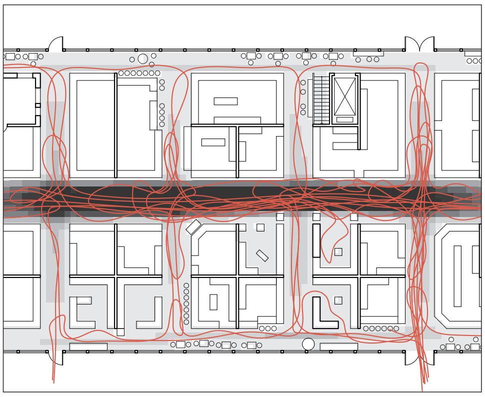


Figure 90. Through Vision value combined with movement routes in the Copenhagen Food Market.

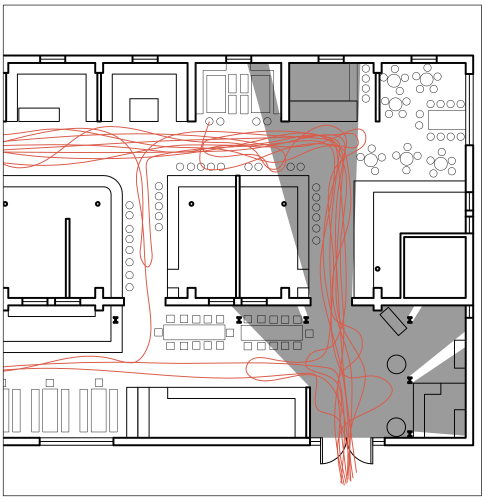


Figure 91. Isovists from the main entrance combined with the movement in the Malmö Food Market.

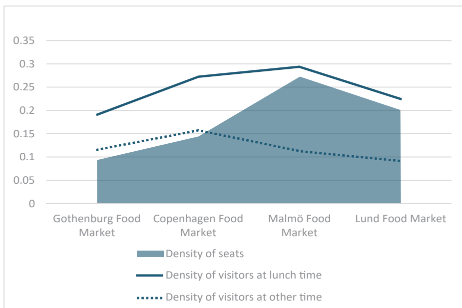


Figure 92a. Relation between density of seats and density of visiting people in the four markets during lunch time and other time.

- **Where visitors choose to buy products seems primarily related to the location of products but not spatial conditions.**

In the four markets, where people choose to buy products is not based on the spatial conditions. There is a tendency that the location of some popular products, such as meat, cured food, cheese and seafood, has a strong effect on visitors' choice. For instance, some meat shops deeper in the system are somewhat visited more than other types of shops closer to the accessible core.

It is not surprising but noteworthy. Although the spatial conditions do not apparently affect the choice of products, it could have impact on how people perceive products and spaces. Take Lund Food Market as an example. Meat shop and seafood shop are placed close to the accessible core, and the buying crowds lead to an unexpected jam at the main passage. The unexpected stop could provide good opportunities for encounters. Thurs, it reflects on should the popular shops be placed at the space of high visibility and accessibility or the space deeper in the system. The two opposite design options could lead to the same buying behavior but different choice of route and visual perception and influence other kinds of behavior.

- **The excessive amount of visitors per seat during the lunch time makes visitors have no choice but to sit at one of the few available seats without thinking where they really want to sit.**

The amount of visitors of the four markets during the lunch time always peaks. However there are not enough seats for everyone, many diners have to wait seats or eat standing up. In that case, more diners are observed to sit at one of the few available seats in front them.

- **More seats with tables lead to more group dining people.**

In Malmö Food Market and Lund Food Market, the number of seats with tables is far more than the number of bar seats, as expected there are more group diners. See Fig.93a that the number of group eating behavior peaks where the number of seats with tables peaks. Besides, although there are also many seats at spaces of low visibility, more group diners choose to sit at spaces of relatively high visibility. In other words, seats with tables especially those with high visual connectivity value are more often used by group diners.

Adding to this, more family especially with young children and old people are observed in Malmö Food Market and Lund Food Market. Seats with tables of relatively higher accessibility tend to attract more family and disable diners.

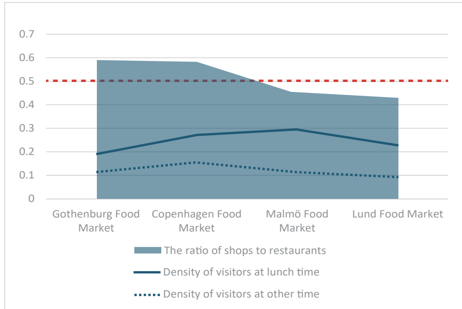


Figure 92b. Relation between ratio of shops to restaurants and density of visiting people in the four markets during lunch time and other time.

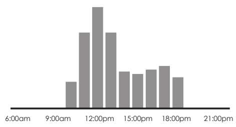


Figure 92c. Number of visitors in Malmö Food Market.

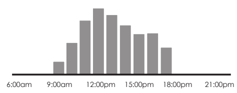


Figure 92d. Number of visitors in Gothenburg Food Market.

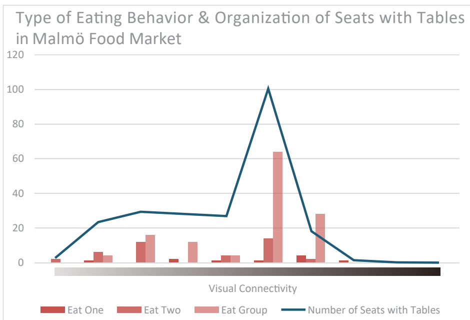


Figure 93a. Relation between eating behavior and organization of seats with tables regarding the visual connectivity in Malmö Food Market.

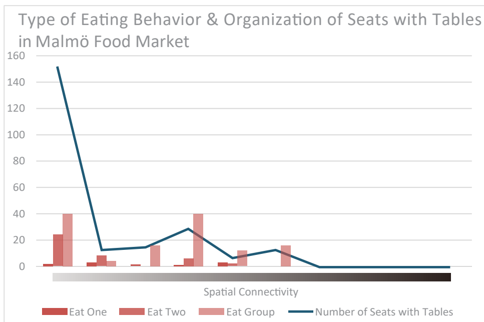


Figure 93b. Relation between eating behavior and organization of seats with tables regarding the spatial connectivity in Malmö Food Market.

See Fig.93b that although the number of seats with tables of low accessibility is far more than that of relatively high accessibility, the number of group eating behavior at the two points are similar. Seats with tables of higher accessibility are more attractive for group diners.

- **Single visitors prefer to choose bar seats with better visibility.**

In Malmö Food Market and Lund Food Market, as expected, there is a tendency that the bar seats are more used by single diners. In addition, visibility of bar seats also influences people's choice that bar seats with better visibility are more chosen (see Fig.94a and Fig.94b that single diners only show at the spaces of relatively higher visual connectivity value although there are many bar seats at spaces of low visibility).

- **More visitors are observed to stop to figure out where to go at the entrances with the long and narrow isovists and crossroads.**

From the isovist analysis, the isovists from entrances tend to have a high effect on the stopping behavior. Take Lund Food Market as an example. The two main entrances are entrance A and entrance B (see Fig.95). The counted number of passing by the two main entrances are similar. However, more stopping behavior are observed at entrance B. Visitors can have wide view from the entrance A but narrow and long view from entrance B. The similar phenomenon also occurs in Copenhagen Food Market (see Fig.96). Long and narrow isovist from entrance C leads to numbers of 'stopping to figure out where to go' behavior while less visitors stop at entrance D, which provides wide isovist for visitors. There is a reasonable interpretation that if visitors can not have a wide view of the market hall as soon as they get in, the possibility of stopping to figure out where to go could increase.

- **There is a tendency that in some markets, stopping to figure out where to go behavior decreases when visitors can see more counters and shops from entrances.**

- **There is a tendency that stopping to look at products behavior relates to visibility and accessibility of counters.**

Counters of higher visibility and accessibility tend to attract those passing by stop and have a look. The number of standing and looking people peaks at the nodes of relatively higher visibility. Moreover, the spatial conditions of counters tends to have an effect on where people stand and look. In Fig.97a and Fig.97b, although many counters are placed at spaces of low accessibility and visibility, but less people would stop there and have a look at products.

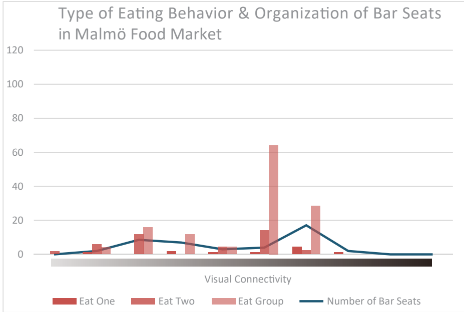


Figure 94a. Relation between eating behavior and organization of bar seats regarding the visual connectivity in Malmö Food Market.

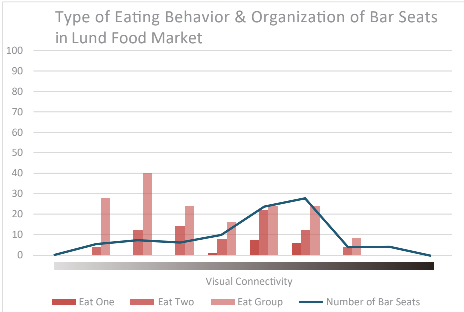


Figure 94b. Relation between eating behavior and organization of bar seats regarding the visual connectivity in Lund Food Market.

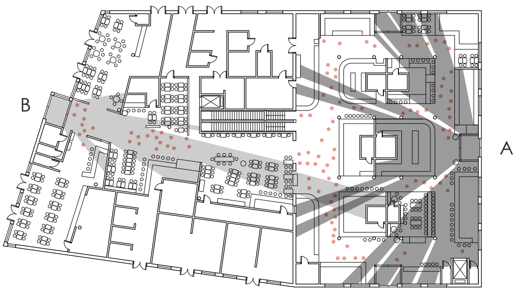


Figure 95. The isovists from the two main entrances combined with standing positions in the Lund Food Market.

Figure 96. The isovists from the two main entrances combined with standing positions in the Copenhagen Food Market.

It seems that, where people stop and glance over is not only about the choice of products but also the choice of visibility and accessibility.

- **It seems that spaces of high visibility and relatively low accessibility are more used for long standing like standing and chatting with friends.**

In Gothenburg Food Market, due to the special layouts, there are some spaces of high visibility but low accessibility (see Fig.98a and Fig.98b). The behavior stopping and chatting with friends are observed more at these space.

- There are not apparent differences between single standing behavior and group standing behavior regarding the spatial analysis. However, during the observation, it seems that more group visitors are observed stopping in the middle of passages while more single visitors are observed stopping at two sides of passages.

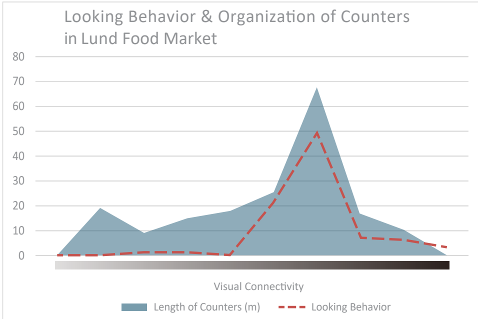


Figure 97a. Relation between stopping to look at products behavior and organization of counters regarding the visual connectivity in Lund Food Market.

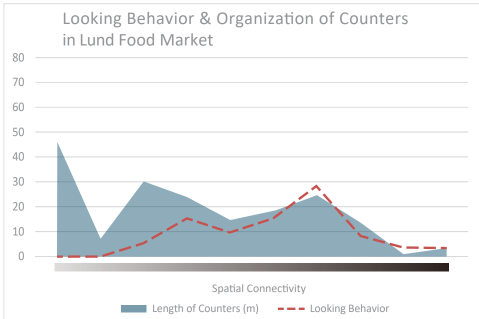


Figure 97b. Relation between stopping to look at products behavior and organization of counters regarding the spatial connectivity in Lund Food Market.

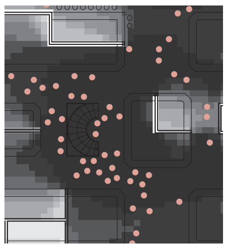


Figure 98a. The visual connectivity value combined with standing positions in the Gothenburg Food Market at the central part.

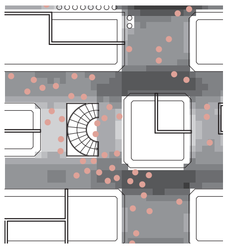


Figure 98b. The spatial connectivity value combined with standing positions in the Gothenburg Food Market at the central part.

Type of Use	Observation	Analysis Method	Result	Detail Description
Number of visitors	Counted visitors in the market hall at specific time (lunch time and other time).	Quantitative count, Statistical Correlation.	Relates to density of seats and the ratio of shops to restaurants.	More seats and restaurants tend to attract more customers during the lunch time. However, more retails and shops tend to keep the high visiting flows all the day.
Eating (Sitting)	Occupancy of seats (general eating behavior)	Quantitative count, Connectivity, Statistical Correlation	Relates to seats position.	During the overcrowded lunch time, visitors have no choice but to sit at one of the few available seats. This may also the result of excessive amount of visitors per seat.
Eating by oneself	Sitting by oneself for a long time, often being absorbed in the cellphone	Visual comparison, Quantitative count, Connectivity, Statistical Correlation	Tends to relate to the visibility of bar seats	The seats deeper or less accessible in the space have a tendency to be relatively more used by single persons. In addition, the statistical correlation study shows that single persons prefer bas seats.
Eating and Dating	Observed two visitors dining in an intimate atmosphere	Visual comparison, Quantitative count, Connectivity, Statistical Correlation	No apparent result	
Eating with group	Observed more than three visitors, sometimes buying food separately but eating together	Visual comparison, Quantitative count, Connectivity, Statistical Correlation	Tends to relate to seats type.	The seats with tables are more often used for group eating. Common sitting area with tables is popular for visitors who want to eat different food with friends. Seats with tables of relatively higher accessibility tend to attract more family and disable diners.
Buying	Short stop in front of specific counters to purchase or wait to purchase products through verbal contact with vendors	Visual comparison, Quantitative count, Connectivity, Statistical Correlation	Relates to a combination of type of products and location of products.	It seems that special products such as seafood, meat and cheese are popular and the location of these products primarily affect the visitors' choice.
Walking path	Noted down path choices of visitors through their visits (general moving behavior)	Individual trails, Through vision, Isovist analysis, Visual comparison	Relates to through vision, tends to relate to isovists from entrances and density of products along the passages.	The analysis provides the highest correlation between through vision and movement - as most visitors walking at the high through vision space. What's more, more products lead to high visiting flow.
Informal stopping	Observed standing for a while without buying behavior (general standing behavior)	Visual comparison, Quantitative count, Connectivity, Statistical Correlation	Relates to visibility.	Nodes of high visibility tend to produce more standing behavior.
Stopping to have a look at the products	Observed stop and looking at the products or advertising boards	Visual comparison, Quantitative count, Connectivity, Statistical Correlation	Relates to the visibility and accessibility of counters	Counters of higher visibility and accessibility tend to attract those passing by stop and have a look. Moreover, where people stop and glance over is not only about the choice of visibility and accessibility but also the choice of products.
Figuring out where to go	Observed short stop and gazing around and moving	Through vision, Isovist analysis, Visual comparison	Relates to isovists from entrances and number of visible counters and shops from entrances	The behavior stop to figure out where to go tends to occur at the entrances with the long and narrow isovists. There is a tendency that in some markets, stopping to figure out where to go behavior decreases when visitors can see more counters and shops from entrances.
Talking with friends	Observed stop and relaxed interaction	Visual comparison, Quantitative count, Connectivity, Statistical Correlation	Tends to relate to visibility and accessibility.	Space of high visibility but relatively low accessibility are more used for long time standing like standing and chatting with friends.
Waiting to pass	Short stop at the overcrowded space and wait for pass	Visual comparison, Quantitative count, Connectivity, Statistical Correlation	Relates to where crowds are.	The question where visitors wait to pass could be transformed as the question where the crowds are. Thurs, both the formal standing behavior (buying) and the informal standing behavior could lead to the jam.

Table 3. The categories of patterns of use and the relation with spatial form.

2.8 Discussion and Conclusion:

It seems that formal patterns of use relate more with the spatial layouts. Although individual diners and group diners make different choice of seats, the sitting behavior are primarily affected by location of seats and type of seats but not spatial conditions. Besides, the number of buying visitors does not peak at the visibility and accessibility core. Some popular shops attract a lot of buying visitors although they are less visible and accessible in the system. Organization of products has a clearer effect on where and how people choose to buy than spatial conditions.

The spatial conditions tend to have a higher impact on informal patterns of use. The visibility has significant impact on informal standing behavior. Spaces of high visibility but relatively low accessibility could attract more long standing behavior. There is a high correspondence between 'standing and having a look at products or advertising boards' behavior and visibility of counters. Besides, the narrow and long isovists from entrances contribute to more 'stopping to figure out where to go' behavior. In other words, the informal standing behavior could be predicted. In that case, by changing spatial conditions, for example changing the location of visibility core, architects could to some extent change the location of standing crowds.

There is the strongest relation between movement and 'through vision' value. Moreover, the density of shops along the passages and the isovists from entrances also influence the choice of routes.

As conclusion, it is worthy to understand that, first, there is an apparent relation between several patterns of use and spatial conditions. However, other patterns of use seem to follow the spatial layouts. Patterns of use tend to follow both spatial conditions and spatial layouts, which in general constitute spatial form, in different ways. Therefore, before producing the design guidelines, a study of how spatial conditions are related to spatial layouts is necessary.

Second, spatial conditions and spatial layouts should be discussed as a combination. On the one hand, when architects choose different design options to achieve specific spatial conditions, it is important to be aware that we cannot design a single condition. Instead, the choice of design options could relate to a combination of visibility, accessibility, isovist area etc. (see Fig.99). On the other hand, within the combination, the relations between different spatial conditions are flexible. In simper words, for example, general high visibility could combine with general low accessibility with large through vision core etc. (see Fig.100) . In that case, according to different demands of use, there are many possible combinations. Hence, during design process, we need to be aware that low value of one single condition does not mean terrible space or less visitors.

Adding to this, different spatial layouts could lead to the same spatial condition. For example, the average accessibility of all seats is relatively low in the four markets but the organization of the sitting areas is totally different. In other words, the similar spatial conditions could be reached through many ways. Hence, it is important for architects to be aware that the relation between design options and spatial conditions are not a single relation. On the contrary, there are flexibilities of design options. The design guidelines in the following section are just a start of the exploration. The challenge is not only to see if architects understand the use-space and space-design relations but to see if they could design with consciousness.

Last, as stated above, by prolonging co-presence and co-awareness, the possibility of encounters and social interactions could increase. The main question about how to increase the potentials for social interaction based on use-space-design relation could be answered partly. The 'use-space' part could be answered but the 'design' part could not. The question of how to prolong co-presence and co-awareness could be subdivided into more precise questions: where people stop, where people walk, how to increase formal and informal stop, when formal and informal stop occurs, how to prolong formal and informal stop.

Thus, the analysis of spatial layouts and spatial conditions is the analysis of stopping crowds and movement. For instance, informal stopping crowds are most observed at space of high visibility and relatively low accessibility. The location of visibility cores, products and entrances have an effect on where stopping crowds are. There is the strongest relation between movement and through vision core. In that case, stop behavior and movement could be changed by changing spatial layouts and spatial conditions. And then co-presence and co-awareness could be shaped.

3 PROTOTYPE EXPLORATION

From previous spatial analysis, the flexible relation between spatial layouts and spatial conditions are presented. Meanwhile, from previous behavior analysis, the patterns of use relate to both spatial layouts and spatial conditions. Hence, before building the use-space-design relation, deeper understanding of how specific design options could generate spatial conditions is necessary. Besides, this thesis is for both professional architects and normal people like vendors and market managers. In that case, the professional diagrams and conclusions should be translated into more readable knowledge. The aim of this section is to investigate how to control specific spatial conditions through specific design options. The findings of this section is helpful to design with consciousness that the choice of each design options has effect on spatial relations and conditions and in turn on patterns of use.

In this section, some important spatial layouts, which are observed from previous analysis and have a significant effect use patterns, are discussed and compared to opposite spatial layouts in control group.

3.1 Basic Prototypes

- Introduction

According to the previous spatial analysis, The two types of organization principle plus two types of axis (see Fig.60) are found and in this section,are used as the basic models (Model A). Only the shape and the organization axis are discussed. Based on the general organization of the four food markets, the scale of the street like models are 1460sq. with 4*2 shop islands while the grid like models are 1600sq. with 3*3 shop islands. Each shop island is kept as an 8m*8m square and divided into four independent shops with a cross division wall in the middle.

Through some changes and improvements, some disturbances of the basic models that could influence the analysis results are removed. The new basic models (Model C), which also follow the two types of organization shape plus two types of axis, are analysis as the original design options. All the following prototype explorations are based on the Model C and can be regarded as the combination of original design options and other design options.

- Model A

In this section, only the shape and the organization axis are discussed. The spatial connectivity value are analyzed in the situation that people cannot walk into the interior spaces of all shops. While visual connectivity value are analyzed in the situation that all the counters are lower than eye level.

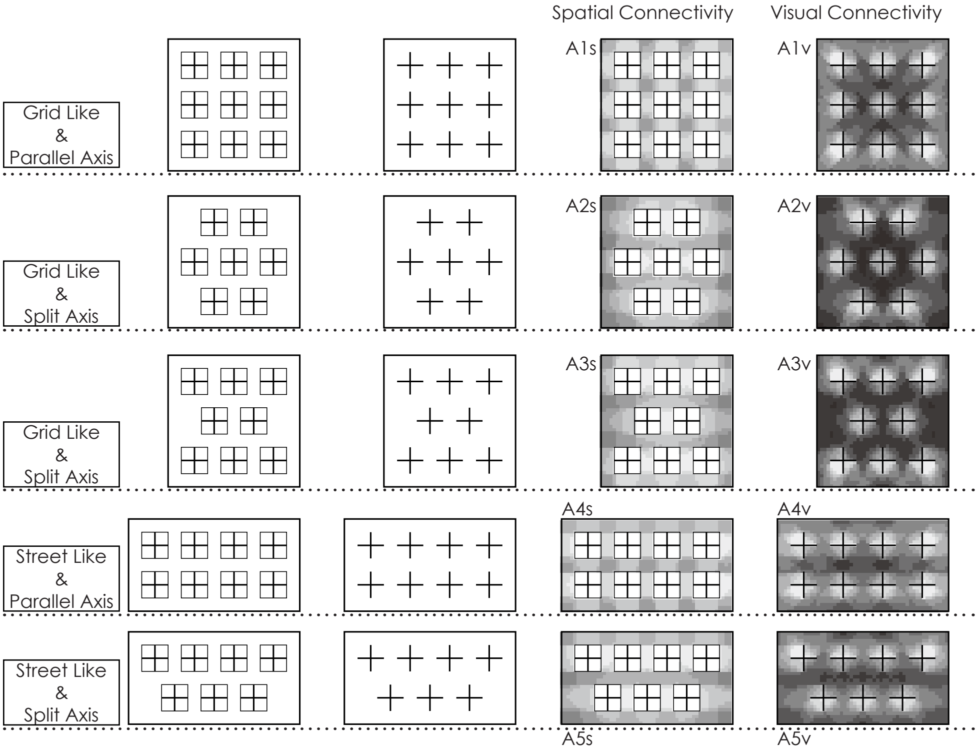


Figure 102. Prototype exploration of the basic organization A.*

- Model B

The peripheral paths in the split grid models have high connectivity value. It seems that the effect of wide peripheral paths on spatial conditions is highlighted. In order to decrease the disturbance, in the Model B, the width of all paths is kept as 4m by widening the size of the peripheral shops. There are no geometrical main paths in the models.

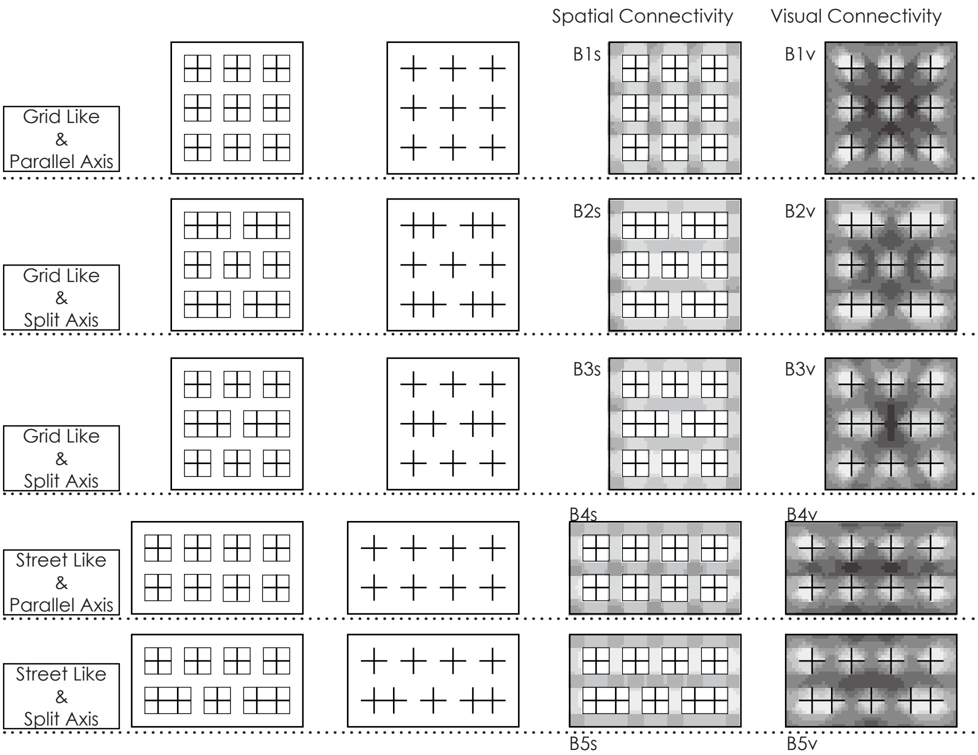


Figure 103. Prototype exploration of the basic organization B.*

- Model C

The traverse peripheral paths could be regarded as the disturbance of the connectivity analysis in the Model B. Therefore, I change the shape of the model to create the split peripheral paths. Model C is used as the new basic model and all the following prototype exploration are based on Model C. Hence, Model C is defined as the original design options when comparing the connectivity and through vision value with other design options.

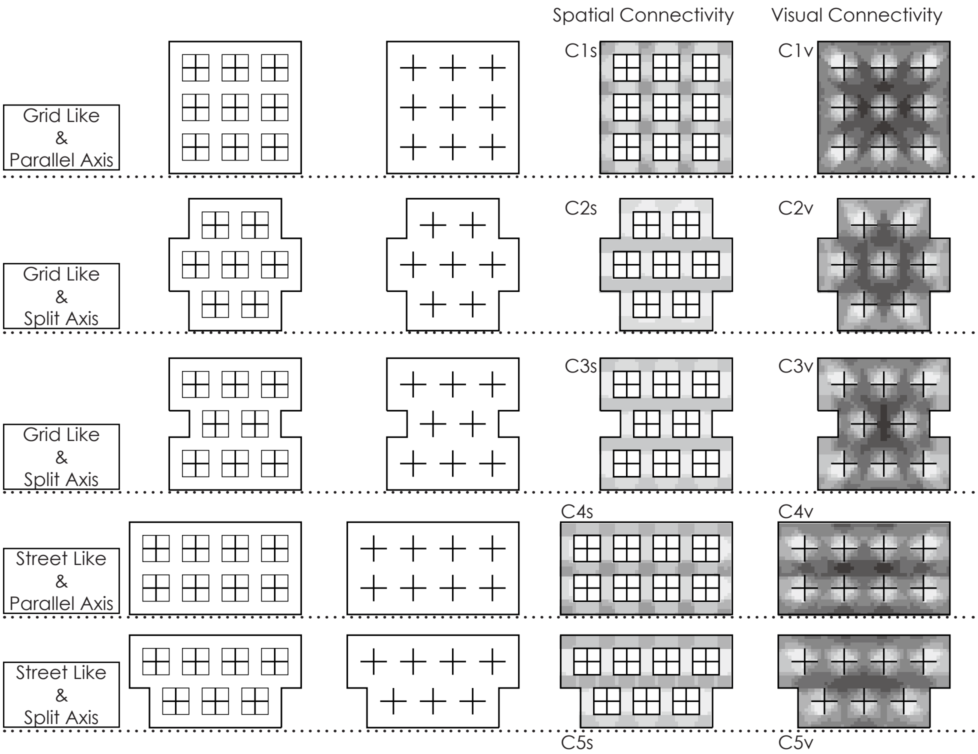


Figure 104. Prototype exploration of the basic organization C.*

* Connectivity value is analyzed and the value ranges from 60 to 700 corresponding to the color range from light gray to dark gray.

- **Reflections of original options**

1. In the test of Model A, it is obvious that the traverse peripheral paths in prototype A2, A3 and A5 (the split axis model) have higher connectivity value than the central paths. It can be understand that the discrete paths are less connected to other paths although they are at the geometrical center. However, if we compare the result from the parallel axis models (A1v) and split axis models (A2v and A3v), the connectivity value of the both central and peripheral paths is higher in the split axis models than in parallel axis models. The wide peripheral paths influence spatial condition. Hence I need to exclude the distraction by adjusting the split grid model.
2. The Model B is the development of the Model A. In order to keep the path width in 4m and exclude the geometrical main path, the shop islands at the corner are larger. Hence the division walls are added to remain the same size of each shop. The analysis results of the split axis models (B2v, B3v) are valuable. However, the peripheral paths also effect the spatial condition. In that case, I need to develop another prototype to exclude the traverse paths in split axis models.
3. In Model C, the shape of the split axis models are changed and two peripheral paths are replaced by several split paths. The connectivity value is high at the center in the parallel axis prototypes (C1 and C4) while low in the split axis prototypes (C2, C3 and C5). It is also interesting to note that in the model C4v, the most connective spaces are the two spots of the central path instead of the whole path.
4. Visual & Spatial Connectivity value: parallel axis models > split axis models
5. Visual & Spatial Connectivity value: grid like models < street like models
6. Through vision value: grid like models < street like models
7. Through vision value: parallel axis models > split axis models

3.2 Two Boundaries Explorations

Boundaries to Visibility and Accessibility

- Introduction

According to the previous spatial analysis, the boundaries to visibility and accessibility have significant effect on visual conditions and accessible conditions in the four markets. Due to the different layouts of the two boundaries, different situations for example the centrality of visibility overlapped with centrality of accessibility are observed in one food market but totally separated in another food market. In order to get deeper knowledge about how boundaries to visibility and accessibility could generate visual and accessible conditions, the explorations of the two boundaries are produced. In this section, two opposite layouts of the two boundaries are discussed and compared based on the Model C (the original design options).

The aim is to see a) how the general visual and accessible environment could change when the layouts of the two boundaries change by comparing the average value of all nodes in different models; b) how the visibility cores could change when the layouts of the two boundaries change by comparing the location and size of visibility cores in different models.

- 'Open the Corner' Options

Grasshopper programme is used to develop the boundaries to visibility in order to keep the exploration process controllable (see Fig.106). As each shop island is set as an 8m*8m square, this exploration focuses on the how visibility and accessibility could change when the boundaries accessibility of each shop island are removed or replaced by boundaries to visibility, from the corner. In other words, the walls and high shelves are replaced by counters and advertising boards from the corner.

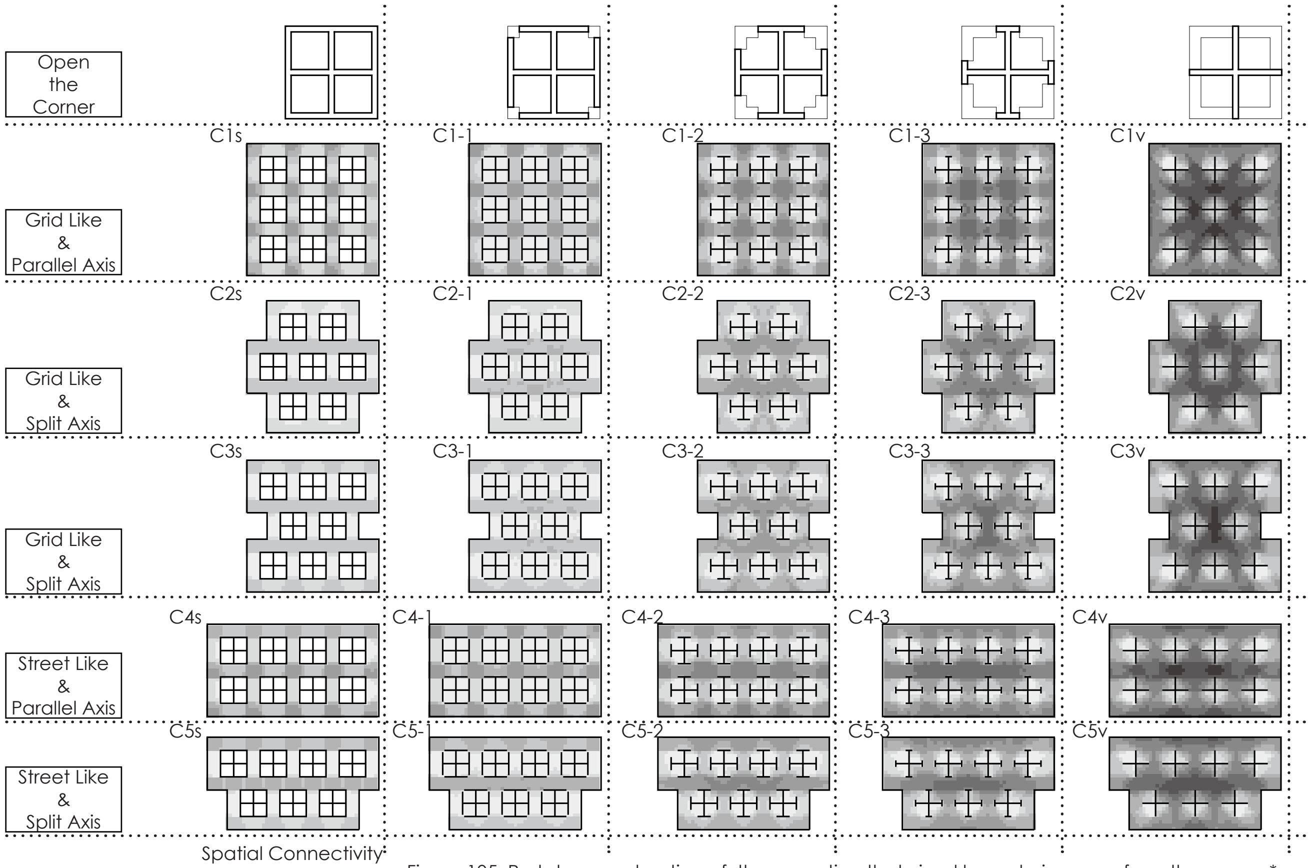


Figure 105. Prototype exploration of the operation that visual boundaries open from the corner.*

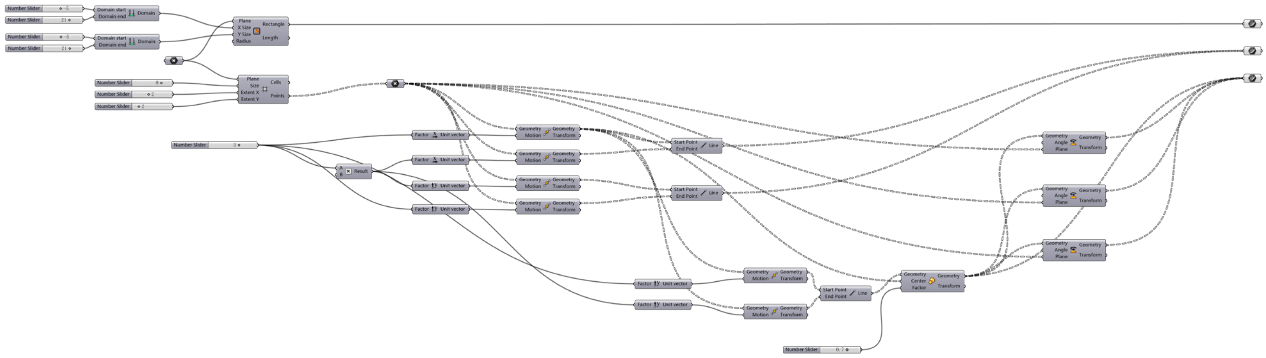


Figure 106. The work process in Grasshopper programme regarding the operation that open the visual boundaries from the corner.

- 'Keep the Corner' Options

In this prototype test, the corners of the shop islands are kept as the boundaries to accessibility. It is the comparative test of the 'open the corner' options because I want to know more about how different layouts of the two boundaries could generate visibility. The length of the boundaries to accessibility in each model are same with that in the previous model by controlling the same parameters in Grasshopper programme (see Fig.108).

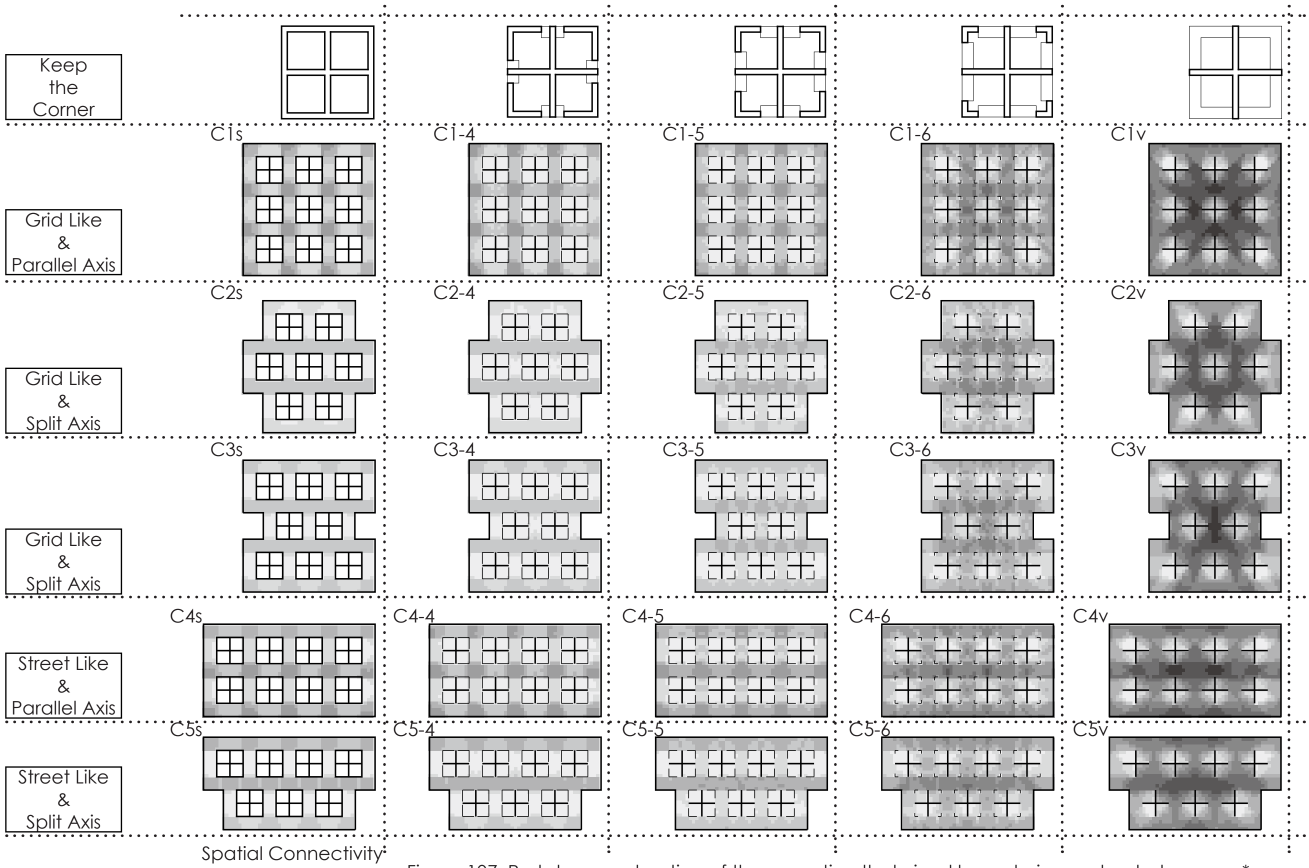


Figure 107. Prototype exploration of the operation that visual boundaries are kept at corners.*

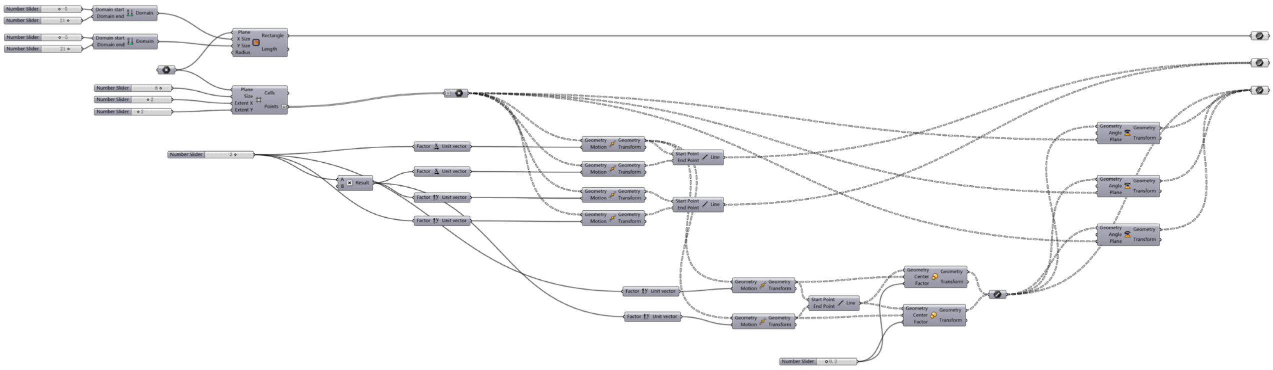


Figure 108. The work process in Grasshopper programme regarding the operation that keep the visual boundaries at the corner.

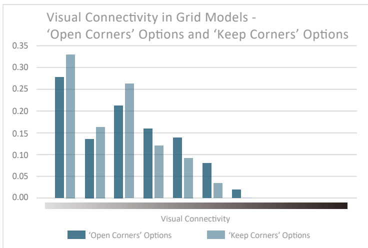


Figure 109. Visual connectivity value in grid like models contributed by 'open corners' options and 'keep corners' options.*

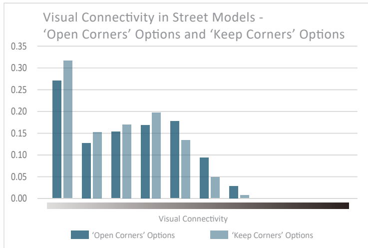


Figure 110. Visual connectivity value in street like models contributed by 'open corners' options and 'keep corners' options.*

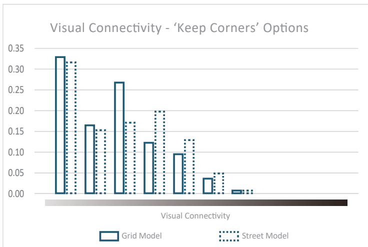


Figure 111. Visual connectivity value contributed by 'keep corners' options.*

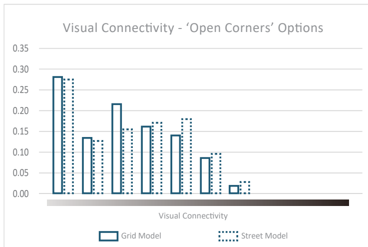


Figure 112. Visual connectivity value contributed by 'open corners' options.*

* Connectivity value is analyzed and the value ranges from 60 to 700 corresponding to the color range from dark blue to red.

- **Reflections of 'open the corner' options and 'keep the corner' options**

1. 'Open the corner' Options: The models from Cn-1 to Cn-3 illustrate the process that the boundaries to visibility of each shop island are replaced by boundaries to accessibility from the corner. Obviously, the connectivity value of central part becomes higher and higher when the corners are opened gradually in the split axis prototypes (see the change from C2-1, C2-2 to C2-3). The most connective part swishes from peripheral long path to center part of the model.
2. 'Keep the corner' Options: The visual conditions do not show apparent differences in split axis models although boundaries to visibility are gradually replaced by boundaries to accessibility (see the change from C2-4, C2-5 to C2-6 and change from C3-4,C3-5 to C3-6). In addition, the average connectivity value of all models keeps at a low level and the size of visibility cores is small even when the boundaries to visibility are largely removed. In other words, keeping the walls, or high selves, at the corner above the eye level contributes to a strong sense of privacy.
3. From Fig.109 and Fig.110, 'open the corner' options contribute to more number of higher value nodes in both grid like models and street like models. Besides, the number of higher value nodes in street like models is more than that in grid like models. Hence, according to the data collection and analysis, I find that:
 Visual connectivity value: 'open corners' options > 'keep corners' options
 Visual connectivity value: grid like models < street like models
 Visual connectivity value: parallel axis models > split axis models

3.3 Paths Explorations

- Introduction

The path explorations can be considered as the expanded explorations of how spatial layouts could generate visibility and accessibilities cores. According to the previous spatial analysis, the visibility cores and accessibility cores always locate at the center of the markets. In that case, I would like to test if there are any design options could change the location of visibility cores and accessibilities cores. Hence, at first, I created the geometrical main passages by widening different paths based on Model C (the original design options). The analysis consists of comparison of general visual and accessible environment (the average value of all nodes), location of visibility cores and accessibility cores. After that, I decided to explore what will happen if I remove the geometrical main passages and place an interior open square. The two kinds of explorations are discussed and compared as the opposite design tests based on Model C. Finally, the through vision value are analyzed in order to understand how these design options could generate movement. The aim is to see a) how the general visual and accessible environment could change when the layouts of the passages or squares change; b) how the visibility cores could change when the layouts of the passages or squares change; c) how the movement could be influenced. The analysis results are compared both within each design options and among the five design options (including the original design options).

* Connectivity value is analyzed and the value ranges from 60 to 700 corresponding to the color ranges from light gray to dak gray. The through vision value is analyzed based on the accessible boundary models and the value ranges from 0 to 10000 corresponding to the color ranges from ligh gray to dark gray.

- 'Widen Central Paths' Options

The options are based on the Model C from previous section. The geometrical main paths are created by widening central paths. The central paths are changed to 6m. The other paths are constricted till 2m. The connectivity value is analyzed.

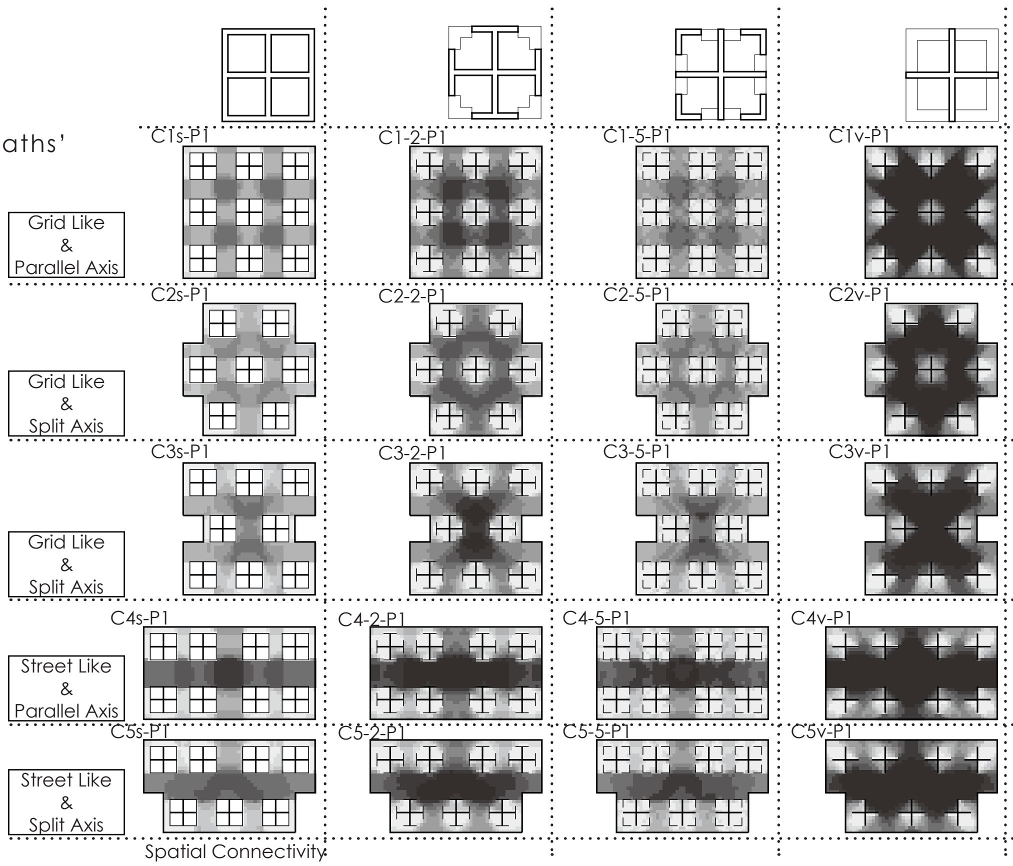


Figure 113. Prototype exploration of the operation that central paths are wider than the rest paths.*

- 'Widen Peripheral Paths' Options

In this exploration, the different situation is created by widening the peripheral paths to 6m. On the contrary, the central paths are constricted till 2m. In that case, the geometrical main paths are created at periphery. The connectivity value was analyzed.

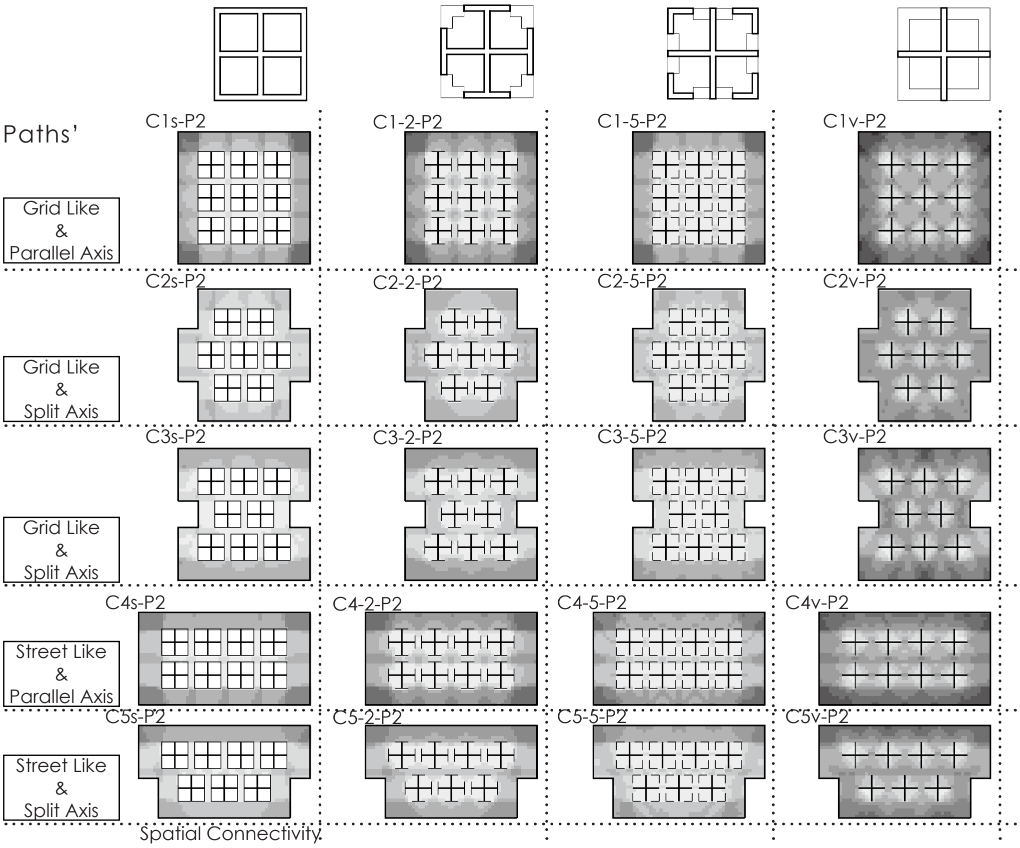


Figure 114. Prototype exploration of the operation that peripheral paths are wider than the rest paths.*

- 'Remove Peripheral Shops' Options

In order to understand more how the spatial condition is influenced by widening the off-center paths, I replace the peripheral shops as a flexible square. The width of the other paths are set at 4m based on the Model C. The connectivity value is analyzed.

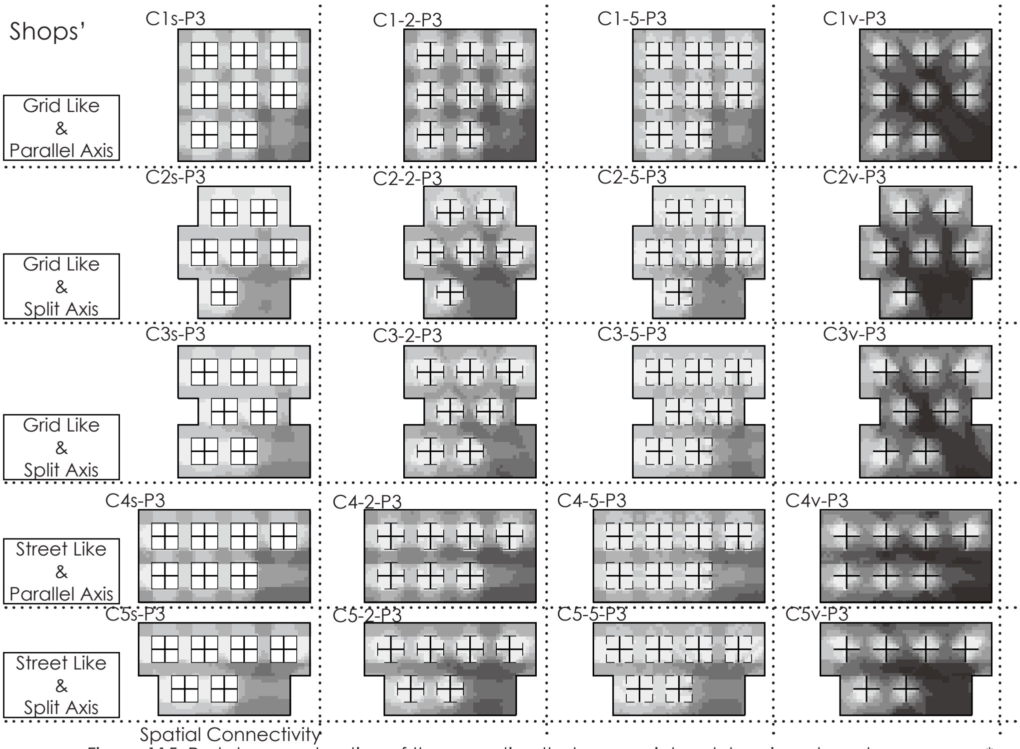


Figure 115. Prototype exploration of the operation that one peripheral shop is replaced as a square.*

- 'Remove Central Shops' Options

It is a contrastive test that illustrates how the spatial condition is effected by replacing central shops as a flexible square. Due to the special organization of the two street like models, the removed shops could be regarded as the peripheral shops. However, the result of the analysis is still valuable because the position of the flexible squares are totally different from that in the previous exploration. The connectivity value is analyzed.

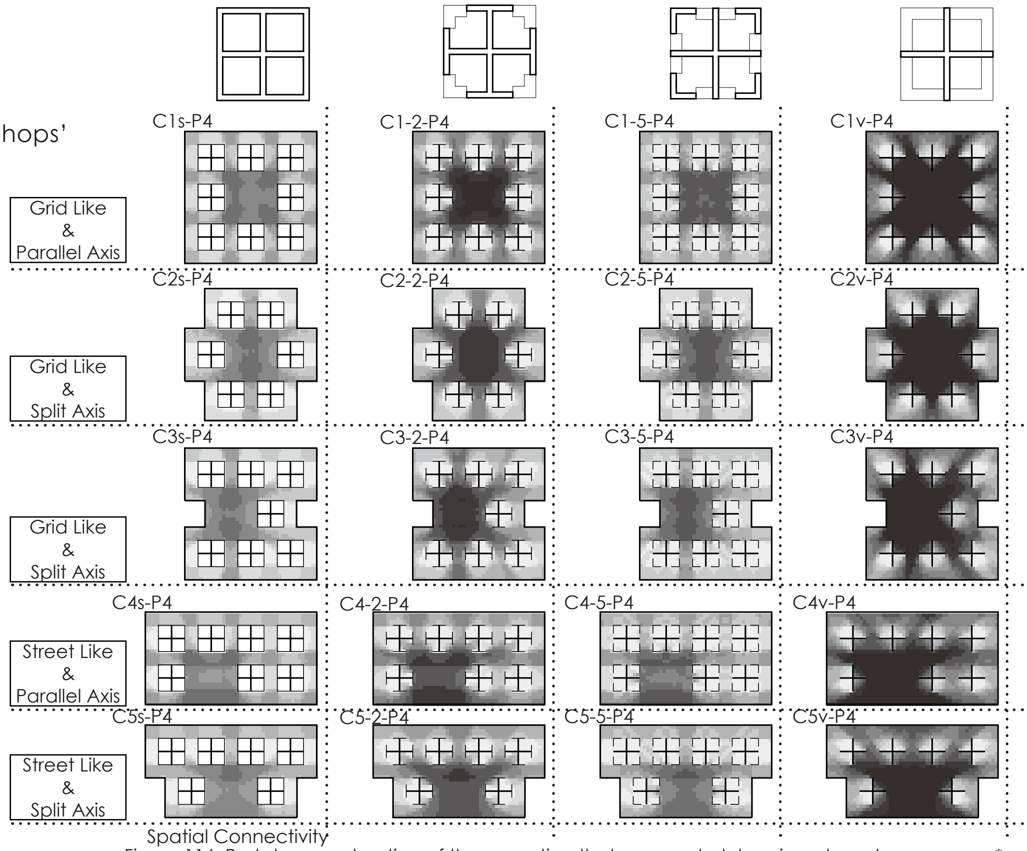


Figure 116. Prototype exploration of the operation that one central shop is replaced as a square.*

Through Vision Value

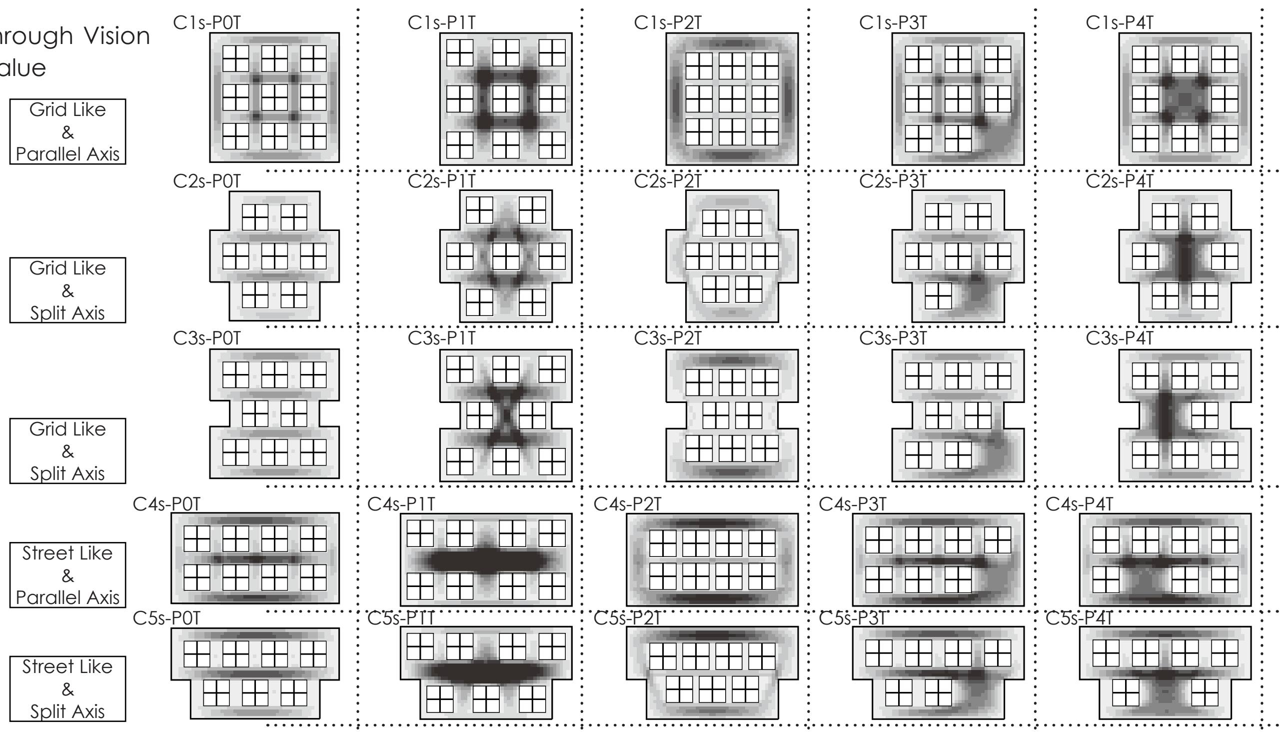


Figure 117. The through vision analysis of the five previous operations.*

- **General Reflections**

1. Spatial connectivity value: 'widen central paths' options > 'remove central shops' options = 'remove peripheral shops' options > 'widen peripheral paths' options
2. Visual connectivity value: 'widen central paths' options > 'remove central shops' options > 'remove peripheral shops' options > 'widen peripheral paths' options.
3. Through vision value: 'widen central paths' options > 'remove central shops' options > 'remove peripheral shops' options > 'widen peripheral paths' options
4. Comparing the original options, the 'widen peripheral paths' options contribute to lower visual connectivity average value in grid like split axis models, street like parallel axis models and street like split axis models.

- **Reflections of 'widen central path' options**

1. Spatial connectivity: 'widen central paths' options contribute to the highest spatial connectivity value in street like models.
2. Visual connectivity: 'widen central paths' options contribute to the highest visual connectivity value in grid like parallel axis models.
3. Through vision: 'widen central paths' options contribute to high average through vision value in parallel axis models but a dramatic increase of average through vision value in split axis models compared with original options.
4. The visual cores overlap with the movement cores especially in street like models.
5. The central shop in the grid like model is important because it is both the visual core and the movement core. Besides, 'widen central paths' options contribute to a ring path at the center with two sides shops in the grid like models.

- **Reflections of 'widen peripheral path' options**

1. Spatial connectivity: 'widen peripheral path' options contribute to higher spatial connectivity value in parallel axis models.
2. Visual connectivity: 'widen peripheral path' options contribute to higher visual connectivity value in parallel axis models.
3. Through vision: 'widen peripheral path' options contribute to a relatively higher increase of average through vision value in split axis models compared with original options.
4. The 'widen peripheral path' options move the movement cores from the central paths to peripheral paths. In that case, the number of shops along the high through vision value paths increase.

- **Reflections of 'remove central shop' options**

1. Spatial connectivity: 'remove central shop' options contribute to higher spatial connectivity value in grid like models.
2. Visual connectivity: 'remove central shop' options contribute to high visual connectivity value in grid like parallel axis models
3. Through vision: 'remove central shop' options contribute to a dramatic increase of average through vision value in split axis models compared with original options. Besides, the location of movement core does not be influenced.
4. The visual cores are separated from the movement cores.

- **Reflections of ‘remove peripheral shop’ options**

1. Spatial connectivity: ‘remove peripheral shop’ options contribute to relatively high spatial connectivity value in street like parallel axis models.
2. Visual connectivity: ‘remove peripheral shop’ options contribute to relatively high visual connectivity value in grid like parallel axis models.
3. Through vision: ‘remove peripheral shop’ options contribute to relatively high through vision value in street like parallel axis models. However, there are not apparent improvements of through vision value in all type of models.
4. The location of movement cores is influenced by the location of the removed shops.

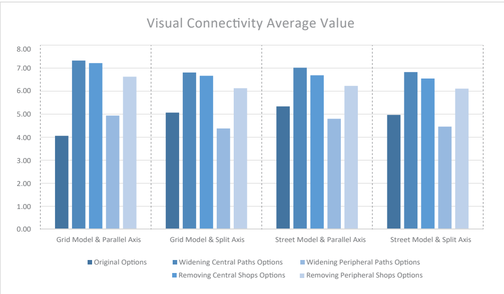


Figure 118a. Average visual connectivity value of all nodes contributed by five design options.

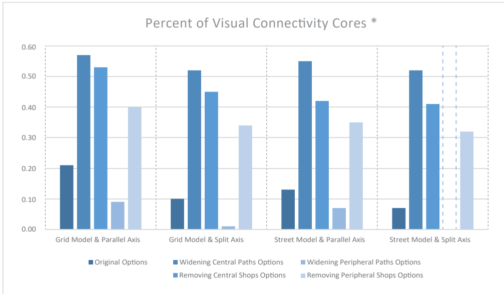


Figure 118b. Percent of visual connectivity cores contributed by five design options.

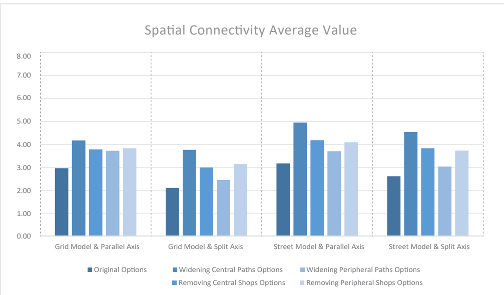


Figure 119a. Average spatial connectivity value of all nodes contributed by five design options.

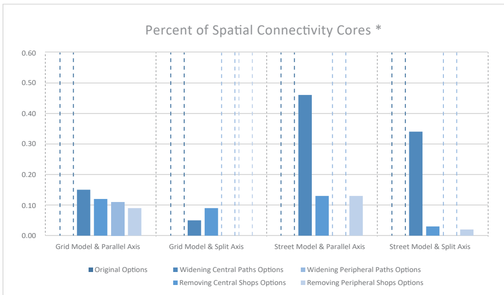


Figure 119b. Percent of spatial connectivity cores contributed by five design options.

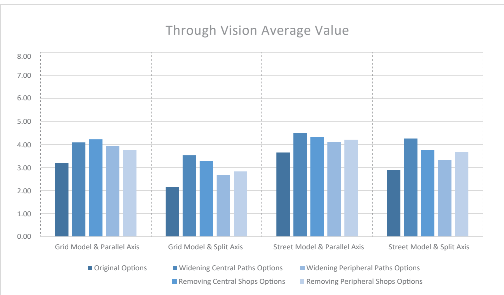


Figure 120a. Average through vision value of all nodes contributed by five design options.

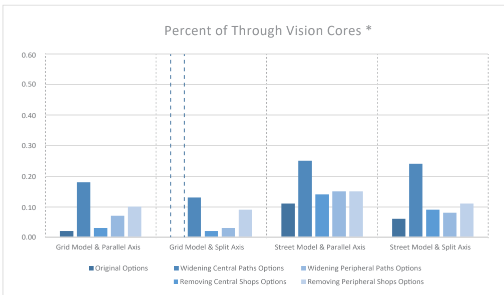


Figure 120b. Percent of through vision cores contributed by five design options.

* The dark gray nodes (high value nodes)are defined as high value cores. In that case, the number of high value nodes contributed by five design options are presented in Fig.118b, Fig.119b and Fig.120b.
* The color range of visual connectivity and spatial connectivity is same in all prototypes in order to compare the value on a higher level. In that case, there are not dark gray nodes in some prototypes. The blue dotted lines stand for zero number of dark gray nodes in that type of prototype in Fig.118b, Fig.119b and Fig.120b..

3.4 Entrances Explorations

- Introduction

According to the previous behavior analysis, isovists from entrances influence both 'stopping to figure out where to go' behavior and the choice of route. In that case, based on Model C, the explorations of how the location of entrances could lead to different isovists hence influence the first glimpse of visitors are necessary. In this explorations, two opposite layouts of entrances are discussed and compared. The aim is to see a) how the isovist areas could change when the location of entrances changes; b) how many shops and counters can be seen from entrance. Adding to this, the test also produces the idea that how 'the location of entrances' options could combine with the 'boundaries to visibility and accessibility' options in order to create maximum isovist area and number of visible shops and counters from entrances.

- 'Entrances Face to Shops' Options

According to the observation, what people see from the entrance affects where people prefer to move when they get in. The entrances are placed directly facing to shops. The isovist areas (the gray polygons), number of visible shops form entrances and length of visible counters (the red and yellow lines stand for visible counters from different entrances) are analyzed.

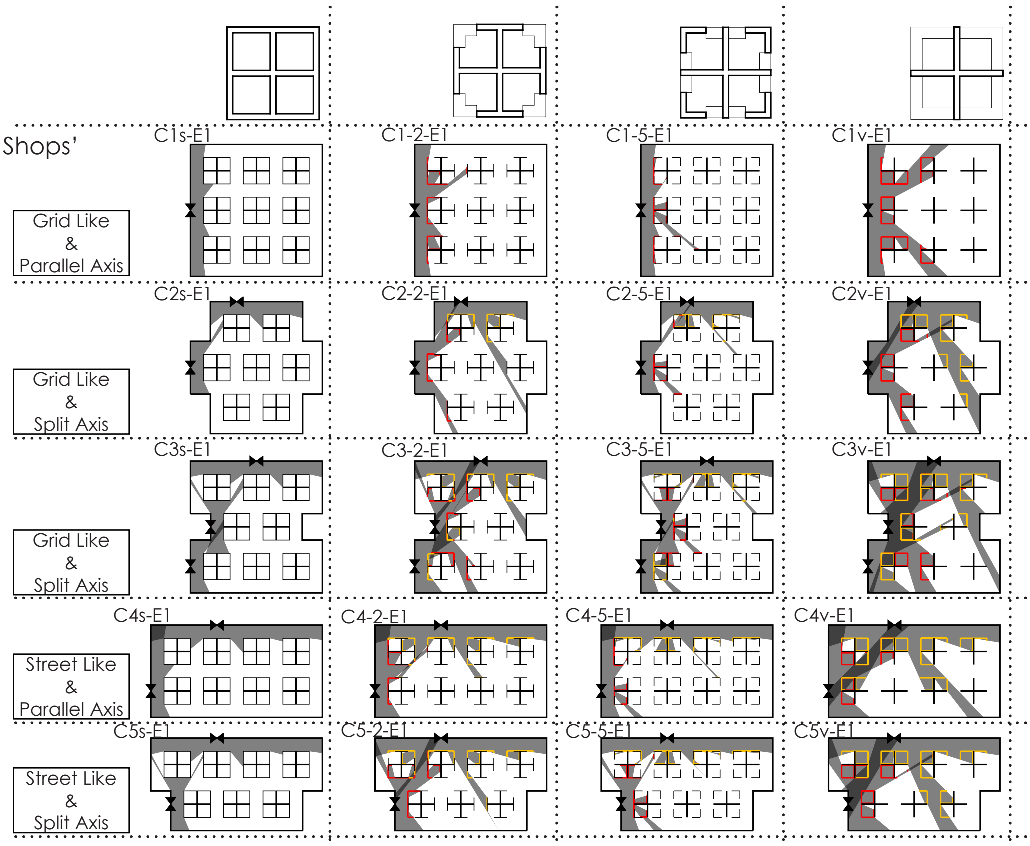


Figure 121. Prototype exploration of the operation that entrances are placed directly facing to the shops.

- ‘Entrances Face to Streets’ Options

This models are created as the contrastive test in order to learn more about the organization of entrances. The entrances are placed at the end of the paths. The isovist areas (the gray polygons), number of visible shops form entrances and length of visible counters (the red and yellow lines stand for visible counters from different entrances) are analyzed.

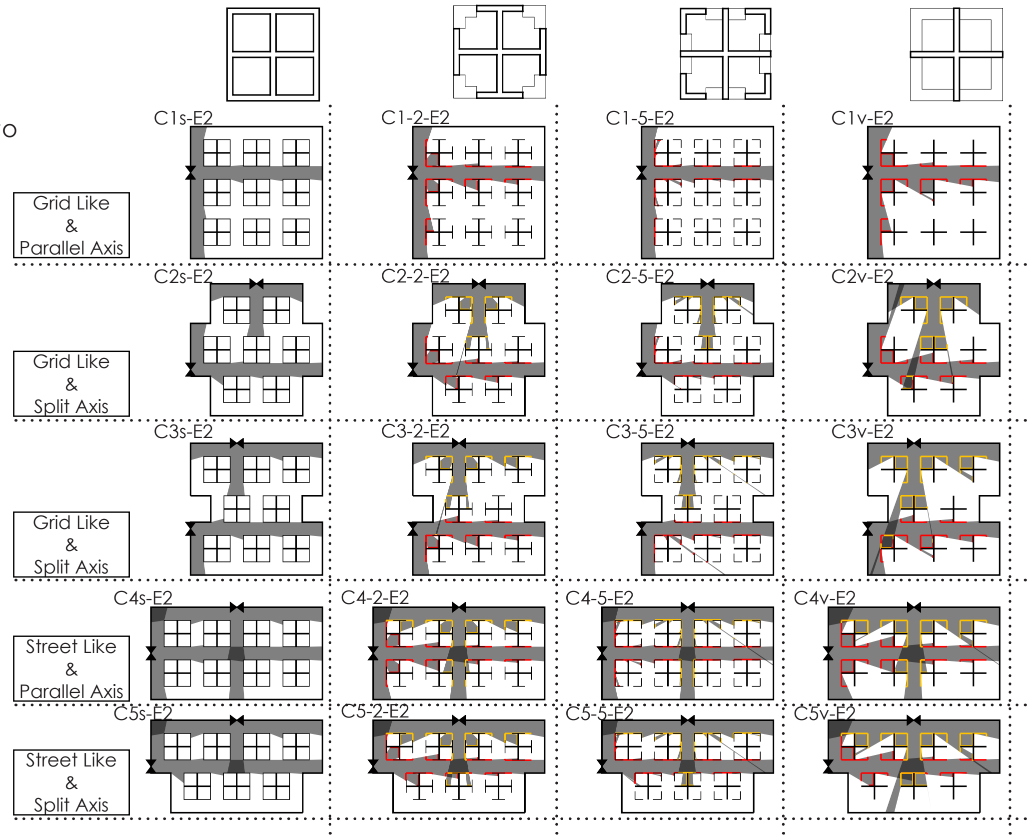


Figure 122. Prototype exploration of the operation that entrances are placed directly facing to the paths.

- **Reflections of Isovist from entrances: ‘entrances face to shops’ options & ‘entrances face to streets’ options – isovist area**

1. ‘Entrances face to streets’ options contribute to larger isovist areas from entrances in street like models.
2. ‘Entrances face to shops’ options contribute to larger isovist areas from entrances in parallel axis models.
3. In grid like parallel axis model, when cooperates with ‘open corners’ and ‘keep corners’ options, ‘entrances face to streets’ options contribute to larger isovist areas from entrances. When there are not eye level enclosures of shops, ‘entrances face to streets’ options and ‘entrances face to shops’ options contribute to the similar isovist areas.
4. In grid like split axis model, when cooperates with ‘keep corners’ options, ‘entrances face to streets’ options tend to contribute to relatively larger isovist areas from entrances. When cooperates with ‘open corners’ options or there are not eye level enclosures, the ‘entrances face to shops’ options contribute to the largest isovist areas.
5. In street like parallel axis model, when cooperates with ‘open corners’ and ‘keep corners’ options, ‘entrances face to streets’ options tend to contribute to larger isovist areas from entrances. When there are not eye level enclosures, the ‘entrances face to shops’ options contribute to the largest isovist areas.
6. In street like split axis model, when cooperates with ‘open corners’ and ‘keep corners’ options, ‘entrances face to streets’ options contribute to larger isovist areas from entrances. When there are not eye level enclosures, the ‘entrances face to shops’ options contribute to the largest isovist area.

- **Reflections of Isovist from entrances: 'entrances face to shops' options & 'entrances face to streets' options – number of visible shops from entrances.**

1. 'Entrances face to streets' options contribute to more visible shops from entrances.
2. More shops can be seen from entrances in street like models.
3. In street like split axis models, 'entrances face to streets' options contribute to the most visible shops from entrances.
4. In street like models 'entrances face to streets' options contribute to more visible shops from entrances.
5. In grid like parallel model, 'entrances face to streets' options could contribute to more visible shops.
6. In grid like split axis model, when cooperates with 'open corners' and 'keep corners' options, 'entrances face to streets' options contribute to more visible shops, when there are not eye level enclosures, the 'entrances face to shops' options contribute to more visible shops.

- **Reflections of Isovist from entrances: 'entrances face to shops' options & 'entrances face to streets' options – visible counter length from entrances.**

1. When cooperates with 'open corners' and 'keep corners' options, 'entrances face to streets' options contribute to more visible counters, when there are no enclosures, the 'entrances face to shops' options and the 'entrances face to streets' options contribute to similar length of visible counters.
2. In grid like split axis model, more counters can be seen from entrances than in grid like parallel models. The length of visible counters from entrances in grid like split axis model is similar with it in street like models (both parallel axis and split models).
3. In parallel axis models, when cooperates with 'open corners' and 'keep corners' options, 'entrances face to streets' options contribute to more visible counters, when there are not eye level enclosures, the 'entrances face to shops' options contribute to more visible counters.
4. In grid like split axis models, when there are not eye level enclosures, the 'entrances face to shops' options contribute to longest visible counters.
5. Both 'entrances face to shops' options and 'entrances face to streets' options could contribute to more visible counters in street like split axis models.
6. In grid like parallel axis models, 'entrances face to shops' options contribute more visible counters than 'entrances face to streets' options when there are not eye level enclosures.

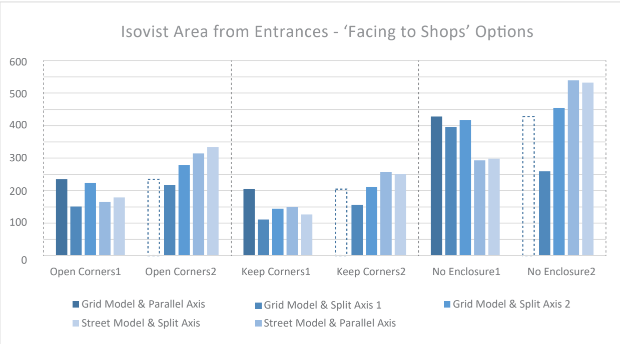


Figure 123. Isovist area from entrances contributed by 'facing to shops' options in all type of models.

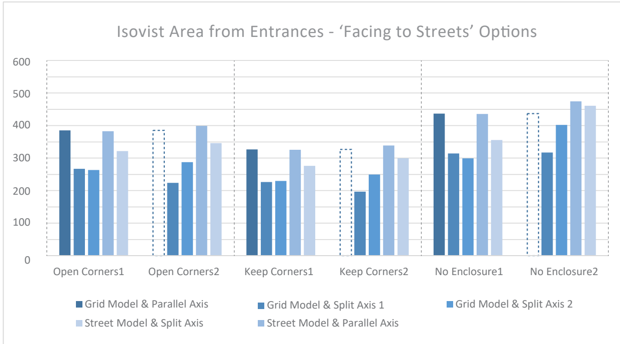


Figure 124. Isovist area from entrances contributed by 'facing to streets' options in all type of models.

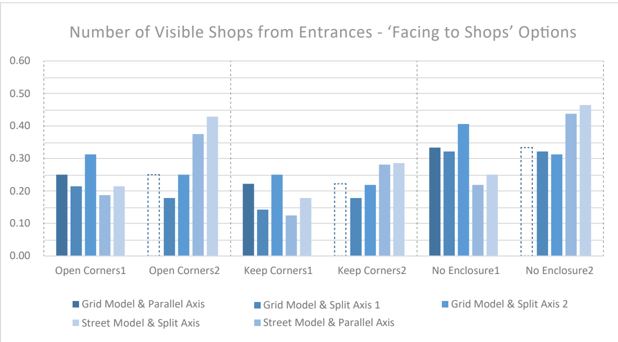


Figure 125. Number of visible shops from entrances contributed by 'facing to shops' options in all type of models.

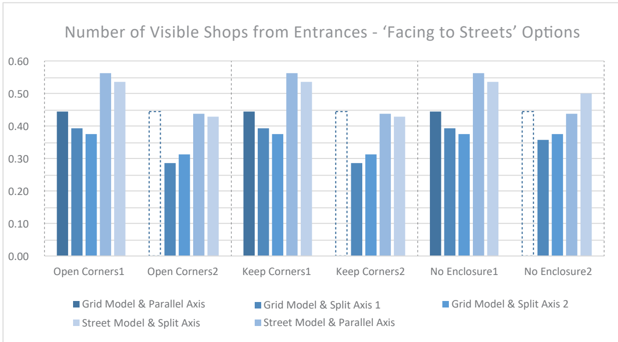


Figure 126. Number of visible shops from entrances contributed by 'facing to streets' options in all type of models.

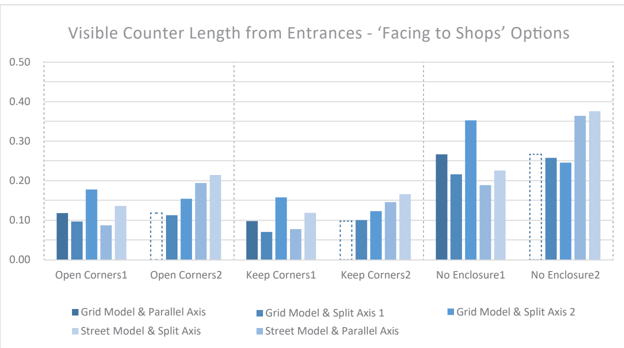


Figure 127. Length of visible counters from entrances contributed by 'facing to shops' options in all type of models.

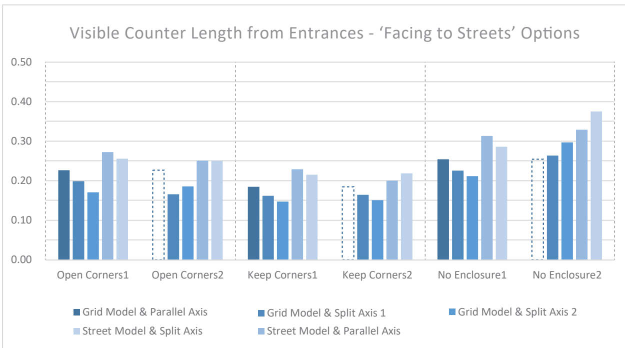


Figure 128. Length of visible counters from entrances contributed by 'facing to streets' options in all type of models.

3.5 Discussion and Conclusion

Type of Models / Design Options	Grid Like Model: Grid Like Parallel Axis Model	Grid Like Model: Grid Like Split Axis Model	Street Like Model: Street Like Parallel Axis Model	Street Like Model: Street Like Split Axis Model
Average Visual Connectivity Value				Average 5.08
Original Options	4.06	5.07	5.34	4.97
Open Corners Options	3.41	2.85	3.37	3.05
Keep Corners Options	2.97	2.39	3.44	2.61
Widen Central Paths Options	7.33	6.81	7.02	6.83
Widen Peripheral Paths Options	4.94	4.38	4.80	4.46
Remove Central Shops Options	7.22	6.67	6.69	6.55
Remove Peripheral Paths Options	6.63	6.13	6.23	6.11
Average Spatial Connectivity Value				Average 3.54
Original Options	2.96	2.10	3.17	2.61
Open Corners Options				
Keep Corners Options				
Widen Central Paths Options	4.17	3.76	4.95	4.54
Widen Peripheral Paths Options	3.72	2.45	3.70	3.03
Remove Central Shops Options	3.78	2.99	4.18	3.83
Remove Peripheral Paths Options	3.83	3.14	4.09	3.73
Average Through Vision Value				Average 3.63
Original Options	3.20	2.16	3.67	2.89
Open Corners Options				
Keep Corners Options				
Widen Central Paths Options	4.11	3.54	4.52	4.27
Widen Peripheral Paths Options	3.94	2.67	4.13	3.33
Remove Central Shops Options	4.24	3.30	4.33	3.77
Remove Peripheral Paths Options	3.78	2.84	4.22	3.69

Table 4. The categories of average value average value of visual connectivity, spatial connectivity, through vision in the two plus two models combining with different design options. The darker color represents the higher value.

Type of Models / Design Options		Grid Like Model: Grid Like Parallel Axis Model	Grid Like Model: Grid Like Split Axis Model	Street Like Model: Street Like Parallel Axis Model	Street Like Model: Street Like Split Axis Model
Isovist Area - Face to Shops Options	Open Corners	234.80	278.30	314.27	334.14
	Keep Corners	204.60	210.88	256.82	251.40
	No Enclosures	427.92	454.85	539.01	532.20
Isovist Area - Face to Streets Options	Open Corners	385.27	287.73	399.00	346.08
	Keep Corners	326.60	249.67	338.61	299.77
	No Enclosures	436.82	402.14	474.63	460.89
					Average 351.93
Visible Shops % - Face to Shops Options	Open Corners	0.25	0.31	0.38	0.43
	Keep Corners	0.22	0.25	0.28	0.29
	No Enclosures	0.33	0.41	0.44	0.46
Visible Shops % - Face to Streets Options	Open Corners	0.44	0.39	0.56	0.54
	Keep Corners	0.44	0.39	0.56	0.54
	No Enclosures	0.44	0.39	0.56	0.54
					Average 0.41
Visible Counters % - Face to Shops Options	Open Corners	0.12	0.18	0.19	0.21
	Keep Corners	0.10	0.16	0.15	0.17
	No Enclosures	0.27	0.35	0.36	0.38
Visible Counters % - Face to Streets Options	Open Corners	0.23	0.20	0.27	0.26
	Keep Corners	0.18	0.16	0.23	0.22
	No Enclosures	0.25	0.30	0.33	0.38
					Average 0.24

Table 5. The categories of the maximum isovist areas from entrances, number of visible shops from entrances and length of visible counters from entrances in the two plus two models combining with different design options. The darker color represents the higher value.

Percent of Visual Connectivity Cores				
Type of Models / Design Options	Grid Like Model		Street Like Model	
	Grid Like Parallel Axis Model	Grid Like Split Axis Model	Street Like Parallel Axis Model	Street Like Split Axis Model
Original Options	0.21	0.10	0.13	0.07
Open Corners Options	0.03	0.01	0.03	0.02
Keep Corners Options	0.01	0.00	0.01	0.00
Widen Central Paths Options	0.57	0.52	0.55	0.52
Widen Peripheral Paths Options	0.09	0.01	0.07	0.00
Remove Central Shops Options	0.53	0.45	0.42	0.41
Remove Peripheral Paths Options	0.40	0.34	0.35	0.32
Percent of Spatial Connectivity Cores				
Type of Models / Design Options	Grid Like Model		Street Like Model	
	Grid Like Parallel Axis Model	Grid Like Split Axis Model	Street Like Parallel Axis Model	Street Like Split Axis Model
Original Options	0.00	0.00	0.00	0.00
Open Corners Options				
Keep Corners Options				
Widen Central Paths Options	0.15	0.05	0.46	0.34
Widen Peripheral Paths Options	0.11	0.00	0.00	0.00
Remove Central Shops Options	0.12	0.09	0.13	0.03
Remove Peripheral Paths Options	0.09	0.00	0.13	0.02
Percent of Through Vision Cores				
Type of Models / Design Options	Grid Like Model		Street Like Model	
	Grid Like Parallel Axis Model	Grid Like Split Axis Model	Street Like Parallel Axis Model	Street Like Split Axis Model
Original Options	0.02	0.00	0.11	0.06
Open Corners Options				
Keep Corners Options				
Widen Central Paths Options	0.18	0.13	0.25	0.24
Widen Peripheral Paths Options	0.07	0.03	0.15	0.08
Remove Central Shops Options	0.10	0.09	0.15	0.11
Remove Peripheral Paths Options	0.03	0.02	0.14	0.09

Table 6. The categories of the percent of visibility cores, accessibility cores, through vision cores in the two plus two models combining with different design options. The darker color represents the higher value.

The tables above list the a) average value of visual connectivity, spatial connectivity, through vision, b) the percent of visibility cores, accessibility cores, through vision cores and c) the maximum isovist areas from entrances, number of visible shops from entrances and length of visible counters from entrances in the two plus two models combining with different design options as discussed above. The darker blue in the table represents higher value. Below-average value is light blue.

I would like to stress again that the high or low value is meaningless unless we discuss it based on the pre-defined goals and see if it could achieve the goals. In this thesis, the goal is to increase and prolong co-presence and co-awareness. In that case, the high value reflects better visual or accessible environment. Hence, design options would not be recommended in specific models if the value, which is colored white, in the table is lower than 90% of average value because I do not think these design options with low value can increase and prolong co-presence and co-awareness.

Moreover, it is also important that the spatial conditions should be considered as a combination. We cannot design one single spatial condition. Seeing Fig.129a to Fig.131b, for example, when we choose the 'Widen Central Paths' Option in grid like parallel axis models, we should be aware that, on the one hand, the spatial conditions generated by this option are a combination of:

1. Highest average visual connectivity value (could reflect the best general visual environment)
2. Largest visibility cores (could reflect the largest areas that support the potential of standing behavior)

3. Relatively high average spatial connectivity value (could reflect good general accessible environment)
4. Relatively large accessibility cores
5. Medium average through vision value
6. Relatively large through vision cores (could reflect large areas that support large number of movement)
7. Separated visibility cores and accessibility cores (see Table.7) etc.

On the other hand, within the combination, the relations between different spatial conditions are flexible. Again taking the ‘Widen Central Paths’ Option in grid like parallel axis models as examples. The medium average through vision value combines with the highest average visual connectivity value but separated visibility cores and accessibility cores. While in street like parallel axis models, the highest average through vision value combines with the relatively high average visual connectivity value and the overlapped visibility cores and accessibility cores. The flexible combinations contribute to various spaces.

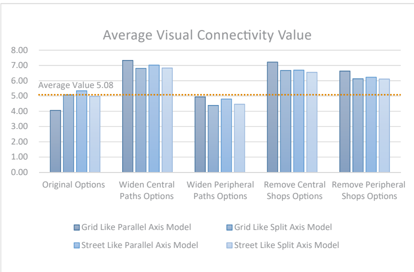


Figure 129a. Average visual connectivity value contributed by different design options.

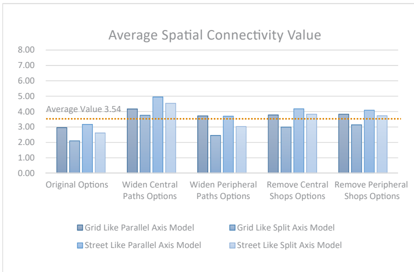


Figure 130b. Average spatial connectivity value contributed by different design options.

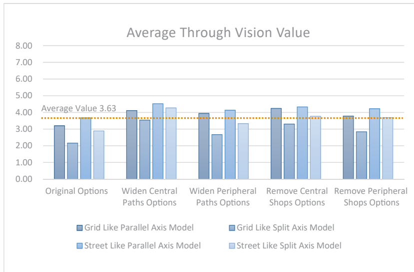


Figure 131a. Average through vision value contributed by different design options.

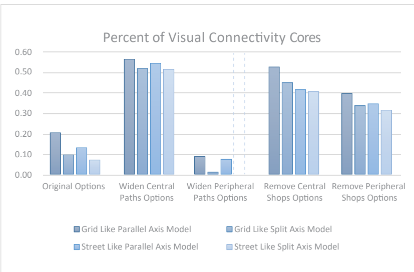


Figure 129b. Percent of visual connectivity cores contributed by different design options.

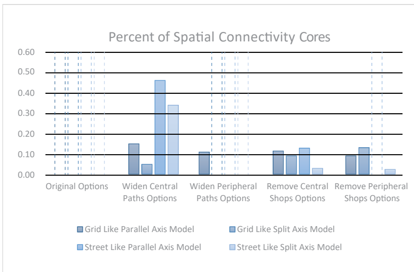


Figure 130b. Percent of spatial connectivity cores contributed by different design options.

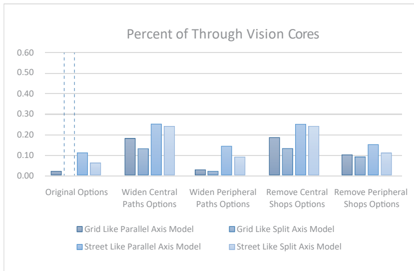


Figure 131b. Percent of through vision cores contributed by different design options.

Figure 132. Isovist area from entrances contributed by different design options.

Figure 133. Percent of visible shops from entrances contributed by different design options.

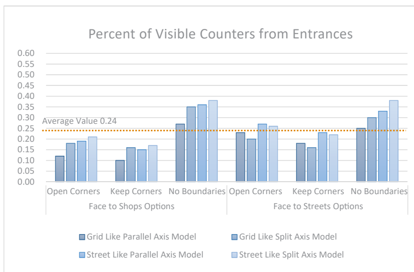


Figure 134. Percent of visible counters from entrances contributed by different design options.

Location of Visual Connectivity Cores				
Type of Models / Design Options	Grid Like Model		Street Like Model	
	Grid Like Parallel Axis Model	Grid Like Split Axis Model	Street Like Parallel Axis Model	Street Like Split Axis Model
Original Options	around central shops	around central shops	in the middle of central passages	in the middle of central passages
Open Corners Options	around central crossroads	around central shops	in the middle of central passages	in the middle of central passages
Keep Corners Options	in the middle of central passages	around central shops	several spots at central passages	several spots at central passages
Widen Central Paths Options	the central passages around central shops	around central shops	along the central passages	along the central passages
Widen Peripheral Paths Options	at the corners of peripheral passages	in the middle of peripheral passages	along the peripheral passages	along the peripheral passages
Remove Central Shops Options	at the central square and surrouding passages	at the central square and surrouding passages	at the central square and nearby passages	at the central square and nearby passages
Remove Peripheral Paths Options	at the peripheral square and around central shops	at the peripheral square and around central shops	at the peripheral square and in the middle of central passages	at the peripheral square and in the middle of central passages
Location of Spatial Connectivity Cores				
Type of Models / Design Options	Grid Like Model		Street Like Model	
	Grid Like Parallel Axis Model	Grid Like Split Axis Model	Street Like Parallel Axis Model	Street Like Split Axis Model
Original Options	at crossroads	along long passages	at crossroads	along long passages
Open Corners Options				
Keep Corners Options				
Widen Central Paths Options	at central crossroads	at central crossroads	in the middle of central passages	in the middle of central passages
Widen Peripheral Paths Options	at the corners of peripheral passages	along the peripheral passages	at the corners of peripheral passages	at the corners of peripheral passages
Remove Central Shops Options	at central crossroads and the central square	at central crossroads and the central square	at the nearby passages and the central square	at central crossroads and the central square
Remove Peripheral Paths Options	at peripheral crossroads and the peripheral square	at the nearby passages and the peripheral square	along the nearby passages and the peripheral square	at peripheral crossroads and the peripheral square
Location of Through Vision Cores				
Type of Models / Design Options	Grid Like Model		Street Like Model	
	Grid Like Parallel Axis Model	Grid Like Split Axis Model	Street Like Parallel Axis Model	Street Like Split Axis Model
Original Options	at central crossroads	in the middle of long passages	along the central passages and other long passages	in the middle of central passages and other long passages
Open Corners Options				
Keep Corners Options				
Widen Central Paths Options	around central shops and central crossroads	at central crossroads	along the central passages	along the central passages
Widen Peripheral Paths Options	along the peripheral passages	in the middle of long peripheral passages	along the peripheral passages	in the middle of long peripheral passages
Remove Central Shops Options	at central crossroads	in the middle of central passages	along the central passages and nearby passages	along the central passages
Remove Peripheral Paths Options	at the nearby crossroads	at the nearby crossroads	along the central passages and nearby passages	along the central passages

Table 7. The categories of location of visibility cores, accessibility cores and through vision cores in the two plus two models combining with different design options.

It is obvious that grid like models have higher visual connectivity value while street like models have higher spatial connectivity value and through vision value. Moreover, the visual connectivity value, spatial connectivity value and through vision value are higher in parallel axis models than in split axis models. Therefore, the grid like parallel axis model could be the first choice as architects want to create both nice visibility and accessibility. The street like parallel axis models could be chosen as architects focus on accessibility most.

The less eye level boundaries, the better visibility. When there are not eye level enclosures of shops, the visual connectivity value and isovist areas from entrances could reach a high level. If the eye level boundaries are necessary, opening the eye level boundaries at corners could contribute to relatively better visibility while keeping the eye level boundaries at corners could contribute to more privacy.

Through different design options, the location of movement cores and visibility cores could be changed. The central shops in grid like models and the central paths in street like models are important because they are both movement cores and visibility cores. In a simple way, the movement cores and visibility cores overlap at the center. However, by replacing different shops with open spaces, the location of visibility cores could be changed. Besides, by widening different paths, the location of movement cores could also be changed. Thus, the location of movement cores and visibility cores could be separated.

Visitors could see more from entrances in street like models. The parallel axis models do not have significant advantages on isovist areas, number of visible shops and length of visible counters from entrances compared with split axis. Hence, changing the location of entrances could become an effective way to improve the spatial conditions in split axis models.

When document the number of visible shops from entrances, an interesting phenomenon occurs that the 'face to streets' options contribute to the same number of visible shops at a high level in all type of models. In other words, the 'face to streets' options could be used when architects want to design two different market halls but similar spaces at entrances in order to create the sense of déjà vu in different architectures.

As conclusion, what is the most important reflections of the prototype exploration? On the one hand, the explorations produce some counter-intuitive results. In a design process, architects design spaces through specific ways, which are presumed to be the appropriate design options in order to reach specific spatial conditions and then shape social activities. However, some findings from the prototype test are unexpected nevertheless true. The reason to point this out is to stress the importance of designing with consciousness. On the other hand, it becomes clear that although some design options could not contribute to good spatial conditions, the cooperation with other design options could improve the spatial conditions. In other words, during the design process, architects always have to make compromise on for instance the limitation of site, the design specification, the law etc., which could lead to discontent design results. But there are still many design options that could improve the design results. For example, the visual and spatial connectivity value are relatively low in split axis models. However, by changing the location of entrances, we could increase the isovist areas, number of visible shops and length of visible counters from entrances, thus improving the spatial conditions. It also provides the idea about how to renovate old market. During the renovation process, architects are limited by the old space and structure but need to create different space under different context. From the exploration, various design options can be used as the combination of old space and structure and then to increase of decrease spatial relations and conditions. Without the prototype exploration, we could never know how different design options could impact on spatial conditions letting alone how to direct users' behavior and social activities.

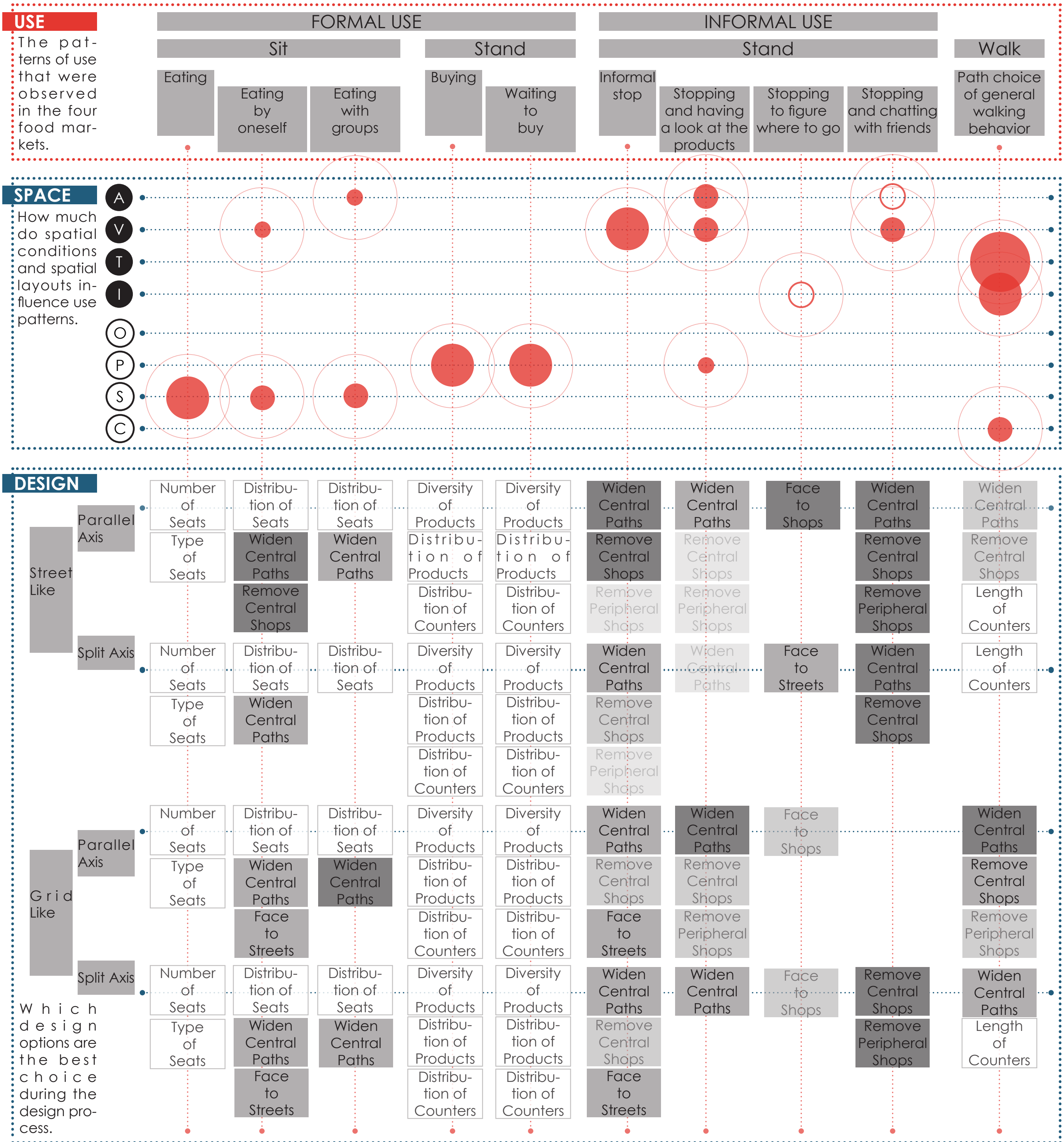
Finally, after this section, the answer of main question could be supplement expanded. The prototype exploration shows how to control specific spatial conditions through specific design options. In other words, it answers the 'design' part, which could not be answered in previous research section, of the main question.

4 DESIGN GUIDELINES

Through case investigations, the relation between use patterns and spatial conditions and the relation between use patterns and spatial layouts are presented. Moreover, the relation between spatial layouts and spatial conditions are performed through prototype explorations. In this section, usability based design guidelines will be introduced. The results for these researches produce the foundation to conclude design guidelines in order to answer the main question: How to increase the potentials for encounters and social interaction in public buildings? And the subdivided questions: How to increase and prolong co-presence and co-awareness? How do patterns of use have a concrete spatial dimension and structure? How to build the bridge between use and design?

As the end project, the design guidelines could contribute to design process about how to basically shape spaces for both architects and citizens. However, the design guidelines should be regarded as the start step to think more about the design process and could be adjusted based on more detailed researches in the future. What is the most important is not only about the design guidelines, but also about design with consciousness.

4.1 Use-Space-Design Relation



Type of Use	Relation with Spatial Form		Design Options		
	Relation with Spatial Layouts	**Relation with Spatial Conditions**			
Increase visiting flows only during lunch time	High density of seats		1. Increase the number of seats;		
			2. Set more sitting areas		
	Low ratio of shops to restaurants.		Increase the number of restaurants		
Increase visiting flows all the day	High ratio of shops to restaurants.		1. Increase the number of shops and cafes;		
			2. Increase the diversity of shops;		
			3. Increase the number of common sitting areas		
Support eating behavior (Formal stop)	Number of seats		1. Increase the number of seats;		
			2. Decrease decrease the density of seats within a sitting area.		
Support eating by oneself behavior	Bar seats	High visibility of bar seats	Provide better view from bar seats	Grid like parallel axis	1. Place bar seats close to center of the market hall or along the main passages;
					2. Place less divided walls or high shelves around bar seats;
					3. When the divided walls are necessary, use glass walls or replace them as glass walls at the corners of sitting areas.
				Grid like split axis	1. Place bar seats close to center of market hall or interior squares;
					2. Place less divided walls or high shelves around bar seats;
					3. When the divided walls are necessary, use glass walls or replace them as glass walls at the corners of sitting areas.
				Street like parallel axis	1. Place bar seats close to center of the market hall or along the main passages;
					2. Place less divided walls or high shelves around bar seats;
					3. When the divided walls are necessary, use glass walls or replace them as glass walls at the corners of sitting areas.
				Street like split axis	1. Place bar seats close to interior squares or along wide passages;
					2. Place less divided walls or high shelves around bar seats;
					3. When the divided walls are necessary, use glass walls or replace them as glass walls at the corners of sitting areas.
Support eating and dating behavior					
Support eating with group behavior	Common sitting area		Create not only siting areas peculiar to specific restaurants but also common sitting areas that service for all shops		
	Seats with tables		Create more seats with tables		
		High accessibility of seats with tables	Create easily accessible seats with tables	Grid like parallel axis	1. Place seats with tables along central passages or close to interior square
					2. Place less envelopes of sitting areas
				Grid like split axis	1. Place seats with tables along wide and long passages or close to interior square
					2. Place less envelopes of sitting areas
				Street like parallel axis	1. Place seats with tables along wide passages and close to crossroads;
					2. Place less envelopes of sitting areas
				Street like split axis	1. Place seats with tables along wide and long passages and close to crossroads
					2. Place less envelopes of sitting areas
Support buying behavior (Formal stopping)	Type of products		1. Set meat shops, seafood shops and cheese shops as the main shops in the markets.		
			2. Set some special food shops for example local food shops, asian food shops etc.		
	Location of products		Place the popular shops separately but close to the center of markets.		

Type of Use	Relation with Spatial Form: Relation with Spatial	Relation with Spatial Form: Relation with Spatial	Design Options		
Organize walking		More through vision cores	Create long and continue passages	Grid like parallel axis	Widen central passages to create a wide ring passage.
				Grid like split axis	Widen central passages to create a wide ring passage.
				Street like parallel axis	Widen central or peripheral passages to create continually long passages
				Street like split axis	Widen central or peripheral passages to create continually long passages
		Increase average through vision value	Create better walking environment	Grid like parallel axis	Place interior square (indoor open space) at the center of markets.
				Grid like split axis	Widen central passages.
				Street like parallel axis	Widen central passages or place interior square (indoor open space) at the center of markets.
				Street like split axis	Widen central passages.
	Better organization of the spaces facing to entrances		Place shops instead of sitting areas at the space directly face to entrances.		
	High density of products along passages		1. Increase the number of active interfaces like counters and advertise boards along passages.		
			2. Set two sides shops along passages.		
Support informal stop		Visibility	Create less high walls and shelves, replace them with glass walls and low show-cases.		
Support stopping to have a look at the products behavior		High visibility and accessibility of counters	Create easily accessible and visible counters	Grid like parallel axis	1. Place counters along central passages or close to interior square
					2. Create longer counters at the crossroads
				Grid like split axis	1. Place counters along wide and long passages or close to interior square
					2. Create longer counters at the crossroads
				Street like parallel axis	1. Place counters along wide passages and close to crossroads
					2. Place less high shelves
				Street like split axis	1. Place counters along wide and long passages and close to crossroads
					2. Place less high shelves
Support figuring out where to go behavior		Isovist from entrances	Better view and more visible shops and counters from entrances	Grid like parallel axis	Place entrances facing to long passages especially passages with two sides shops;
				Grid like split axis	Place entrances facing to shops;
				Street like parallel axis	Place entrances facing to shops;
				Street like split axis	Place entrances facing to shops or long passages especially passages with two sides shops
Support talking with friends behavior		High visibility and relatively low accessibility	Separate visibility cores from movement cores	Grid like parallel axis	1. Place interior square (indoor open space) at the corner of market or end of long passages
					2. Widen peripheral passages (the movement cores would be the middle of passages while the visibility cores would be the corners)
				Grid like split axis	Place interior square (indoor open space) at the corner of market or end of long passages
				Street like parallel axis	1. Place interior square (indoor open space) at the corner of market or end of long passages
					2. Widen peripheral passages (the movement cores would be the middle of passages while the visibility cores would be the corners)
				Street like split axis	Place interior square (indoor open space) at the corner of market or end of long passages
Support waiting to pass behavior		High visibility	Create less visual boundaries	1. Use counters and low show-cases: increases general visibility in markets and provides better view to interior shops' shelves.	
				2. When the divided walls are necessary, use glass walls as divided walls	
				3. When the envelopes of shops are necessary, replace the high shelves or walls at the corner of the shops as low show-cases or glass walls in order to increase general visibility in markets and provide better view to interior shops' shelves.	

4.2 Design Guidelines

And finally, I would like answer the main question of this thesis that how does spatial form support and generate, or hinder and obstruct potentials for encounter and social interaction in public buildings? As mentioned above, by prolong co-presence and co-awareness, the possibilities of encounters and social interactions could be increased. Architects could indirectly influence encounters and social interactions through specific design options. The question of how to organize and prolong co-presence and co-awareness could be transformed as the question of how to organize stopping crowds and movements; and how to prolong both formal and informal stopping behavior. Thus, the abstract questions could be transformed to more operational questions.

The general design principles is to:

- **Increase the visiting population** (increasing co-presence)
- **Increase relations of mutual visibility between people while stopping and moving** (increasing co-awareness)
- **Support eating use** (prolong and increase formal stop)
- **Support standing crowds** (prolong and increase informal stop)
- **Organize moving routes and slow pace** (prolong co-presence)

Design guidelines (HOW to materialize design principles):
Increase the visiting population:

- Density of seats:
  High density of seats could increase the visiting population during lunch time a lot.
- Number of shops and restaurants:
  1. More restaurants could increase the visiting population during lunch time.
  2. More shops and cafe could keep the visiting population all the day.
- Type of products:
  1. Increase the number of popular products like meat, seafood and cheese.
  2. Increase the number of special products like local food, Asian food etc.

Increase relations of mutual visibility between people while stopping and moving:

- Less visual boundaries (see Fig 136a):
  1. Use counters and low show-cases: increases general visibility in markets and provides better view to interior shops' shelves.
  2. When the divided walls are necessary, use glass walls as divided walls.
  3. When the boundary of shops are necessary, replace the high shelves or walls at the corner of the shops as low show-cases or glass walls in order to increase general visibility in markets and provide better view to interior shops' shelves.
  4. Widen passages to increase visual encounters between stopping people and moving people.
- Choice of structure:
  1. Street like model > grid like model
  2. Parallel axis > split axis

Support eating use:

- Number of seats:
  1. Increase number of seats
  2. Decrease the density of seats within a sitting area
- Type of seats: bar seats and seats with tables
  Increasing the number of seats with tables could support more group eating behavior, however, bar seats are also important to support single eating behavior.
- Visibility and accessibility of seats:
  1. Increase visibility of bar seats by placing bar seats close to the geometric center of markets and interior square.
  2. Decrease accessibility of bar seats by setting glass walls as or low show-cases as divided objects for bar seats areas in order to prevent other visitors passing across the sitting areas. (see Fig 136b)
  3. Increase accessibility of seats with tables by place seats close to but not in wide crossroads or along wide passages. Don't set wide passages within sitting areas in order to prevent other visitors passing across the sitting areas. (see Fig 136c)

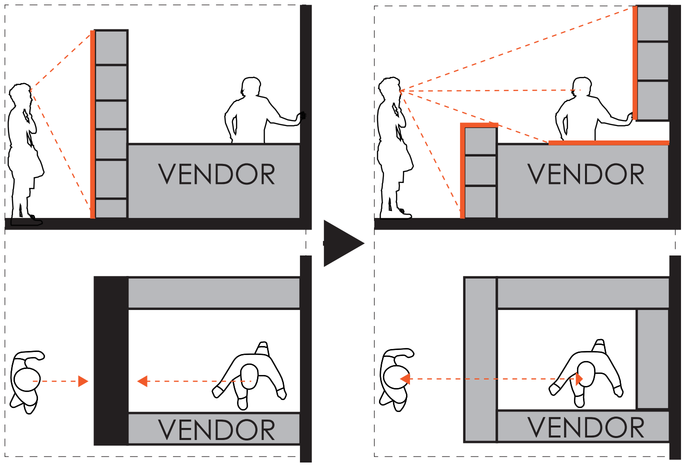


Figure 136a. Examples of less visual boundaries.

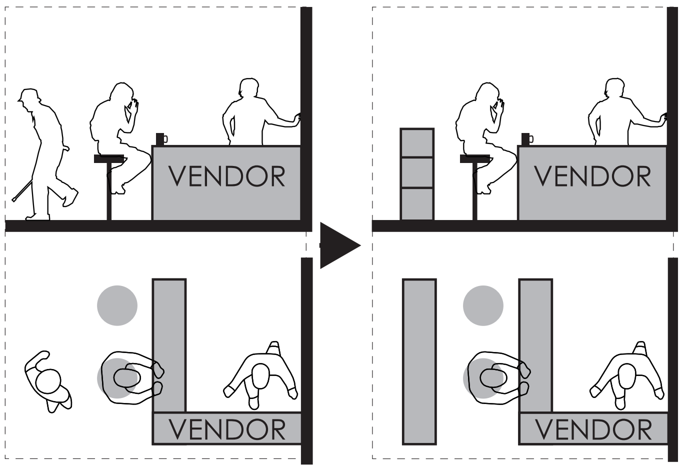


Figure 136b. Examples of decreasing accessibility of bar seats.

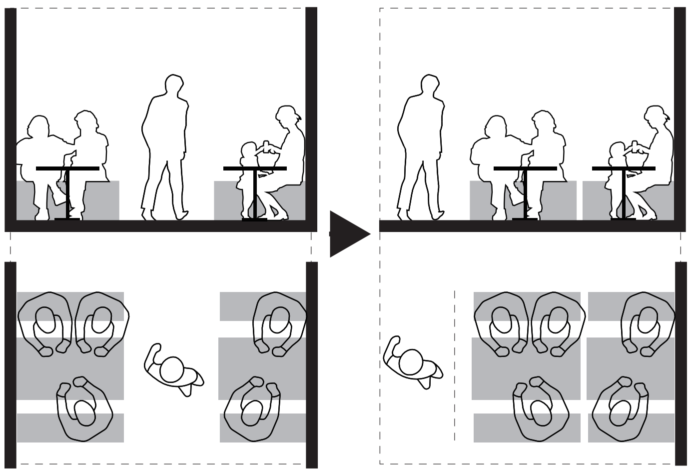


Figure 136c. Examples of increasing accessibility of sitting areas.

Support standing crowds:

- Separate visibility cores from movement cores

  Widen the end of passages or crossroads or corners of markets to create spaces that people can stop for a little while without obstructing passing people. In that case, the passages are not only as corridors for movements but also for people to stop.
- Visibility and accessibility of counters
  1. Place more counters along central passages or other wide and long passages.
  2. Create longer counters at the crossroads. (see Fig 136e)
  3. Place less high shelves.

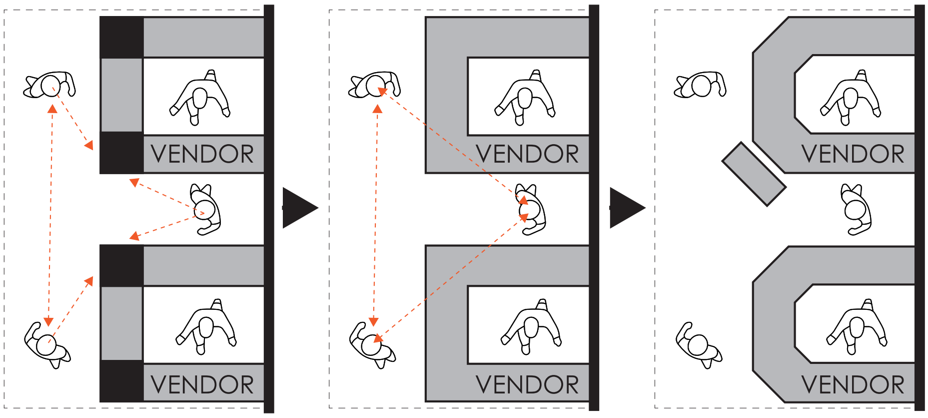


Figure 136e. Examples of increasing length of counters at the crossroads.

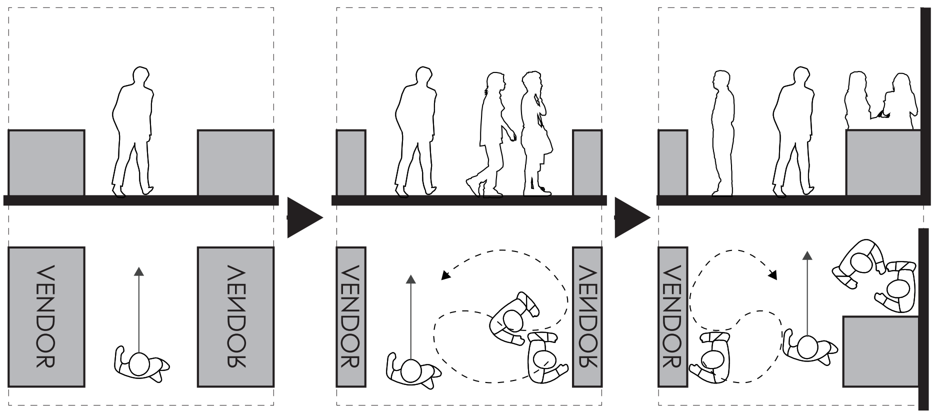


Figure 136f. Examples of the way to provide possibility of moving fast, strolling and stop.

- Organization of entrances:
  1. When the market is street like, placing entrances directly facing to interior passages, especially long and wide passages with two sides shops could provide better view from entrances for visitors; however, placing entrances facing to shops could provide more visible shops and counters from entrances.
  2. When the market is grid like, placing entrances facing to shops could provide better view from entrances for visitors; however, placing entrances directly facing to interior passages, especially long and wide passages with two sides shops could provide more visible shops and counters from entrances.

Organize moving routes and slow pace

- Movement cores:
  1. Choice of structure: Street like model > grid like model; Parallel axis > split axis.
  2. Widen passages especially central passages. In that case, enough spaces are provides for people who want to move fast and people who want to stroll. Strolling people could slow the moving speed if they would not obstruct other movement. (see Fig 136f)
  3. Replace central shops as indoor open space, which could be used as sitting areas, or just resting areas with sofa, or flexible exhibition area for vendors.

- Overlap movement cores and visibility cores:
    Choice of structure: Street like model
- Organization of entrances:
    Place shops instead of sitting areas at the space directly face to entrances.
- Density of shops along paths
  1. Increase the number of active interfaces like counters and advertise boards along passages.
  2. Set two sides shops along passages.

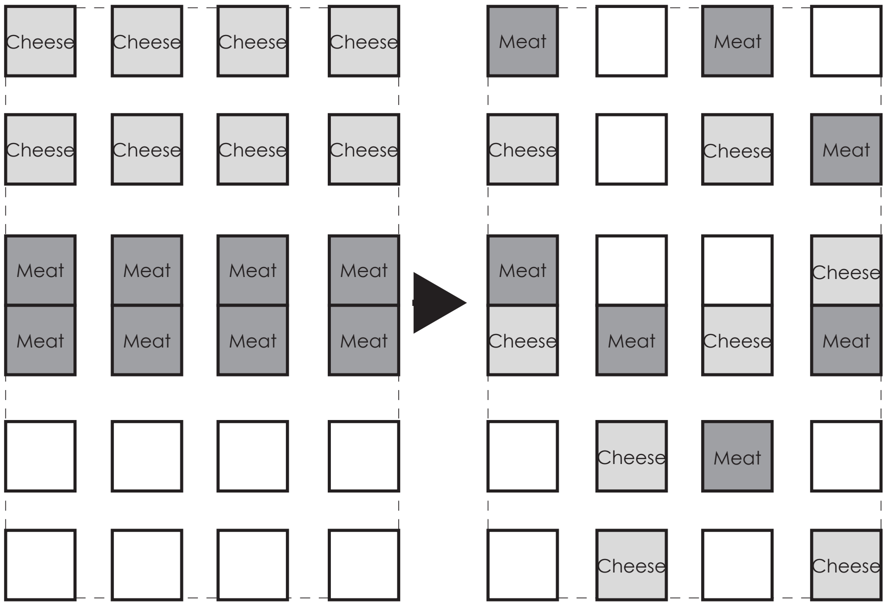


Figure 136g. Examples of how to separate same type of shops.

- Organization of products (see Fig 136g):
    Place the popular shops (or same type of shops) separately but could be close to the center of markets. (This option may have a negative effect on convenience of the market because customers have to walk more in order to compare the same type of products or to reach other popular products from different shops.)

Something important:

- The central space in grid like model:
  1. If placing shops at the central space, choose the most popular shops like meat shops, seafood shops and cheese shops; or special shops.
  2. If placing interior square at the central space, place some flexible and common seats for people not only sit and eat, but also stop to chat with friends.
- Although the visibility of seats is important, it will be better leave space of high visibility for counters but not seats:
  1. Place counters along wide and long passages
  2. Place counters at the center of markets
  3. Place seats close to interior squares
  4. Place seats close to but not in the center of markets

4.2 Concluding Discussion

Finally, I would like to conclude this thesis. First, the whole story of the thesis and the whole research process will be explained again briefly. The relation between patterns of use and spatial forms from behavior analysis as well as the relation between spatial layouts and spatial conditions will be summarized. And then, the summaries of the prototype explorations will be performed. After that, some important results will be highlighted as the answer of what is learned about co-presence and co-awareness in case of markets. At last, I would like to show some unexpected findings from the research as the inspiration of future study.

Due to the industrialization and globalization, the situation that more and more strangers come to cities leads to the social segregation. Social segregation is not only the social problem but also the spatial problem at urban and architecture level. Co-presence and co-awareness could be the key issue. By increasing and prolonging co-presence and co-awareness the opportunities of encounter and social interaction could increase. In that case, I choose the active food markets as research objects. Though the spatial analysis I find the relation between spatial layouts and spatial conditions, and through behavior analysis I find the relation between patterns of use and spatial forms. In order to get deeper understanding about how spatial layouts could generate specific spatial conditions, I produce the prototype exploration part. The selection of the prototype and design options is based on the findings from spatial analysis. The prototype exploration help me to know the choice of design options has an effect on the spatial relations and conditions and in turn on patterns of use, movement, co-presence and co-awareness. As the end project, the usability based design guidelines are produced to answer the main question: how to increase and prolong co-presence and co-awareness and then to improve the social segregation.

After summarizing the whole research process, some key results of the research need to be presented.
First of all, spatial conditions and spatial layouts should be discussed as a combination. On the one hand, when architects choose different design options to achieve specific spatial conditions, it is important to be aware that we cannot design a single condition. Instead, the choice of design options could relate to a combination of visibility, accessibility, isovist area etc. On the other hand, within the combination, the relations between different spatial conditions are flexible. In simper words, for example, general high visibility could combine with general low accessibility with large through vision core etc. In that case, according to different demands of use, there are many possible combinations. Hence, during design process, we need to be aware that low value of one single condition does not mean terrible space or less visitors.

Second, there is an apparent relation between informal use and spatial conditions. However, formal use seems to follow the spatial layouts. Patterns of use tend to follow both spatial conditions and spatial layouts, which in general constitute spatial form, in different ways. Hence, the question of how to support co-presence and co-awareness could be transformed as how to support formal and informal use and then subdivided as how to support standing crowds and movement. That is the reason why in the prototype test, not only the value of connectivity and through vision but also the location of connectivity cores and through vision cores are compared. By analyzing if the visibility cores overlapped with or separated from accessibility cores and movement cores, the location of standing crowds and movement could be predicted.

Third, the explorations produce some counter-intuitive results. In a design process, architects design spaces through specific ways, which are presumed to be the appropriate design options in order to reach specific spatial conditions and then shape social activities. However, some findings from the prototype test are unexpected nevertheless true. The reason to point this out is to stress the importance of designing with consciousness.

Last, it becomes clear that although some design options could not contribute to good spatial conditions, the cooperation with other design options could improve the spatial conditions. In other words, during the design process, architects always have to make compromise on for instance the limitation of site, the design specification, the law etc., which could lead to discontent design results. But there are still many design options that could improve the design results. For example, the visual and spatial connectivity value are relatively low in split axis models. However, by changing the location of entrances, we could increase the isovist areas, number of visible shops and length of visible counters from entrances, thus improving the spatial conditions. Without the prototype exploration, we could never know how different spatial organizations could impact on spatial conditions letting alone how to direct users' behavior and social activities.

Adding to this, during the prototype test, the unexpected potential of old markets renovation is highlighted. Some design options could contribute to significant improvement of spatial conditions compared the original design options in the same models. It provides the idea of how to rebuild the market following the old structure and shape. How to change or improve the spatial conditions within the old structure and shape. It could become the inspiration of future studies.

What makes this thesis different is that I not only investigate physical cases, but based on the findings from the case investigation, I go one step further and produce the prototype exploration part. The prototype exploration helps me be aware of the choice of design options could affect the spatial relations and conditions and in turn affect use patterns. It provides me the idea that design with consciousness. Moreover, through the prototype exploration part, the professional diagrams and conclusions could be translated into more general and readable design knowledge. During the Master Thesis process, I found that many architects showed negative attitude towards Space Syntax because they were not interested in theory and would not spend time to have a look at it. However, we are aware of the power and value of this theory. Hence, we should shoulder the responsibility to introduce it to more people. We can't force all people to learn it but we can share the research results with more people if we could translate the professional research into readable knowledge. This thesis is written for not only professional researcher or architects, but also for vendors, market managers, officials and those who want to design commercial spaces but don't know how to do. Finally, the main question could be answered in a more readable and concrete way.

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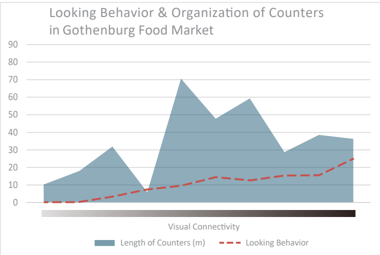
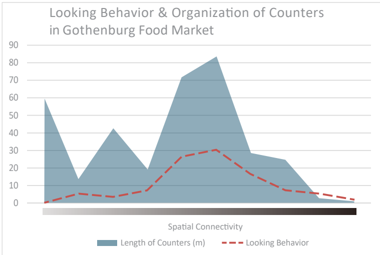
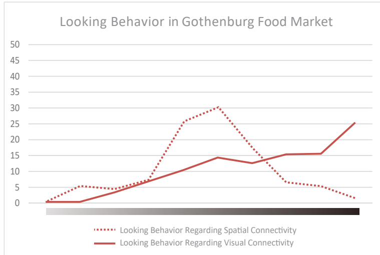
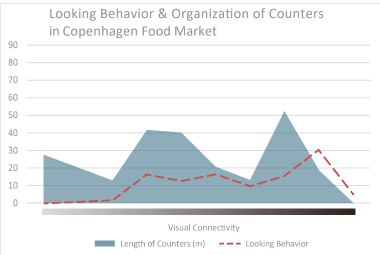
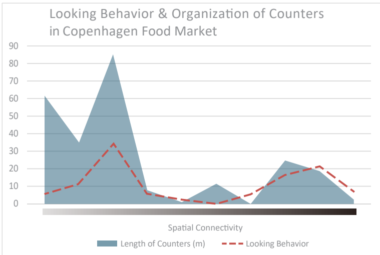
Analysis Image List

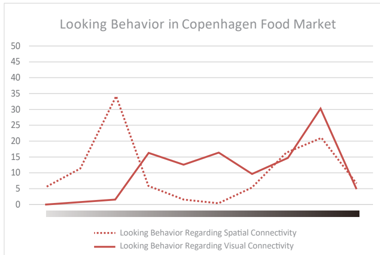


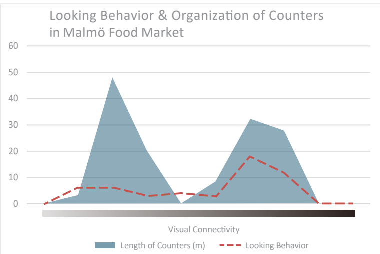


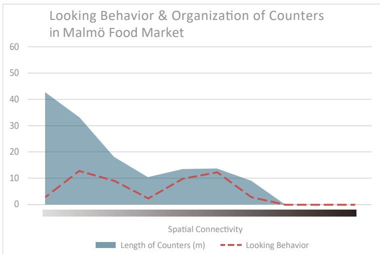


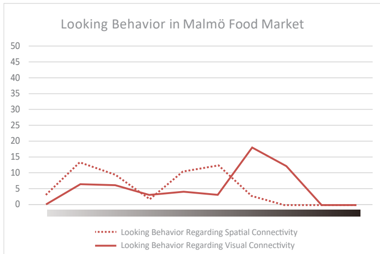


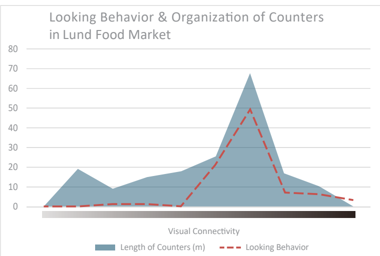


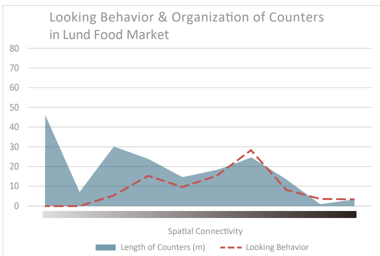


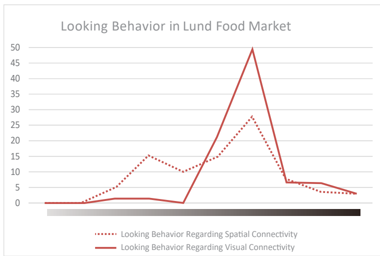


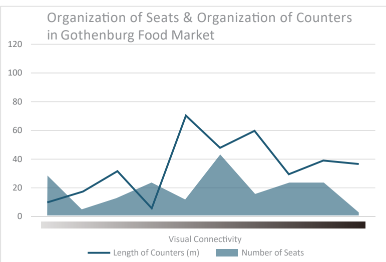


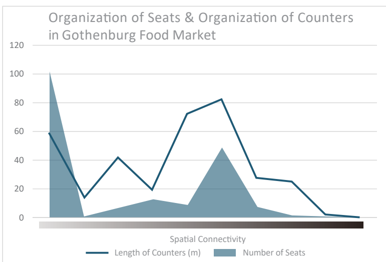


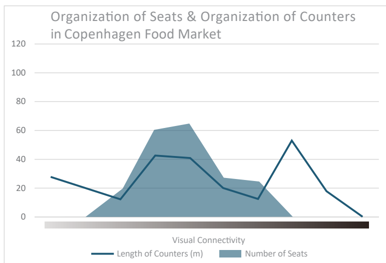


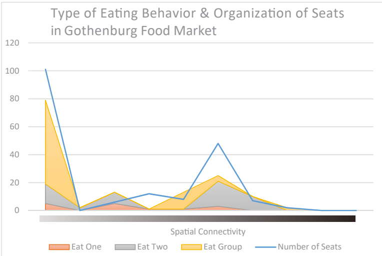








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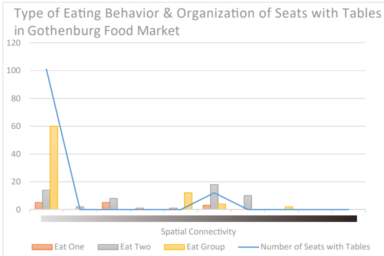
Eat Two
Eat Group
Number of Seats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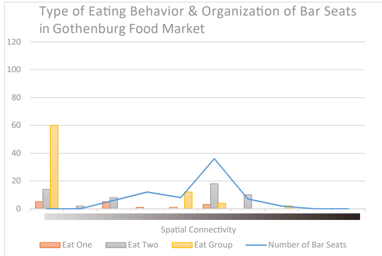
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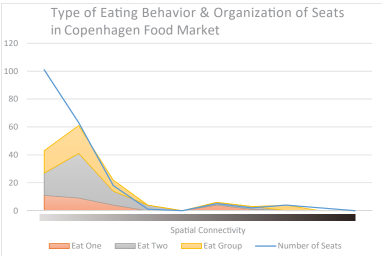
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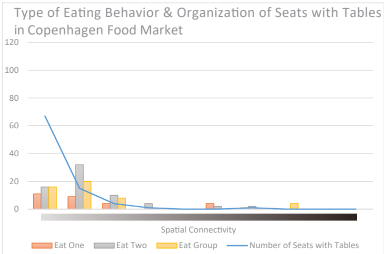
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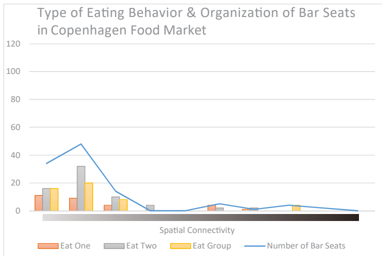
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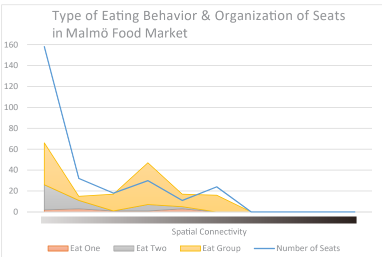
Number of Bar Seats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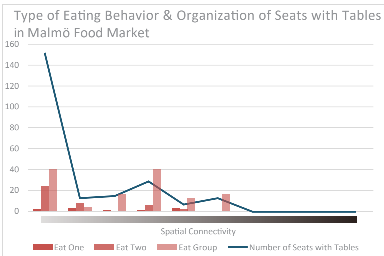
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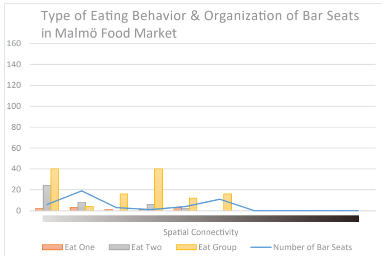
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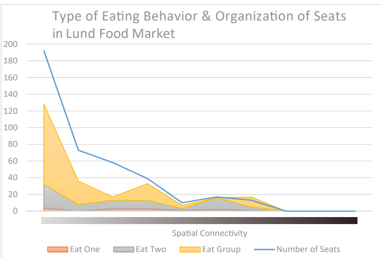
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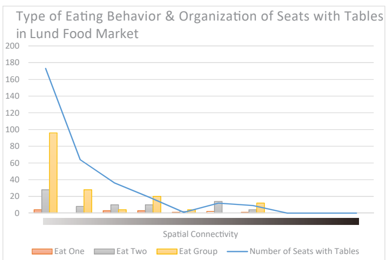
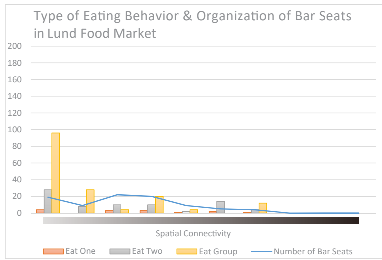
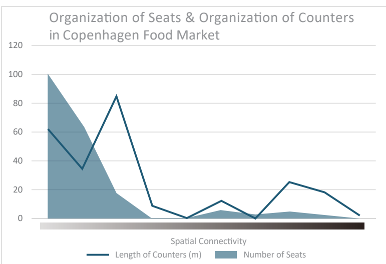
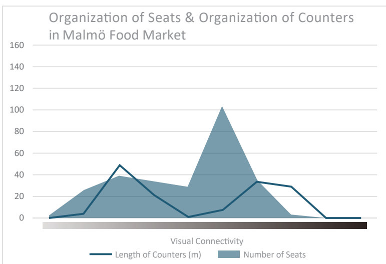
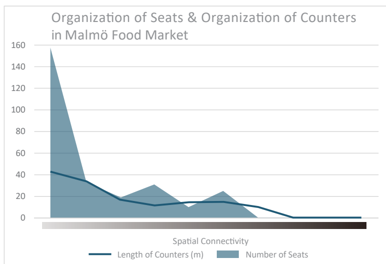
Eat Group
Number of Seats

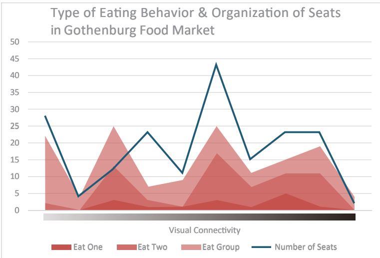

Type of Eating Behavior & Organization of Seats with Tables
in Lund Food Market
Spatial Connectivity
Eat One
Eat Two
Eat Group
Number of Seats with Tables

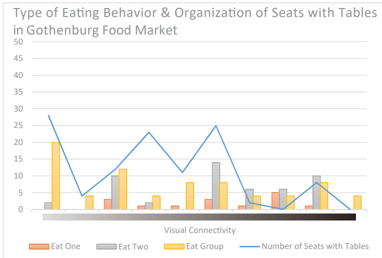

Type of Eating Behavior & Organization of Bar Seats
in Lund Food Market
Spatial Connectivity
Eat One
Eat Two
Eat Group
Number of Bar Seats

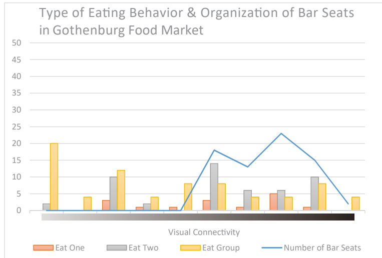

Organization of Seats & Organization of Counters
in Copenhagen Food Market
Spatial Connectivity
Length of Counters (m)
Number of Seats

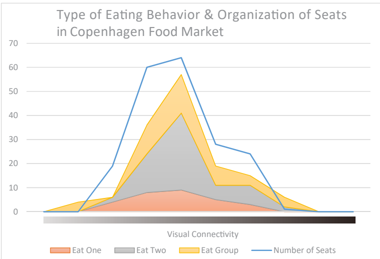

Organization of Seats & Organization of Counters
in Malmö Food Market
Visual Connectivity
Length of Counters (m)
Number of Seats

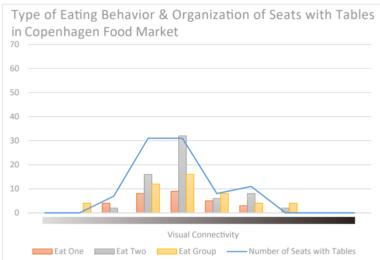

Organization of Seats & Organization of Counters
in Malmö Food Market
Spatial Connectivity
Length of Counters (m)
Number of Seats

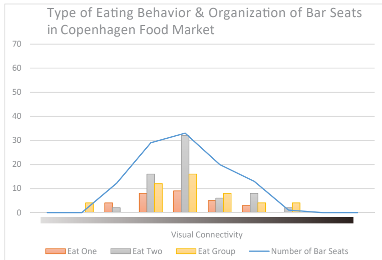

Type of Eating Behavior & Organization of Seats
in Gothenburg Food Market
Visual Connectivity
Eat One
Eat Two
Eat Group
Number of Seats

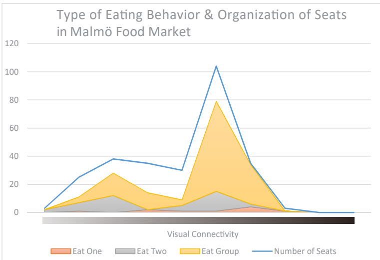

Type of Eating Behavior & Organization of Seats with Tables
in Gothenburg Food Market
Visual Connectivity
Eat One
Eat Two
Eat Group
Number of Seats with Tables

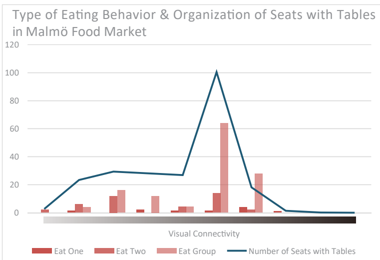

Type of Eating Behavior & Organization of Bar Seats
in Gothenburg Food Market
Visual Connectivity
Eat One
Eat Two
Eat Group
Number of Bar Seats

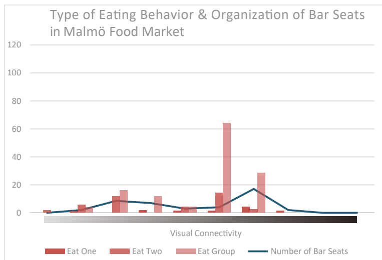

Type of Eating Behavior & Organization of Seats
in Copenhagen Food Market
Visual Connectivity
Eat One
Eat Two
Eat Group
Number of Seats

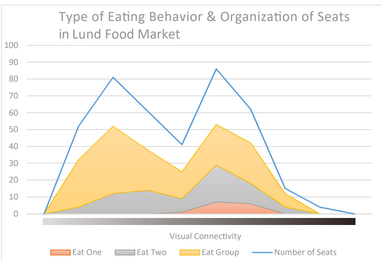

Type of Eating Behavior & Organization of Seats with Tables
in Copenhagen Food Market
Visual Connectivity
Eat One
Eat Two
Eat Group
Number of Seats with Tables

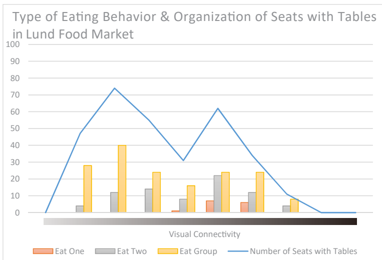

Type of Eating Behavior & Organization of Bar Seats
in Copenhagen Food Market
Visual Connectivity
Eat One
Eat Two
Eat Group
Number of Bar Seats

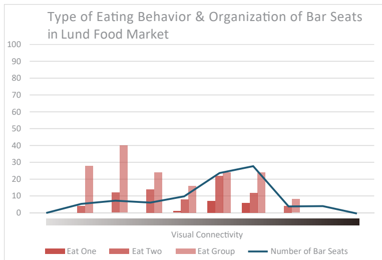

Type of Eating Behavior & Organization of Seats
in Malmö Food Market
Visual Connectivity
Eat One
Eat Two
Eat Group
Number of Seats

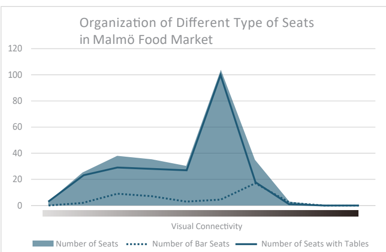

Type of Eating Behavior & Organization of Seats with Tables
in Malmö Food Market
Visual Connectivity
Eat One
Eat Two
Eat Group
Number of Seats with Tables

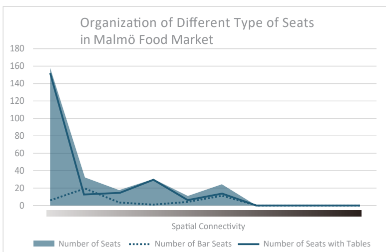

Type of Eating Behavior & Organization of Bar Seats
in Malmö Food Market
Visual Connectivity
Eat One
Eat Two
Eat Group
Number of Bar Seats

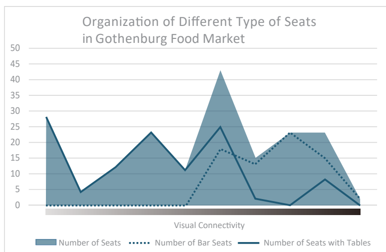

Type of Eating Behavior & Organization of Seats
in Lund Food Market
Visual Connectivity
Eat One
Eat Two
Eat Group
Number of Seats

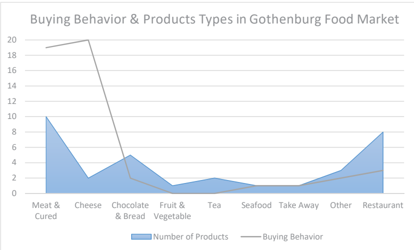

Type of Eating Behavior & Organization of Seats with Tables
in Lund Food Market
Visual Connectivity
Eat One
Eat Two
Eat Group
Number of Seats with Tables

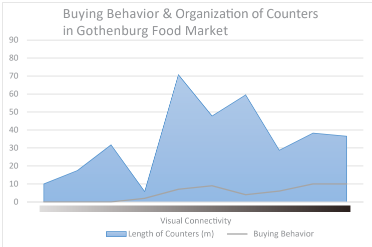

Type of Eating Behavior & Organization of Bar Seats
in Lund Food Market
Visual Connectivity
Eat One
Eat Two
Eat Group
Number of Bar Seats

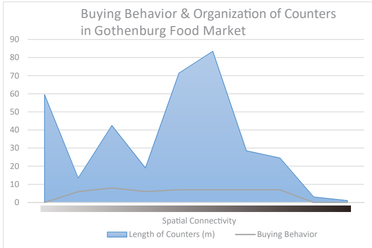

Organization of Different Type of Seats
in Malmö Food Market
Visual Connectivity
Number of Seats
Number of Bar Seats
Number of Seats with Tables

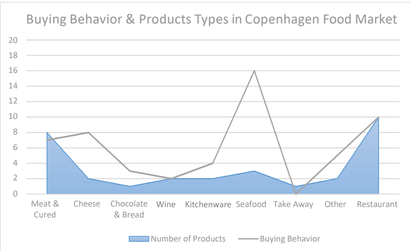

Organization of Different Type of Seats
in Malmö Food Market
Spatial Connectivity
Number of Seats
Number of Bar Seats
Number of Seats with Tables

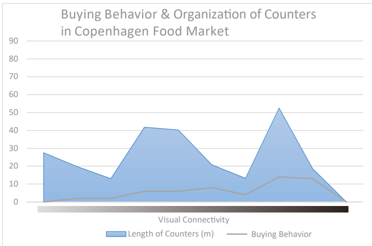

Organization of Different Type of Seats
in Gothenburg Food Market
Visual Connectivity
Number of Seats
Number of Bar Seats
Number of Seats with Tables

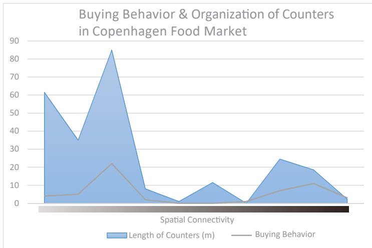

Buying Behavior & Products Types in Gothenburg Food Market
Meat & Cured
Cheese
Chocolate & Bread
Fruit & Vegetable
Tea
Seafood
Take Away
Other
Restaurant
Number of Products
Buying Behavior

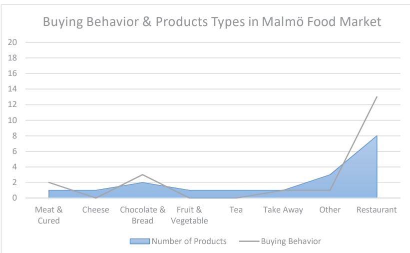

Buying Behavior & Organization of Counters in Gothenburg Food Market
Visual Connectivity
Length of Counters (m)
Buying Behavior

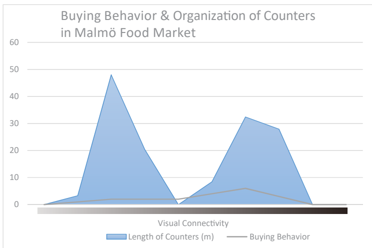

Buying Behavior & Organization of Counters in Gothenburg Food Market
Spatial Connectivity
Length of Counters (m)
Buying Behavior

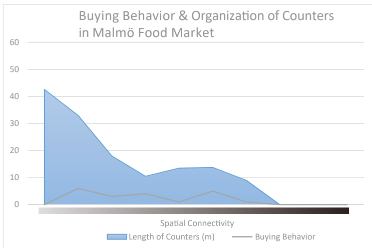

Buying Behavior & Products Types in Copenhagen Food Market
Meat & Cured
Cheese
Chocolate & Bread
Wine
Kitchenware
Seafood
Take Away
Other
Restaurant
Number of Products
Buying Behavior

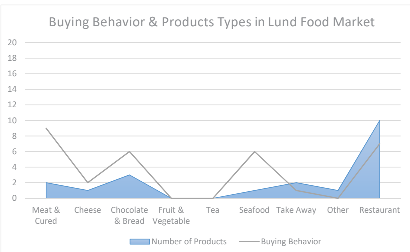

Buying Behavior & Organization of Counters in Copenhagen Food Market
Visual Connectivity
Length of Counters (m)
Buying Behavior

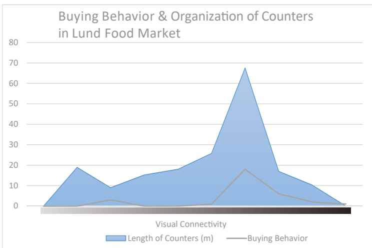

Buying Behavior & Organization of Counters in Copenhagen Food Market
Spatial Connectivity
Length of Counters (m)
Buying Behavior

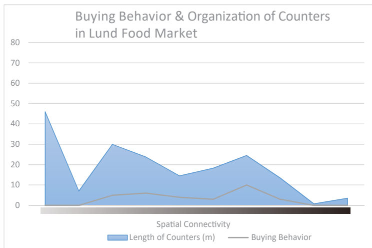

Buying Behavior & Products Types in Malmö Food Market
Meat & Cured
Cheese
Chocolate & Bread
Fruit & Vegetable
Tea
Take Away
Other
Restaurant
Number of Products
Buying Behavior

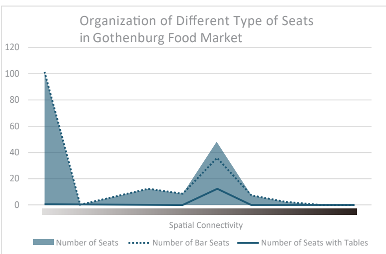

Buying Behavior & Organization of Counters in Malmö Food Market
Visual Connectivity
Length of Counters (m)
Buying Behavior

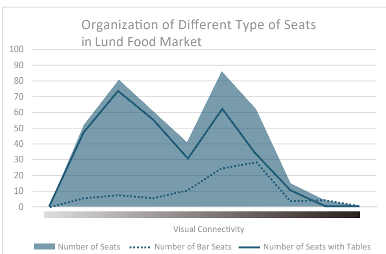

Buying Behavior & Organization of Counters in Malmö Food Market
Spatial Connectivity
Length of Counters (m)
Buying Behavior

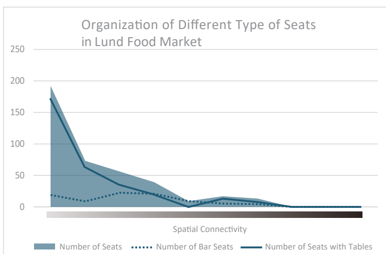

Buying Behavior & Products Types in Lund Food Market
Meat & Cured
Cheese
Chocolate & Bread
Fruit & Vegetable
Tea
Seafood
Take Away
Other
Restaurant
Number of Products
Buying Behavior


Buying Behavior & Organization of Counters in Lund Food Market
Visual Connectivity
Length of Counters (m)
Buying Behavior


Buying Behavior & Organization of Counters in Lund Food Market
Spatial Connectivity
Length of Counters (m)
Buying Behavior


Organization of Different Type of Seats in Gothenburg Food Market
Spatial Connectivity
Number of Seats
Number of Bar Seats
Number of Seats with Tables


Organization of Different Type of Seats in Lund Food Market
Visual Connectivity
Number of Seats
Number of Bar Seats
Number of Seats with Tables


Organization of Different Type of Seats in Lund Food Market
Spatial Connectivity
Number of Seats
Number of Bar Seats
Number of Seats with Tables

Date Collection

	Gothenburg Food Market	Copenhagen Food Market	Malmö Food Market	Lund Food Market
Building Type	Traditional	Contemporary	Traditional + Contemporary	Traditional + Contemporary
Footprint (㎡)	2720.0	4237.0	2215.0	2004.0
Food Market Area (㎡) (Area)	1990.0	1350.0	1320.0	2004.0
Number of Shops (Ns)	31	28	17	18
Number of Retails (Nr)	23	20	11	9
Total Scale of Retails (Sr)	561.4	430.0	289.5	286.0
Average Scale of Retails (Ar)	24.2	21.5	26.3	31.8
Number of Restaurants (Ne)	8	10	8	10
Total Scale of Restaurant (Including Sitting Area) (Se)	328.0	368.6	471.5	736.8
Average Scale of Restaurant (Including Sitting Area) (Ae)	41.0	36.9	58.9	73.7
Number of Seats (Nseat)	184	196	361	403
Number of Customers (Lunch Time) (NcL)	380	370	390	450
Number of Customers (Other Time) (NcO)	230	210	150	180
Number of Paths (Np)	10	9	6	7
Average Width of Main Paths (m) (Wp1)	5.2	3.8	3.0	4.0
Average Width of Minor Paths (m) (Wp2)	2.6	2.3	2.3	2.1
Average Extent of Paths (m) (Lp)	29.8	34.0	27.2	37.0
Number of Entrances (NE)	9	6	5	4

Table 8. The comparative statistics for the size, density and population density in the four market.

	Gothenburg Food Market	Copenhagen Food Market	Malmö Food Market	Lund Food Market
Ns/Area	0.016	0.021	0.013	0.009
(Sr+Se)/Area	0.447	0.592	0.577	0.510
Sr/Area	0.282	0.319	0.219	0.143
Se/Area	0.165	0.273	0.357	0.368
Nseat/Area	0.092	0.145	0.273	0.201
Nseat/Se	0.561	0.532	0.766	0.547
Ar/Ae	0.590	0.583	0.447	0.431
Ar/Area	0.012	0.016	0.020	0.016
Ae/Area	0.021	0.027	0.045	0.037
Wp1/Area	0.003	0.003	0.002	0.002
Wp2/Area	0.001	0.002	0.002	0.001
Lp/Area	0.015	0.025	0.021	0.018
NE/Area	0.005	0.004	0.004	0.002
NcO/Area	0.116	0.156	0.114	0.090
NcL/Area	0.191	0.274	0.295	0.225
NcL/Nseat	2.065	1.888	1.080	1.117
NcL/NcO	1.652	1.762	2.600	2.500

Table 9. The data calculation for the description of the relation between the population density and density of the markets.

Explanation:

- Ns/Area: Density of shops
- (Sr+Se)/Area: Proportion of shops
- Sr/Area: Proportion of retails
- Se/Area: Proportion of restaurants
- Ar/Area: Density of retails
- Ae/Area: Density of restaurants
- Wp1/Area: Average main path width ratio
- Wp2/Area: Average minor path width ratio
- Lp/Area: Average path extend radio
- Nseat/Area: Density of seats
- Nseat/Se: Density of seats regard to restaurant
- Ar/Ae: Proportional relation of retails and restaurants
- NE/Area: Density of entrances
- NcO/Area: Density of population at other time
- NcL/Area: Density of population at lunch time
- NcL/Nseat: Saturation of seats at lunch time
- Ncl/NcO: Floating rate of population

Two Boundaries	(Blue - Red) Number of Nodes										All
Open Corners	5869	2698	4033	3454	3249	1797	436	0	0	0	21536
Keep Corners	6931	3371	4899	3198	2264	802	71	0	0	0	21536
Open Corners - Grid	3640	1681	2783	2072	1798	1037	221	0	0	0	13232
%	0.28	0.13	0.21	0.16	0.14	0.08	0.02	0.00	0.00	0.00	1.00
Open Corners - Street	2229	1017	1250	1382	1451	760	215	0	0	0	8304
%	0.27	0.12	0.15	0.17	0.17	0.09	0.03	0.00	0.00	0.00	1.00
Keep Corners - Grid	4325	2130	3505	1582	1217	439	34	0	0	0	13232
%	0.33	0.16	0.26	0.12	0.09	0.03	0.00	0.00	0.00	0.00	1.00
Keep Corners - Street	2606	1241	1394	1616	1047	363	37	0	0	0	8304
%	0.31	0.15	0.17	0.19	0.13	0.04	0.00	0.00	0.00	0.00	1.00
Open Corners - Grid - Parallel	1127	472	952	642	897	577	133	0	0	0	4800
%	0.23	0.10	0.20	0.13	0.19	0.12	0.03	0.00	0.00	0.00	1.00
Value	0.23	0.20	0.60	0.54	0.93	0.72	0.19	0.00	0.00	0.00	3.41
Open Corners - Grid - Split	2513	1209	1831	1430	901	460	88	0	0	0	8432
%	0.30	0.14	0.22	0.17	0.11	0.05	0.01	0.00	0.00	0.00	1.00
Value	0.30	0.29	0.65	0.68	0.53	0.33	0.07	0.00	0.00	0.00	2.85
Open Corners - Street - Parallel	1063	561	642	550	897	507	148	0	0	0	4368
%	0.24	0.13	0.15	0.13	0.21	0.12	0.03	0.00	0.00	0.00	1.00
Value	0.24	0.26	0.44	0.50	1.03	0.70	0.20	0.00	0.00	0.00	3.37
Open Corners - Street - Split	1166	456	608	832	554	253	67	0	0	0	3936
%	0.30	0.12	0.15	0.21	0.14	0.06	0.02	0.00	0.00	0.00	1.00
Value	0.30	0.23	0.46	0.85	0.70	0.39	0.12	0.00	0.00	0.00	3.05
Open Cormers - Parallel	2190	1033	1594	1192	1794	1084	281	0	0	0	9168
%	0.24	0.11	0.17	0.13	0.20	0.12	0.03	0.00	0.00	0.00	1.00
Open Corners - Split	3679	1665	2439	2262	1455	713	155	0	0	0	12368
%	0.30	0.13	0.20	0.18	0.12	0.06	0.01	0.00	0.00	0.00	1.00
Keep Corners - Grid - Parallel	1327	577	1237	538	834	253	34	0	0	0	4800
%	0.28	0.12	0.26	0.11	0.17	0.05	0.01	0.00	0.00	0.00	1.00
Value	0.28	0.24	0.77	0.45	0.87	0.32	0.05	0.00	0.00	0.00	2.97
Keep Corners - Grid - Split	2998	1553	2268	1044	383	186	0	0	0	0	8432
%	0.36	0.18	0.27	0.12	0.05	0.02	0.00	0.00	0.00	0.00	1.00
Value	0.36	0.37	0.81	0.50	0.23	0.13	0.00	0.00	0.00	0.00	2.39
Keep Corners - Street - Parallel	1224	676	713	650	833	239	33	0	0	0	4368
%	0.28	0.15	0.16	0.15	0.19	0.05	0.01	0.00	0.00	0.00	1.00
Value	0.56	0.31	0.49	0.74	0.95	0.33	0.05	0.00	0.00	0.00	3.44
Keep Corners - Street - Split	1382	565	681	966	214	124	4	0	0	0	3936
%	0.35	0.14	0.17	0.25	0.05	0.03	0.00	0.00	0.00	0.00	1.00
Value	0.35	0.29	0.52	0.98	0.27	0.19	0.01	0.00	0.00	0.00	2.61
Keep Corners - Parallel	2551	1253	1950	1188	1667	492	67	0	0	0	9168
%	0.28	0.14	0.21	0.13	0.18	0.05	0.01	0.00	0.00	0.00	1.00
Keep Corners - Split	4380	2118	2949	2010	597	310	4	0	0	0	12368
%	0.35	0.17	0.24	0.16	0.05	0.03	0.00	0.00	0.00	0.00	1.00
General	(Blue - Red) Number of Nodes										All
Grid Model - Parallel Axis V	64	93	91	124	168	480	250	274	56	0	1600
%	0.04	0.06	0.06	0.08	0.11	0.30	0.16	0.17	0.04	0.00	1.00
Value	0.04	0.12	0.17	0.31	0.53	1.80	1.09	1.37	0.32	0.00	4.06
Grid Model - Parallel Axis A	0	499	212	170	143	0	0	0	0	0	1024
%	0.00	0.49	0.21	0.17	0.14	0.00	0.00	0.00	0.00	0.00	1.00
Value	0.00	0.97	0.62	0.66	0.70	0.00	0.00	0.00	0.00	0.00	2.96
Grid Model - Split Axis V	130	184	309	445	540	417	497	267	27	0	2816
%	0.05	0.07	0.11	0.16	0.19	0.15	0.18	0.09	0.01	0.00	1.00
Value	0.05	0.13	0.33	0.63	0.96	0.89	1.24	0.76	0.09	0.00	5.07

Grid Model - Split Axis A	641	385	830	0	0	0	0	0	0	0	1856
%	0.35	0.21	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Value	0.35	0.41	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.10
Street Model - Parallel Axis V	82	94	78	203	186	377	254	154	28	0	1456
%	0.06	0.06	0.05	0.14	0.13	0.26	0.17	0.11	0.02	0.00	1.00
Value	0.06	0.13	0.16	0.56	0.64	1.55	1.22	0.85	0.17	0.00	5.34
Street Model - Parallel Axis A	56	228	317	190	153	0	0	0	0	0	944
%	0.06	0.24	0.34	0.20	0.16	0.00	0.00	0.00	0.00	0.00	1.00
Value	0.06	0.48	1.01	0.81	0.81	0.00	0.00	0.00	0.00	0.00	3.17
Street Model - Split Axis V	68	102	122	180	252	302	194	92	0	0	1312
%	0.05	0.08	0.09	0.14	0.19	0.23	0.15	0.07	0.00	0.00	1.00
Value	0.05	0.16	0.28	0.55	0.96	1.38	1.04	0.56	0.00	0.00	4.97
Street Model - Split Axis A	252	108	233	271	0	0	0	0	0	0	864
%	0.29	0.13	0.27	0.31	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Value	0.29	0.25	0.81	1.25	0.00	0.00	0.00	0.00	0.00	0.00	2.61
Passage	(Blue - Red) Number of Nodes										All
Widen Center Grid Parallel Axis V	127	80	71	45	98	120	144	84	147	684	1600
%	0.08	0.05	0.04	0.03	0.06	0.08	0.09	0.05	0.09	0.43	1.00
Value	0.08	0.10	0.13	0.11	0.31	0.45	0.63	0.42	0.83	4.28	7.33
Widen Center Grid Parallel Axis A	174	28	5	412	202	45	158	0	0	0	1024
%	0.17	0.03	0.00	0.40	0.20	0.04	0.15	0.00	0.00	0.00	1.00
Value	0.17	0.05	0.00	1.61	0.99	0.26	1.08	0.00	0.00	0.00	4.17
Widen Center Grid Split Axis V	277	137	160	120	217	266	167	279	347	846	2816
%	0.10	0.05	0.06	0.04	0.08	0.09	0.06	0.10	0.12	0.30	1.00
Value	0.10	0.10	0.17	0.17	0.39	0.57	0.42	0.79	1.11	3.00	6.81
Widen Center Grid Split Axis A	344	87	249	556	317	215	88	0	0	0	1856
%	0.19	0.05	0.13	0.30	0.17	0.12	0.05	0.00	0.00	0.00	1.00
Value	0.19	0.09	0.40	1.20	0.85	0.70	0.33	0.00	0.00	0.00	3.76
Widen Center Street Parallel Axis V	136	71	80	73	118	94	87	114	95	588	1456
%	0.09	0.05	0.05	0.05	0.08	0.06	0.06	0.08	0.07	0.40	1.00
Value	0.09	0.10	0.16	0.20	0.41	0.39	0.42	0.63	0.59	4.04	7.02
Widen Center Street Parallel Axis A	153	139	52	81	72	10	234	127	76	0	944
%	0.16	0.15	0.06	0.09	0.08	0.01	0.25	0.13	0.08	0.00	1.00
Value	0.16	0.29	0.17	0.34	0.38	0.06	1.74	1.08	0.72	0.00	4.95
Widen Center Street Split Axis V	131	72	77	61	98	86	106	114	120	447	1312
%	0.10	0.05	0.06	0.05	0.07	0.07	0.08	0.09	0.09	0.34	1.00
Value	0.10	0.11	0.18	0.19	0.37	0.39	0.57	0.70	0.82	3.41	6.83
Widen Center Street Split Axis A	191	59	107	66	28	115	189	109	0	0	864
%	0.22	0.07	0.12	0.08	0.03	0.13	0.22	0.13	0.00	0.00	1.00
Value	0.22	0.14	0.37	0.31	0.16	0.80	1.53	1.01	0.00	0.00	4.54
Removing Center Grid Parallel Axis V	67	90	80	62	90	186	181	163	128	553	1600
%	0.04	0.06	0.05	0.04	0.06	0.12	0.11	0.10	0.08	0.35	1.00
Value	0.04	0.11	0.15	0.16	0.28	0.70	0.79	0.82	0.72	3.46	7.22
Removing Center Grid Parallel Axis A	0	322	161	165	166	148	126	0	0	0	1088
%	0.00	0.30	0.15	0.15	0.15	0.14	0.12	0.00	0.00	0.00	1.00
Value	0.00	0.59	0.44	0.61	0.76	0.68	0.69	0.00	0.00	0.00	3.78
Removing Center Grid Split Axis V	132	169	186	277	264	250	262	276	213	787	2816
%	0.05	0.06	0.07	0.10	0.09	0.09	0.09	0.10	0.08	0.28	1.00
Value	0.05	0.12	0.20	0.39	0.47	0.53	0.65	0.78	0.68	2.79	6.67
Removing Center Grid Split Axis A	376	330	360	222	227	299	170	0	0	0	1984
%	0.19	0.17	0.18	0.11	0.11	0.15	0.09	0.00	0.00	0.00	1.00
Value	0.19	0.33	0.54	0.45	0.57	0.90	0.60	0.00	0.00	0.00	2.99
Removing Center Street Parallel Axis V	85	71	63	123	113	187	199	155	92	368	1456

%	0.06	0.05	0.04	0.08	0.08	0.13	0.14	0.11	0.06	0.25	1.00
Value	0.06	0.10	0.13	0.34	0.39	0.77	0.96	0.85	0.57	2.53	6.69
Removing Center Street Parallel Axis A	65	130	190	169	215	103	136	0	0	0	1008
%	0.06	0.13	0.19	0.17	0.21	0.10	0.13	0.00	0.00	0.00	1.00
Value	0.06	0.26	0.57	0.67	1.07	0.61	0.94	0.00	0.00	0.00	4.18
Removing Center Street Split Axis V	71	73	82	116	107	144	186	126	118	289	1312
%	0.05	0.06	0.06	0.09	0.08	0.11	0.14	0.10	0.09	0.22	1.00
Value	0.05	0.11	0.19	0.35	0.41	0.66	0.99	0.77	0.81	2.20	6.55
Removing Center Street Split Axis A	161	30	190	219	112	188	28	0	0	0	928
%	0.17	0.03	0.20	0.24	0.12	0.20	0.03	0.00	0.00	0.00	1.00
Value	0.17	0.06	0.61	0.94	0.60	1.22	0.21	0.00	0.00	0.00	3.83
Widen Periphery Grid Parallel Axis V	24	212	117	306	228	418	149	124	22	0	1600
%	0.02	0.13	0.07	0.19	0.14	0.26	0.09	0.08	0.01	0.00	1.00
Value	0.02	0.27	0.22	0.77	0.71	1.57	0.65	0.62	0.12	0.00	4.94
Widen Periphery Grid Parallel Axis A	180	24	204	379	78	46	113	0	0	0	1024
%	0.18	0.02	0.20	0.37	0.08	0.04	0.11	0.00	0.00	0.00	1.00
Value	0.18	0.05	0.60	1.48	0.38	0.27	0.77	0.00	0.00	0.00	3.72
Widen Periphery Grid Split Axis V	46	286	425	520	993	445	86	15	0	0	2816
%	0.02	0.10	0.15	0.18	0.35	0.16	0.03	0.01	0.00	0.00	1.00
Value	0.02	0.20	0.45	0.74	1.76	0.95	0.21	0.04	0.00	0.00	4.38
Widen Periphery Grid Split Axis A	442	574	410	428	2	0	0	0	0	0	1856
%	0.24	0.31	0.22	0.23	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Value	0.24	0.62	0.66	0.92	0.01	0.00	0.00	0.00	0.00	0.00	2.45
Widen Periphery Street Parallel Axis V	47	170	174	214	311	212	224	104	0	0	1456
%	0.03	0.12	0.12	0.15	0.21	0.15	0.15	0.07	0.00	0.00	1.00
Value	0.03	0.23	0.36	0.59	1.07	0.87	1.08	0.57	0.00	0.00	4.80
Widen Periphery Street Parallel Axis A	131	34	196	368	55	160	0	0	0	0	944
%	0.14	0.04	0.21	0.39	0.06	0.17	0.00	0.00	0.00	0.00	1.00
Value	0.14	0.07	0.62	1.56	0.29	1.02	0.00	0.00	0.00	0.00	3.70
Widen Periphery Street Split Axis V	30	159	173	288	284	233	142	3	0	0	1312
%	0.02	0.12	0.13	0.22	0.22	0.18	0.11	0.00	0.00	0.00	1.00
Value	0.02	0.24	0.40	0.88	1.08	1.07	0.76	0.02	0.00	0.00	4.46
Widen Periphery Street Split Axis A	108	209	192	277	57	21	0	0	0	0	864
%	0.13	0.24	0.22	0.32	0.07	0.02	0.00	0.00	0.00	0.00	1.00
Value	0.13	0.48	0.67	1.28	0.33	0.15	0.00	0.00	0.00	0.00	3.03
Removing Periphery Grid Parallel Axis V	53	68	76	95	132	313	219	253	188	203	1600
%	0.03	0.04	0.05	0.06	0.08	0.20	0.14	0.16	0.12	0.13	1.00
Value	0.03	0.09	0.14	0.24	0.41	1.17	0.96	1.27	1.06	1.27	6.63
Removing Periphery Grid Parallel Axis A	0	328	217	141	217	88	97	0	0	0	1088
%	0.00	0.30	0.20	0.13	0.20	0.08	0.09	0.00	0.00	0.00	1.00
Value	0.00	0.60	0.60	0.52	1.00	0.49	0.62	0.00	0.00	0.00	3.83
Removing Periphery Grid Split Axis V	108	130	231	302	368	331	394	350	407	195	2816
%	0.04	0.05	0.08	0.11	0.13	0.12	0.14	0.12	0.14	0.07	1.00
Value	0.04	0.09	0.25	0.43	0.65	0.71	0.98	0.99	1.30	0.69	6.13
Removing Periphery Grid Split Axis A	455	216	628	136	370	179	0	0	0	0	1984
%	0.23	0.11	0.32	0.07	0.19	0.09	0.00	0.00	0.00	0.00	1.00
Value	0.23	0.22	0.95	0.27	0.93	0.54	0.00	0.00	0.00	0.00	3.14
Removing Periphery Street Parallel Axis V	70	64	147	56	139	277	192	201	208	102	1456
%	0.05	0.04	0.10	0.04	0.10	0.19	0.13	0.14	0.14	0.07	1.00
Value	0.05	0.09	0.30	0.15	0.48	1.14	0.92	1.10	1.29	0.70	6.23
Removing Periphery Street Parallel Axis A	43	155	217	167	233	67	126	0	0	0	1008
%	0.04	0.15	0.22	0.17	0.23	0.07	0.13	0.00	0.00	0.00	1.00
Value	0.04	0.31	0.65	0.66	1.16	0.40	0.88	0.00	0.00	0.00	4.09

Removing Periphery Street Split Axis V	59	73	79	117	171	199	194	125	248	47	1312
%	0.04	0.06	0.06	0.09	0.13	0.15	0.15	0.10	0.19	0.04	1.00
Value	0.04	0.11	0.18	0.36	0.65	0.91	1.04	0.76	1.70	0.36	6.11
Removing Periphery Street Split Axis A	160	36	208	216	125	162	21	0	0	0	928
%	0.17	0.04	0.22	0.23	0.13	0.17	0.02	0.00	0.00	0.00	1.00
Value	0.17	0.08	0.67	0.93	0.67	1.05	0.16	0.00	0.00	0.00	3.73
Isovist	Open Corners 1	Open Corners 2	Keep Corners 1	Keep Corners 2	No Enclosure1	No Enclosure2					All
Face to Shop Grid & Parallel Area	234.796	0	204.603	0	427.915	0					
Face to Shop Grid & Parallel Counter Length	38.23	0	31.76	0	86.35	0					323.53
%	0.12	0	0.10	0	0.27	0					
Face to Shop Grid & Parallel Visible Shops	9	0	8	0	12	0					36
%	0.25	0	0.22	0	0.33	0					
Face to Shop Grid & Split 1 Area	151.287	216.792	111.066	156.267	396.339	259.478					
Face to Shop Grid & Split 1 Counter Length	24.91	29.02	18.12	25.77	55.55	66.22					256.57
%	0.10	0.11	0.07	0.10	0.22	0.26					
Face to Shop Grid & Split 1 Visible Shops	6	5	4	5	9	9					28
%	0.21	0.18	0.14	0.18	0.32	0.32					
Face to Shop Grid & Split 2 Area	224.22	278.298	144.719	210.882	417.664	454.851					
Face to Shop Grid & Split 2 Counter Length	51.08	44.35	45.36	35.36	101.22	70.52					286.70
%	0.18	0.15	0.16	0.12	0.35	0.25					
Face to Shop Grid & Split 2 Visible Shops	10	8	8	7	13	10					32
%	0.31	0.25	0.25	0.22	0.41	0.31					
Face to Shop Street & Parallel Area	165.013	314.266	149.507	256.815	293.01	539.014					
Face to Shop Street & Parallel Counter Length	25.09	55.81	22.33	41.95	54.33	104.67					287.23
%	0.09	0.19	0.08	0.15	0.19	0.36					
Face to Shop Street & Parallel Visible Shops	6	12	4	9	7	14					32
%	0.19	0.38	0.13	0.28	0.22	0.44					
Face to Shop Street& Split Area	179.055	334.136	126.576	251.403	298.562	532.204					
Face to Shop Street& Split Counter Length	34.39	54.04	30.00	41.86	56.90	94.71					251.78
%	0.14	0.21	0.12	0.17	0.23	0.38					
Face to Shop Street& Split Visible Shops	6	12	5	8	7	13					28
%	0.21	0.43	0.18	0.29	0.25	0.46					
Face to Street Grid & Parallel Area	385.274	0	326.601	0	436.819	0					
Face to Street Grid & Parallel Counter Length	73.43	0	59.78	0	82.37	0					323.53
%	0.23	0	0.18	0	0.25	0					
Face to Street Grid & Parallel Visible Shops	16	0	16	0	16	0					36
%	0.44	0	0.44	0	0.44	0					

Face to Street Grid & Split 1 Area	267.13	224.037	226.519	196.971	314.152	317.03					
Face to Street Grid & Split 1 Counter Length	51.11	42.55	41.59	42.21	57.95	67.67					256.57
%	0.20	0.17	0.16	0.16	0.23	0.26					
Face to Street Grid & Split 1 Visible Shops	11	8	11	8	11	10					28
%	0.39	0.29	0.39	0.29	0.39	0.36					
Face to Street Grid & Split 2 Area	263.576	287.729	229.753	249.671	299.429	402.138					
Face to Street Grid & Split 2 Counter Length	49.06	53.28	42.28	43.31	60.75	85.22					286.70
%	0.17	0.19	0.15	0.15	0.21	0.30					
Face to Street Grid & Split 2 Visible Shops	12	10	12	10	12	12					32
%	0.38	0.31	0.38	0.31	0.38	0.38					
Face to Street Street & Parallel Area	382.729	398.995	325.688	338.606	435.583	474.627					
Face to Street Street & Parallel Counter Length	78.3	72.12	65.88	57.6	90.05	94.6					287.23
%	0.27	0.25	0.23	0.20	0.31	0.33					
Face to Street Street & Parallel Visible Shops	18	14	18	14	18	14					32
%	0.56	0.44	0.56	0.44	0.56	0.44					
Face to Street Street& Split Area	321.625	346.077	276.273	299.774	355.534	460.892					
Face to Street Street& Split Counter Length	64.43	63.15	54.23	55.11	72.08	94.54					251.78
%	0.26	0.25	0.22	0.22	0.29	0.38					
Face to Street Street& Split Visible Shops	15	12	15	12	15	14					28
%	0.54	0.43	0.54	0.43	0.54	0.50					
Passage	(Blue - Red) Number of Nodes (Through Vision)										All
Original Option											
Grid Model & Parallel Axis	44	415	212	105	198	18	16	8	8	0	1024
%	0.04	0.41	0.21	0.10	0.19	0.02	0.02	0.01	0.01	0.00	
Value	0.04	0.81	0.62	0.41	0.97	0.11	0.11	0.06	0.07	0.00	3.20
Grid Model & Split Axis 1	453	185	124	38	56	8	0	0	0	0	864
%	0.52	0.21	0.14	0.04	0.06	0.01	0.00	0.00	0.00	0.00	
Value	0.52	0.43	0.43	0.18	0.32	0.06	0.00	0.00	0.00	0.00	1.94
Grid Model & Split Axis 2	439	234	149	58	112	0	0	0	0	0	992
%	0.44	0.24	0.15	0.06	0.11	0.00	0.00	0.00	0.00	0.00	
Value	0.44	0.47	0.45	0.23	0.56	0.00	0.00	0.00	0.00	0.00	2.16
Street Model & Parallel Axis	132	232	185	128	79	34	54	77	17	6	944
%	0.14	0.25	0.20	0.14	0.08	0.04	0.06	0.08	0.02	0.01	
Value	0.14	0.49	0.59	0.54	0.42	0.22	0.40	0.65	0.16	0.06	3.67
Street Model & Split Axis	342	121	107	136	44	26	36	52	0	0	864
%	0.40	0.14	0.12	0.16	0.05	0.03	0.04	0.06	0.00	0.00	
Value	0.40	0.28	0.37	0.63	0.25	0.18	0.29	0.48	0.00	0.00	2.89
Widening Cental Paths' Option											
Grid Model & Parallel Axis	117	334	140	78	59	43	66	81	27	79	1024
%	0.11	0.33	0.14	0.08	0.06	0.04	0.06	0.08	0.03	0.08	
Value	0.11	0.65	0.41	0.30	0.29	0.25	0.45	0.63	0.24	0.77	4.11
Grid Model & Split Axis 1	285	136	88	92	83	77	53	23	15	12	864
%	0.33	0.16	0.10	0.11	0.10	0.09	0.06	0.03	0.02	0.01	

Value	0.33	0.31	0.31	0.43	0.48	0.53	0.43	0.21	0.16	0.14	3.33
Grid Model & Split Axis 2	277	243	109	71	52	58	56	41	38	47	992
%	0.28	0.24	0.11	0.07	0.05	0.06	0.06	0.04	0.04	0.05	
Value	0.28	0.49	0.33	0.29	0.26	0.35	0.40	0.33	0.34	0.47	3.54
Street Model & Parallel Axis	196	157	167	83	39	38	32	14	15	203	944
%	0.21	0.17	0.18	0.09	0.04	0.04	0.03	0.01	0.02	0.22	
Value	0.21	0.33	0.53	0.35	0.21	0.24	0.24	0.12	0.14	2.15	4.52
Street Model & Split Axis	214	171	121	53	46	38	17	16	30	158	864
%	0.25	0.20	0.14	0.06	0.05	0.04	0.02	0.02	0.03	0.18	
Value	0.25	0.40	0.42	0.25	0.27	0.26	0.14	0.15	0.31	1.83	4.27
Widening Peripheral Paths' Option											
Grid Model & Parallel Axis	36	301	194	102	125	152	45	69	0	0	1024
%	0.04	0.29	0.19	0.10	0.12	0.15	0.04	0.07	0.00	0.00	
Value	0.04	0.59	0.57	0.40	0.61	0.89	0.31	0.54	0.00	0.00	3.94
Grid Model & Split Axis 1	309	255	228	70	2	0	0	0	0	0	864
%	0.36	0.30	0.26	0.08	0.00	0.00	0.00	0.00	0.00	0.00	
Value	0.36	0.59	0.79	0.32	0.01	0.00	0.00	0.00	0.00	0.00	2.08
Grid Model & Split Axis 2	329	306	123	52	50	74	30	28	0	0	992
%	0.33	0.31	0.12	0.05	0.05	0.07	0.03	0.03	0.00	0.00	
Value	0.33	0.62	0.37	0.21	0.25	0.45	0.21	0.23	0.00	0.00	2.67
Street Model & Parallel Axis	170	77	185	196	116	28	28	46	56	42	944
%	0.18	0.08	0.20	0.21	0.12	0.03	0.03	0.05	0.06	0.04	
Value	0.18	0.16	0.59	0.83	0.61	0.18	0.21	0.39	0.53	0.44	4.13
Street Model & Split Axis	204	142	214	122	50	40	24	28	26	14	864
%	0.24	0.16	0.25	0.14	0.06	0.05	0.03	0.03	0.03	0.02	
Value	0.24	0.33	0.74	0.56	0.29	0.28	0.19	0.26	0.27	0.16	3.33
Removing Peripheral Shops' Option											
Grid Model & Parallel Axis	38	342	195	122	166	140	55	11	11	8	1088
%	0.03	0.31	0.18	0.11	0.15	0.13	0.05	0.01	0.01	0.01	
Value	0.03	0.63	0.54	0.45	0.76	0.77	0.35	0.08	0.09	0.07	3.78
Grid Model & Split Axis 1	371	160	128	76	89	48	39	12	5	0	928
%	0.40	0.17	0.14	0.08	0.10	0.05	0.04	0.01	0.01	0.00	
Value	0.40	0.34	0.41	0.33	0.48	0.31	0.29	0.10	0.05	0.00	2.72
Grid Model & Split Axis 2	349	219	160	81	119	88	37	3	0	0	1056
%	0.33	0.21	0.15	0.08	0.11	0.08	0.04	0.00	0.00	0.00	
Value	0.33	0.41	0.45	0.31	0.56	0.50	0.25	0.02	0.00	0.00	2.84
Street Model & Parallel Axis	143	160	164	148	96	97	61	62	48	29	1008
%	0.14	0.16	0.16	0.15	0.10	0.10	0.06	0.06	0.05	0.03	
Value	0.14	0.32	0.49	0.59	0.48	0.58	0.42	0.49	0.43	0.29	4.22
Street Model & Split Axis	248	131	112	132	74	78	67	43	27	16	928
%	0.27	0.14	0.12	0.14	0.08	0.08	0.07	0.05	0.03	0.02	
Value	0.27	0.28	0.36	0.57	0.40	0.50	0.51	0.37	0.26	0.17	3.69
Removing Central Shops' Option											
Grid Model & Parallel Axis	45	352	172	120	163	46	83	63	16	28	1024
%	0.04	0.34	0.17	0.12	0.16	0.04	0.08	0.06	0.02	0.03	
Value	0.04	0.69	0.50	0.47	0.80	0.27	0.57	0.49	0.14	0.27	4.24
Grid Model & Split Axis 1	338	175	118	54	43	50	66	27	25	32	928
%	0.36	0.19	0.13	0.06	0.05	0.05	0.07	0.03	0.03	0.03	
Value	0.36	0.38	0.38	0.23	0.23	0.32	0.50	0.23	0.24	0.34	3.23
Grid Model & Split Axis 2	308	237	129	86	110	52	48	31	25	30	1056
%	0.29	0.22	0.12	0.08	0.10	0.05	0.05	0.03	0.02	0.03	
Value	0.29	0.45	0.37	0.33	0.52	0.30	0.32	0.23	0.21	0.28	3.30
Street Model & Parallel Axis	140	165	173	138	73	65	98	64	49	43	1008

%	0.14	0.16	0.17	0.14	0.07	0.06	0.10	0.06	0.05	0.04	
Value	0.14	0.33	0.51	0.55	0.36	0.39	0.68	0.51	0.44	0.43	4.33
Street Model & Split Axis	247	142	97	120	70	90	64	55	15	28	928
%	0.27	0.15	0.10	0.13	0.08	0.10	0.07	0.06	0.02	0.03	
Value	0.27	0.31	0.31	0.52	0.38	0.58	0.48	0.47	0.15	0.30	3.77

Table 10. General data collection of statistic correlation on prototype explorations.

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