

TOMORROW'S LAST-MILE

Flow analysis on the development of last-mile food logistics and its spatial impacts

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I INTRODUCTION

This paper is written for the Lecture Series on Research Methods as a theoretical basis for the Second Life studio of Architectural Engineering. The development of in different fields in the world changes the way how we should design our physical world. Architects will have a big role in this task. The built environment is a very complex and always-changing thing. Therefore this paper intents to define and formulate what sort of research methods could be used to analyze the change within our sector and respond to this trend the most effective and all-embracing way. A methodology helps to understand what steps to take and in what order.

During the lectures of Research Methods different approaches of taking a methodological perspective were highlighted. Benefits and disadvantages were explained and discussed. All this to enlarge the skill of an architect to form the most valuable input to create an architectural design. These lectures made me realize that the usage of different methods is the best way to approach my research topic. The food supply chain and its last-mile distribution is something that I'm not familiar with. The only way to get a fathomed answer to this field is to be critical on your research method. It is the only way to get a deeper meaning to the design.

Food supply chain and its last-mile distribution – Problem Statement

We live in a digital world. Since the 'invention' of the internet, the world has drastically changed. Communication techniques leaped, the amount of available information increased significantly and so did the way we buy things. We ordered for 12.8 billion euros on products online last year. That amount is increasing. Food – and in detail, the grocery market - is by far the biggest market of all: it has the same value as all the other markets combined. However its share of online purchases – the penetration - keeps staying low until recent developments. It is now the fastest online growing sectors with an annual increase of 29%. Home deliveries will increase rapidly, it will change our street scene, the of number of supermarkets, the urban mobility and this will all affect our built environment. Therefore, it is important to already study the trends of today to be able to respond to the problems that will occur tomorrow. Logistics and distribution are fields of expertise not often linked to the field of architecture. However, I think that architects could have a huge role in the development of the digital trend and connect the spatial, environmental and social parts within the built environment.

In my graduation project, I propose a new model of distribution on the Grotiusplaats in The Hague. I aim to explore the current urban metabolism of The Hague. My research paper compares the current situation with the situation in 2030. It looks at the urban scale with the number of movements to the supermarket and the total covered kilometers. At the building scale, the research paper analyses its flows of organics, amount of movements in and out of the building, energy and warmth. The city of The Hague is with its 6.500 people per square kilometer the densest city of the Netherlands and it is the city with the most congestion of all the Dutch cities. In the center of The Hague above one of the busiest highways spans the Bruggebouw Oost. This will be my design assignment. The exploration of the urban and building scale will help to get insights into the spatial impact of the digital trend of grocery shoppers. The city of The Hague eats more than half a million kilos of food every day. If everything has to be delivered to their doorsteps what will happen with the urban flows and what kind of challenges and opportunities will get out of these developments?

_Which (new) typologies and functions are needed to facilitate the new trend of the food supply chain that meets the climate goals of 2040?

II CALCULATING THE IMPACT

The aim of the research is (1) to project the future regarding online grocery shopping, (2) calculate the impact of a new proposed model of distributing groceries on the urban level and (3) define the flows of such an intervention on the building scale. Furthermore, it aims to include these findings in the design process to respond efficiently and sustainably on this new trend in the last-mile distribution of groceries. These different research goals require a mix of different research methods.

The process analyses is a method used to stimulate urban metabolism. The first part of the research paper is mainly focused on that analysis. It starts with analyzing the past developments of grocery shopping and its spatial and social impacts. The following step is to extrude this trend in combination with professional trend reports on how this last-mile distribution will change in 2030. The approach is a combination of the Grounded Theory and a rationalistic approach. To create a substantiated body of knowledge that I can use for a rationalistic approach to forecast the digital trend, I used Grounded Theory in order to analyze the past: collecting data to formulate conclusions. It exposes the underlying social phenomena which could be projected – with logic – on the future.

From this point, the paper calculates the urban spatial effects: how many movements will there be per district and how many kilometers will be covered per district by using Excel as a tool. Visualizing and harnessing the power of graphic design can help us to understand a complex process.¹ The result is a map which visually shows the impact and changes of this trend and therefore guides to a conclusion, in other words the map functions as a paradigm (see Syllabus I)

The last part of the research consists of calculating how many food, drinks, energy, cars, water and warmth is going in and out of the proposed urban distribution center in 2030. The outcome functions as a program of requirements. A foundation that can guide placing functions in the most convenient way in the design process.

One way you can say it refers to the framework of praxeology. In fact, there are two ways of interpreting this matter. Firstly, the result is a response to the future building flows and its spatial setup. The flows of the new trend in digitally ordering your food will -partly- decide how the building spatially will be designed. Therefore, a significant part of the design will functionally be decided on a very objective researched way. Designing an optimum in logistical, practical and energetical sides. On the other hand, you could interpret it as a large scale praxeology. To look to the urban metabolism as an organism. The building will be part of a bigger urban design and therefore be used as a tool. The building will be a reflection of the current state of flows. However, here the architect comes into play. If we let it happen organically, problems can occur that could be solved by thinking of them on the beforehand.

Motivation of choice

To design a facility of urban last-mile food distribution, I choose to analyze its impact on the urban scale. The effects that this building will have don't stay at its close surroundings but will have a crucial key role in affecting the current urban flows. From the big scale and its (big)data, I was able to calculate the amount the citizen orders, consumes, and how many vehicles and electricity there is needed. This can be transformed into spatial elements and energy amounts: a Material Flow Accounting (also referred to Material Flow Analysis).

¹ Lucas, R. (2015), Research Methods for Architecture. London: Laurence King Publishing, 182.

III RESEARCH-METHODOLOGICAL REFLECTION

Grounded theory and rationalism approach is something that might look like two distant strangers. Albeit, one cannot function without another. To actively use the rationalism approach you must have a baseline of information where you can form logical steps and make therefore logical conclusions from.² The field of last-mile distribution isn't my field of expertise so therefore I had to use this method to form a theory of the future.

To analyze the past using grounded theory is however a hard task I noticed. It is from its origin an inductive method and open-ended from character.³ Because the past ends with the current time it is difficult to not be exposed by thoughts or external influences that can weaken this objective method. Also, the projections are data driven. Therefore must be critically looked at which data is used. From a bird-eye perspective, it looks very objective, but the decision of which data projection is used is defined by the researcher (in this case myself) and could be described as subjective. As Landau (1980) described in his "Notes on the concept of an architectural position" on the view of a historical construction is that you deal with psychological and epistemological obstacles. The human has often the nature to comprehend with simplification (the psychological obstacle). Simplification of the data in my case, in which the trend of online grocery shopping is a complex system, should be treated with suspicion because it can lead to misrepresentation.⁴

The MFA is a tool to thoroughly understand the urban metabolism and its underlying streams. The essence of the tool is the retainment of energy. The first scientist who came up with this theory was the French chemist Antoine Lavoisier. He stated in his theory that nothing can create matter. In every reaction, system or process the amount of energy doesn't change. This concept emerged from the industrial metabolism in the 1860s onwards to the environmental theory of the retainment of energy.⁵ It was until the 1960s that this theory also was used in urban studies.⁶ This was done by the American Wolman (1965). He researched on a fictive city of one million people on water usage and air quality.⁷ An important disclaimer about the work of Wolman is that he was one of the first to state that environmental problems would occur when a city grew to a certain extent. Albeit his model is quite basic, it shows the essence of taking the right data when calculating the flows. The relevance of which source is being used, where this source came from, the zeitgeist of that moment and what the framework is of the researched object – in this case, a city – is crucial on the output and therefore the conclusion of this tool.

The Material Flow Analysis kept on transforming, as in 1990 Girardet proposes a more sophisticated version of the MFA wherein resources are being used circularly. From his point of view, this circular system reflects more on the true nature of our planet referred to a living organism.⁸

Recently, researchers and architects use the MFA as a tool to find a so-called 'cyclifier'. Architectural design that functions – or partly functions – to close loops in an urban flow. Examples like revitalizing plants as part of a landscape design, design with 'waste' materials or locally purify wastewater. Mostly the projects are urban interventions.

The development of the MFA is a clear development of 'scientification of design'. To use the MFA as evidence-based design tool with a holistic scope had become more common in the field of

² Lacey, A.R. (1996), *A Dictionary of Philosophy*, 1st edition, Routledge and Kegan Paul, 1976. 2nd edition, 1986. 3rd edition, Routledge, London, UK, 1996. p. 286

³ Groat, L. N., & Wang, D. (2013). *Architectural research methods*: John Wiley & Sons.

⁴ Landau, R. (1980). *Notes On The Concept Of An Architectural Position*. AA Files.

⁵ Fischer-Kowalski, M. (1998). Society's metabolism. *Journal of Industrial Ecology*, 2(1), 61-78.

⁶ Brunner, P.H., Rechberger, H. (2004). *Practical Handbook of Material Flow Analysis*. London: Lewis Publishers, 5.

⁷ Wolman, A. (1965). The Metabolism of Cities. *Scientific American*, 213(3), 178-190.

⁸ Zhang, Y. (2013). *Urban Metabolism*. *Environmental Pollution*, 178, 463-473, 464.

architecture. Hence, the conclusions based upon such a study (the MFA in this case) do not shape the actual urban or architectural design but merely build upon it. It forms a reference work or a program of requirement, or a conceptual position from which the designer can easily make decisions.

The second research approach I want to elaborate on, is the research on the movement of people (and goods) in a city. The first who researched this matter was Ravenstein.⁹ People do not randomly move in space he stated but it had a clear connection with mobility and distance.

Later in time two diverging but related viewpoints emerged. One side stated that mobility is directly deterred by the costs – in time and energy – linked to the physical distance. This side is very much attached to Newton's law of gravity, where mass attracts mass, where the attractiveness weakens the further it is away.¹⁰

The other camp led by Stouffer (1940) states that there is no relation between distances and mobility, that the distance is a surrogate for the effect of intervention opportunities.¹¹

Since the rise of empirical research, the researcher had the power to analyze big data using GPS of phones in contrast with the older smaller surveys and small-scale observations. This empirical approach led to a conclusion in which all movements – no matter in what city – where all universal. So urban designers and architects could use these conclusions to embody it into their design. In my research, I could therefore substantiate the calculations on these theories. I choose Stouffer's approach because it linked more towards the inner-city movements.

⁹ Ravenstein, E. G. (1885). "The Laws Of Migration". *Journal Of The Statistical Society Of London* 48 (2): 167.

¹⁰ Noulas, Anastasios, Salvatore Scellato, Renaud Lambiotte, Massimiliano Pontil, and Cecilia Mascolo. (2012). "A Tale Of Many Cities: Universal Patterns In Human Urban Mobility". (5)

¹¹ Stouffer S (1940). Intervening opportunities: A theory relating mobility and distance. *American Sociological Review* 5: 845–867.

IV POSITIONING

The digital influences on the world are significant and so are the influences on the built environment. The architect could (and in my opinion should) have a very important role in this matter. The architect should combine different architectural research methods, forecast problems and respond creatively, well-informed and with the right techniques on those trends. I decided to graduate in the Architectural Engineering studio because I thoroughly believe that the role of the architects has shifted in the last couple of decades. We should be educated with a broad variety of tools in order to – not only include the human activities but also – include technical and urban analytical tools to respond on topics like sustainability, material flows and urban mobility. Whereas a building could be more than a building where people dwell, work or play, but part of a bigger urban organism that fits well in the urban tissue and helps with its problems.

Logistical buildings were first a part of the urban tissue, think of the old warehouses along the canals. However, it shifted slowly to the outskirts of cities. It wasn't the architect's role anymore to design them but functional engineers. However, architects should be enabled again to also work in this field. Because those typologies could have a crucial role in the urban tissue. An architect should have the tools to do a movement analysis based on the empirical studies of previous researchers. For as architects have the power to transform this into a spatial key element in form of a design. Klaske Havik (2017) states roughly the same. She stated that the traditional tools of architectural research fail to address the fundamental ambiguities of architecture.¹² The combination of reality and imagination is where architects have a crucial role. Analytical data-driven reality and the response of the architect with his or her fill in that connects the technical challenges with social and spatial qualities.

In my position, I analysed the publicly available data – by using the Grounded Theory - to make a rationalistic forecast on what will might happen in the future. I do not state that it actually will happen, however I enable myself by obtaining tools that could give me insight on the trends and – together with the MFA – empowers me as an architect to respond rationally on it.

The MFA have its crucial role. Analysing the city as a living organism is one thing, but it could be the strength of an architect to use its power, visualize its essence and use it as a tool to get a deeper meaning to the design. It gains insight into the environmental impact and generates ideas for possible architectural interventions.

Also, Hugh Dutton (2000) argued for an integrated design approach in which borders between distinct professional, industrial and construction territories must be transgressed.¹³ Such an approach is also stated by Hooijmeier (2017). In which he proposes to "not only take the operational logic of the natural system in itself as the main driver, but considering the natural system together with the technological urban construction that are already in place".¹⁴ The technological urban construction is of key essence in my research. And, in fact, you can say that the natural system is the system that grew organically. However, we are at a tipping point of changing into a new – digital – era. In which we should ask if we should let the logistical developments grow organically or if we should – as architects – intervene to seek for a more efficient, sustainable and logical system of distributing. Tools like the movements analysis of Stoufer (1940) or the MFA in which enables the architect – so in this case myself – to be able to make substantiated decisions to solve problems that will occur in the future.

Individual architectural position

It is time to broaden the role of the architect. In my opinion, we have to enable him or her with tools that can be used to find the truest essence of a design. In which analytical tools can be used to

¹² Havik, K. (2017). *Acts of Symbiosis; A Literary Analysis of the Work of Rogelio Salmona and Alvar Aalto*.

¹³ Dutton H. (2000) 'An integral approach to structure and Architecture', *Perspecta 31 Reading Structures*, Yale Architectural Journal, Inc.(2000), p.61

¹⁴ Hooijmeijer, F.L., F. Lafleur, and T.T. Trinh. 2017. "Drawing The Subsurface: An Integrative Design Approach". *Procedia Engineering* 209: 61-74.

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analyse the spatial flows that could be changed or be optimised and strengthen the soft sides the architect always had to be the connector between the imagination and reality. Let the design not only be used as a final goal e.g. house people or facilitate working space but also as a tool to solve problems that matter to different fields like logistics, urban congestion or food. The architect as holistic metaboliser: a total view of the essence.

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