

Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences



Graduation Plan: All tracks

Submit your Graduation Plan to the Board of Examiners (Examencommissie-BK@tudelft.nl), Mentors and Delegate of the Board of Examiners one week before P2 at the latest.

The graduation plan consists of at least the following data/segments:

Personal information	
Name	Carolina Cardoso Pera Eboli
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Studio	
Name / Theme	Urban Metabolism
Teachers / tutors	1 st mentor: Ulf Hackauf, 2 nd mentor: Lidewij Tummers
Argumentation of choice of the studio	My personal motivation for this research comes first from the academic field, specifically regarding Urban Metabolism concept. Although this concept is not new, I was exposed to it for the first time throughout my studies at TUDelft and it provided me different understandings of urban contexts. This triggered the will to test this concept in my hometown, Belo Horizonte, in an attempt to propose a shift from the fixed and outdated planning framework to a more holistic perspective that would also have a better chance of being successful. This also relates to my personal perception of planning in Brazilian contexts as rigid frameworks that stumble upon bureaucracy and simplistic perspectives of what are in reality complex relations and, therefore, never achieve the desired goals. By choosing Smart Cities and Urban Metabolism research group, I could deepen my knowledge on Urban Metabolism topic, explore relations between this concept and urban design/planning and reflect upon the spillover effects of this approach. Moreover, using Urban Metabolism as a core element of the project goes in line with the research group's idea of analyzing the performance of an urban system, using material and energy flow analysis, and co-relate it with people and the built environment.

Graduation project	
Title of the graduation project	Metabolic horizon: a regional strategy for Belo Horizonte Metropolitan Region's (RMBH) wastewater and solid waste
Goal	
Location:	Belo Horizonte Metropolitan Region – Brazil

The posed problem,	The Metropolitan Region of Belo Horizonte has gone through an intense process of rapid urbanization for the past century, which has led to sprawl, pressure on resources, infrastructure shortage and environmental hazards. Although the Plan of Integrated Development for RMBH (PDDI-RMBH 2011) addresses to some of these issues, the region can benefit from a new perspective on its urban comprehension in order to embrace existing proposals and develop solutions that increase its environmental performance and resilience. Urban Metabolism, thus, can contribute to this understanding, by looking at the urban relations and flows rather than only focusing on territorial aspects. In the field of resources, wastewater and solid waste flows present urgent issues, especially due to their environmental implications and reliance on heavy infrastructure. However, these flows also possess potentials that point to interconnections in a regional scale, which would permit circularity and contribute to the sustainable development of the region.
research questions and	Main research question: How to develop a feasible regional strategy for RMBH's wastewater and solid waste flows? Sub-questions: 1. What and where are the main challenges in wastewater and solid waste? 2. Where and how wastewater and solid waste flows take place? 3. What are the zones of interventions that have potential to maximize effects of wastewater and solid waste interventions? 4. What are possible solutions to increase environmental performance of wastewater and solid waste flows, within the elected zones of intervention? 5. How can these solutions be implemented in the elected zones of intervention? 6. How did UM approach contributed for the development of RMBH's regional strategy?
design assignment in which these result.	Aims: This thesis has aims to increase the environmental performance of the Metropolitan Region of Belo Horizonte, by creating a regional strategy for the area that guarantees resilience and sustainability in the long term, focusing on wastewater and solid waste flows. In order to do so, this thesis centers on Schuetze et al. steps to increase the sustainability of an Urban Metabolism: apply ecosystem thinking, investigate the optimal resource consumption in different processes and promote "synergies between the different sectors and flows" (Schuetze et al., 2012).

	Thesis out-put: From the methodology (see following item), it is possible to outline a step-by-step outcome of each stage of this thesis. In the Research Clarification, the main output is a definitive research proposal including: problem analysis, research questions, aims, relevance and methodology. In the Descriptive Study I, the outputs are divided into policies analysis outputs, theory and the metabolic analysis. The first one outlines the planning structure of the PDDI-RMBH and Macrozoning and identifies challenges and potentials within the studied flows (territorial perspective). The second one has as end product the definition of adopted concepts and the construction of Urban Metabolism's theoretical base to be applied in the development of the regional strategy. The last one provides the understanding of the current studied flows (how they work, challenges and potentials) and the identification of relations between these flows and the territory (zones of interventions). The Prescriptive Study provides two main outcomes: an inventory of design and planning solutions related to the topic and the area of study; and a regional strategy for RMBH, derived from relations between these solutions, the metabolism of the region and its territory. The latter also unfolds into key projects, defined by criteria (feasibility, stakeholders, phasing), that have as output a detailed illustration of their metabolic framework and spatial implications. The outcomes of the field trip are particularly important for the development of these products, where the actors workshop and site-visits will influence and shape the proposals. Lastly, the Descriptive Study II provides the proposal's evaluation, confronting the thesis' hypothesis, and reflection, by studying its achievements, limitations and future steps.
Process	
Method description	
The methodology of this thesis is based on Lucienne T. M. Blessing and Amaresh Chakrabarti's book <i>DRM – a design research methodology</i> (Blessing & Chakrabarti, 2009). This methodology consists of four main stages: 1. Research Clarification (R.C.) 2. Descriptive Study I (D.S. I) 3. Prescriptive Study (P.S.) 4. Descriptive Study II (D.S. II)	

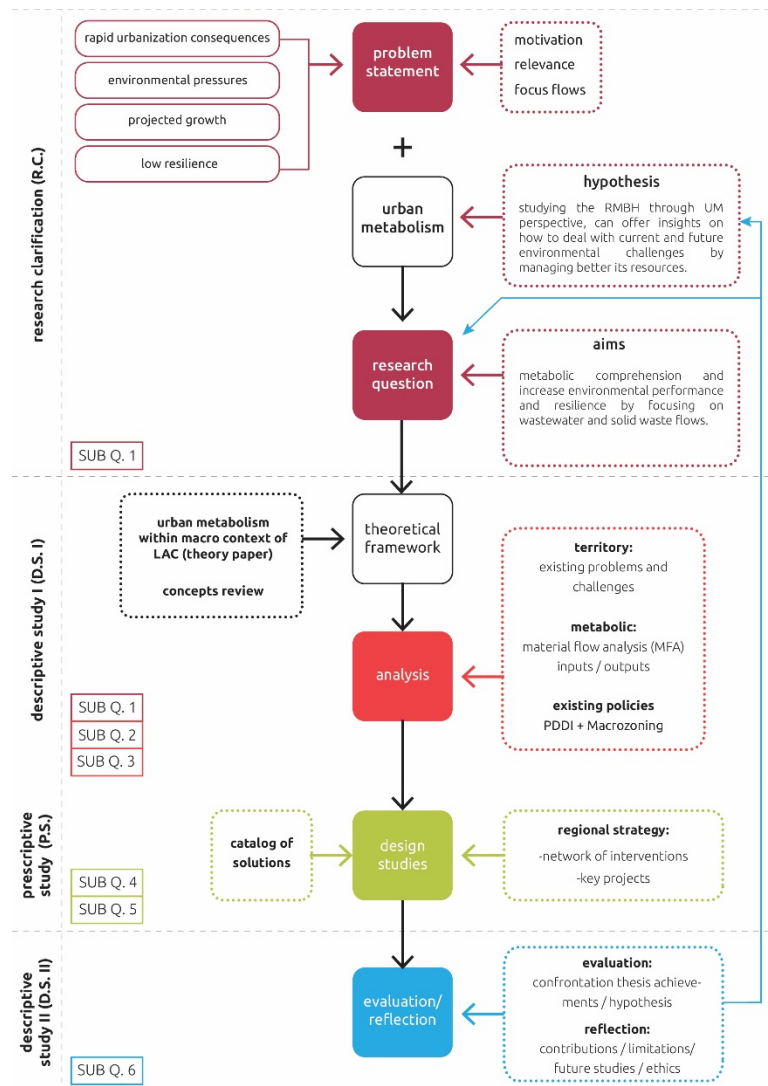


Figure 1- Thesis methodology

1. Research Clarification (R.C.)

This stage relates to the understanding of the problem this thesis wants to tackle. It requires evidence collection and literature studies that clarifies the issue and support the research goal (Blessing & Chakrabarti, 2009). This phase consists on the description of the existing situation (problem field), the formulation of criteria that can be used to evaluate the proposal in later stages (key flows), and the description of the desired situation (a regional strategy) (Blessing & Chakrabarti, 2009). Chapter one of this thesis clarifies these matters and already starts to answer **Sub-question 1: “What are the main challenges in wastewater and solid waste?”**, by making use of literature, existing diagnosis of the PDDI-RMBH (UFMG, 2010), policy and data analysis, GIS and mapping.

2. Descriptive Study I (D.S. I)

The Descriptive Study I consists of literature review that assists detailing the description of the existing situation put forward in the Research Clarification phase, having the desired aims in mind (Blessing & Chakrabarti, 2009). In this thesis, it occurs through the revision of concepts

and a theory paper. The first gives a brief definition on sustainable development and resilience concepts. The second explores Urban Metabolism approaches in Latin America, with a set of examples of sustainable strategies in Latin American cities and their relation with the concept of Urban Metabolism.

In addition, considering that the purpose of this stage is a detailed understanding of the existing situation, this thesis puts forward the site analysis as an additional layer of the Descriptive Study I. This analysis consists of three steps that occur in parallel. The first one is the continuation of **Sub-question 1: “What and where are the main challenges in wastewater and solid waste?”**. This question is answered by studying current policies and engaging in an iterative process with the metabolic analysis developed for Sub-question 2. The second step addresses **Sub-question 2: “Where and how wastewater and solid waste flows take place?”**. This metabolic analysis reveals relationships within wastewater and solid waste flows, also supporting the development of Sub-question 1. It uses Material Flow Analysis (MFA), data analysis (including inputs/outputs), GIS and mapping. The last step regards defining zones of intervention. This definition derives from the confrontation between the territorial analysis, the metabolic analysis and the existing policies. The first one addresses the current challenges, the second points to areas with most potential to maximize metabolic interventions and the last highlights the already established priority areas, increasing the feasibility of the proposals, developed in the next phase. This conclusion uses policy review, data analysis, GIS and mapping as methods and answer **Sub-question 3: “What are the zones of interventions that have potential to maximize effects of wastewater and solid waste interventions?”**

3. Prescriptive Study (P.S.)

According to Lucienne T. M. Blessing and Amaresh Chakrabarti, in this stage occurs the refinement of the desired situation, by putting forward a “vision on how addressing one or more factors in the existing situation would lead to the realization of the desired, improved situation” (Blessing & Chakrabarti, 2009). For that purpose, this thesis elaborates design studies, namely a regional strategy for the RMBH and key projects that elaborate on its spatial implications in the area, divided in 2 steps. The first step answers **Sub-question 4: “What are possible solutions to increase environmental performance of wastewater and solid waste flows, within the elected zones of intervention?”**. This catalog of solutions derives from sustainable solutions developed in existing projects, other existing catalogs or tool-kits originated in academic research and new proposals when necessary. Those solutions are chosen based on a set of criteria that relates to relevance and design impact, consisting of the following dimensions: application to at least neighborhood scale or larger; related to urban design and planning fields; has spatial implications; has positive social impact and allows connections between flows. The methods used in this step are literature and existing projects review and impressions (diagrams, images). The second step is the proposal of a regional strategy for RMBH, by creating a network of interventions using the catalog as base. In order to incorporate stakeholders and increase the proposal's feasibility, a field trip will take place to confront it with the local actors. The field trip also provides insight for the translation of the spatial implications of this proposal into key projects that are relevant for the overall strategy. The main methods in this phase are mapping, sections, impressions (images, collages, diagrams), site-visits and actors workshop. The

combination of network of interventions and key projects answers **Sub-question 5: “How can these solutions be implemented in the elected zones of intervention?”**.

4. Descriptive Study II (D.S. II)

The purpose of the Descriptive Study II is to examine the effects of the proposal and evaluate its achievements, applicability and usefulness (Blessing & Chakrabarti, 2009). Moreover, in this stage there is an indication of conclusions and need for further studies (Blessing & Chakrabarti, 2009). In this thesis, this is realized in two steps: evaluation and reflection. In the evaluation, a critical review of the proposal is made, confronting its findings and achievements with the hypothesis put forward, thus answering **Sub-question 6: “How did UM approach contributed for the development of RMBH’s regional strategy?”**. The reflection, on the other hand, focuses on contributions the thesis has given, in the social and scientific spheres, as well as its limitations, culminating into suggestions for further studies and investigations. Moreover, the reflection also encompasses ethical dimensions. This stage uses narrative and reasoning as main methods. It is important to highlight that, as Blessing and Chakrabarti clarify, this methodology should not be understood as a linear process, but a summary of its main flow (Blessing & Chakrabarti, 2009). Iterations increase understanding and efficiency and are natural to occur within and among stages (Blessing & Chakrabarti, 2009). Therefore, even though some iterations were stressed in the previous descriptions, they are not exclusive, since different studies within each stage will occur in parallel. Also, a same study can be deepened at different stages, according to the development of the work.

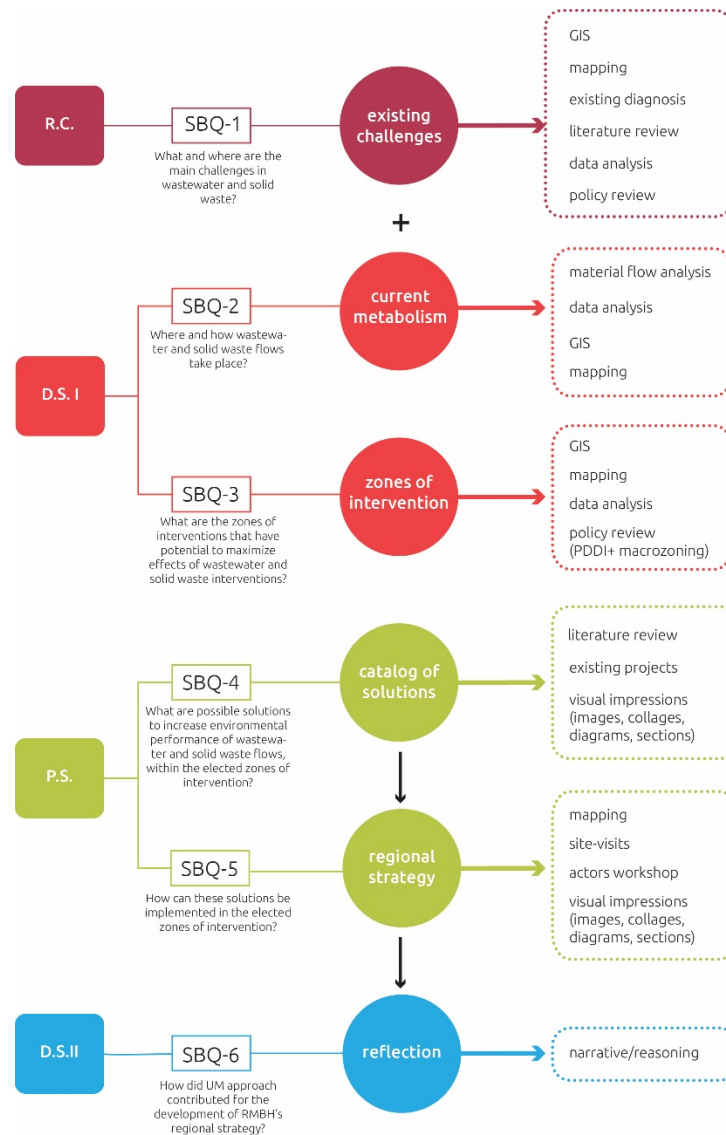


Figure 2 - Sub-research questions and methods

Literature and general practical preference

The theoretical framework of this thesis is developed to provide substantiation to the Urban Metabolism topic and co-related themes. Therefore, it consists of two steps:

1. Urban Metabolism: with the purpose of clarifying the foundations of UM and discuss its application in the macro context of this thesis, this thesis presents a theory paper that provides a brief overview of UM concept itself, a set of existing sustainable solutions in Latin American cities and the translation of the concept in those solutions.

2. sustainable development and resilience: concepts review.

Main literature used (for extended reference list, refer to the P2 Report):

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Reflection

Societal relevance:

This thesis has societal relevance at three different scales: regional, Latin American and global. The largest relevance relies on the regional one. By improving the metabolic performance of RMBH in key waste flows, social spillover effects will take place. One of them relates to health issues, since an efficient management of waste and improvement of the general basic sanitation condition reduce possibilities of contamination and spread of diseases, for example. Another aspect is the increase of the region's environmental protection, with less river pollution and consumption of resources, to name a few, which contribute for increasing its performance, ultimately addressing to climate change issues. Lastly, a good management of resources also allows economic opportunities, improving efficiency and reinforcing the existing regional structure, which adds to the urban life quality. Those social benefits, furthermore, can be transferred to other Latin American cities that underwent similar processes of rapid urbanization and struggle with similar issues. Moreover, since RMBH is inserted in Latin America, one of the most urbanized regions of the world, it can also contribute to other regions that are currently being urbanized, such as Africa and Asia, especially considering their environmental impacts in the global scale. In sub-Saharan cities, for example, waste is projected to increase until 2100 (Hoornweg, Bhada-Tata, & Kennedy, 2013) and how these cities develop are "determinant to the date and intensity of global peak waste" (Hoornweg et al., 2013). Therefore, these regions can absorb knowledge from this work and use it not only to increase their environmental performance in waste flows, but also to increase life quality of their cities.

Scientific relevance

One of the aims of Urbanism track in the Master of Architecture Urbanism and Building Science is to teach students to "integrate social, cultural, economic and political perspectives with the natural and man-made conditions of the site in order to shape and plan for more sustainable development" (TUDelft Department of Urbanism, n.d.). Urban Metabolism proposes to explore this integration by understanding the city from the flows perspective and creating synergies between those flows. The growing interest over Urban Metabolism as a tool highlights the relevance of the topic, since it assists urban planners and designers to develop more sustainable solutions. However, as a concept, it is bound to be continuously in expansion or mutation. How the concept is used or translated considering different contexts and demands, can contribute to stretch its scientific discussion. This thesis triggers a debate on the universality of Urban Metabolism concept by reviewing current sustainable strategies in developing countries and by applying the concept itself in Belo Horizonte Metropolitan Area. Moreover, the thesis touches upon the discussion of how UM's framework, soundly based on scientific research, contributes for design/planning assignments. It puts forward the hypothesis that this framework can provide different insights about urban contexts, which can be translated into design practices. In other words, this thesis provokes discussions on the relation between research and design.

Time planning

