

Universiteit Leiden

ICT in Business

A Maturity Model for Attribution Modeling Maturity Assessment

Name: Student No.: Ziwei Liu s1706411

Date: 1st Supervisor: 2nd Supervisor:

14/07/2017 Dhr. Niels van Weeren Dr. Hans Le Fever

MASTER'S THESIS

Leiden Institute of Advanced Computer Science (LIACS) Leiden University Niels Bohrweg 1 2333 CA Leiden The Netherlands

Acknowledgements

I would like to first express my deep appreciation for my first supervisor Mr. Niels van Weeren, as he provided me with guidelines, suggestions and continuous support along the duration of this thesis project. He allowed the paper to be my own work, but steered me in the right direction whenever he thought that I needed it. I would also like to thank my second supervisor Dr. Hans LeFever for providing valuable feedback and recommendations. I am gratefully indebted to his help towards finalizing the project.

Furthermore, I want to highlight my gratitude towards my supervisors at Squla, Luuk Bakker and Ronald van de Worp, for their trust, insights, continuous assistance and especially the freedom they gave me to be able to work on my thesis while I did the internship. I could not have finished the thesis without their encouragement and effort.

My sincere thanks also go to the experts who were involved in the surveys and interviews for this research project: Frank van't Ende, Tijntje Louwers, Gerard Loosschilder, Ricardo Muyres, Leonie P.M. Peters, and Aron Hartveld. Without their enthusiasm and cooperation, the surveys could not have been successfully conducted.

Finally, I am very grateful to my parents and friends who provided me with support throughout the research project and stood by me through the good and hard times during the two-year master study. This accomplishment would not have been possible without them. Thank you.

Abstract

Attribution Modeling is the technology that deals with customer data for the purpose of assigning credit to various marketing touch points, and thus improving marketing performance ultimately. It is vital for organizations to be aware of the importance of Attribution Modeling so that they can design more effective and efficient marketing strategies. However, despite the focus on Attribution Modeling, many organizations have difficulties applying the most appropriate attribution models. There are numerous attribution models that are currently used, ranging from basic Heuristics Attribution Models to advanced Algorithmic Attribution Models. Organizations need to choose the suitable attribution model based on their capabilities and infrastructures. For this reason, it is crucial for organizations to assess their Attribution Modeling Maturity and make substantial improvement based on their current situation as well as their business goals eventually. In this study, an Attribution Modeling Maturity Model (AMMM) is developed and evaluated as an assessment tool for organizations to identify their Attribution Modeling Maturity.

The study is structured according to an AMMM Development Framework. A literature review was conducted first in order to identify the general characteristics for AMMM. Maturity levels and dimensions that should be included in the model were determined by an overview of existing maturity models related to Attribution Modeling. A Delphi study was conducted later to identify the features that should be included in AMMM within each dimension. The validation process was conducted after it to check the reliability and validity of identified features and dimensions. The model was lastly applied to a real business to evaluate its practical value.

Ten existing maturity models related to Attribution Modeling were analyzed, leading to the establishment of five distinct maturity levels and four dimensions. After three iterations of Delphi questionnaires and interviews, a total of twenty-five features were determined to be included in the AMMM. The validation process of these features supported that the result of the Delphi study is reliable with expected consensus. Application of the model further validated it and proved that it is applicable in practice. Relevant points for improvement were also identified through the application procedure.

The AMMM developed in this study helps identify the strengths and weaknesses of an organization regarding its capabilities to apply attribution modeling techniques. It implies that the culture of the organization and people in the organization are the foundation to develop a good attribution model. Features related to data management and attribution modeling technology are also essential if an organization wants to reach a high level of Attribution Modeling Maturity.

Table of Contents

Acknowledgements	I
Abstract	II
List of Tables	V
List of Figures	VI
1 INTRODUCTION	1
1.1 Problem Statement	1
1.2 Research Objectives	2
1.3 Research Questions	3
1.4 Thesis Structure	4
2 RESEARCH METHODOLOGY	5
2.1 Literature Review Method	6
2.2 AMMM Development Method	6
2.2.1 Maturity Model Development Framework	7
2.2.2 Design Science Approach	8
2.2.3 AMMM Development Framework	9
2.3 Delphi Method	10
3 LITERATURE REVIEW	12
3.1 Attribution Modeling	12
3.1.1 Attribution in Marketing	12
3.1.2 Existing Attribution Models	13
3.1.3 Challenges for Attribution Modeling	20
3.2 Attribution Modeling Maturity	22
3.2.1 Definition	22
3.2.2 Existing Maturity Models	25
4 DEVELOPMENT OF AMMM	29
4.1 Problem Definition	29
4.2 Delphi Study	32
4.2.1 Candidate Selection	32
4.2.2 First Iteration	35
4.2.3 Second Iteration	40
4.2.4 Third Iteration	43
4.2.5 Results	46

	4.3	Validation	.48	
5	AP	PLICATION OF AMMM	.52	
	5.1	Application Process	.52	
	5.2	Results	.54	
6	CC	NCLUSIONS	.57	
	6.1	Research Questions	.57	
	6.2	Limitations	.58	
	6.3	Future Research	.60	
R	efere	nces	.61	
A	ppen	dix I Delphi Study First Iteration Results	.65	
A	ppen	dix II Delphi Study Second Iteration Results	.69	
A	ppen	dix III Delphi Study Third Iteration Results	.71	
A	Appendix IV Application Survey and Results			

List of Tables

Table 1 Focus and Descriptions of Research Methodologies	5
Table 2 Key Tasks to Develop a Maturity Model	7
Table 3 Types of Existing Attribution Models	14
Table 4 Comparisons of Common Heuristics Attribution Models	15
Table 5 Maturity Levels of CMM	24
Table 6 Overview of Existing Maturity Models	26
Table 7 Characteristics of Maturity Levels in Existing Models	
Table 8 Characteristics of AMMM	
Table 9 Dimensions for AMMM	31
Table 10 Knowledge Resource Nomination Worksheet	
Table 11 Categories of Delphi Panel Members	
Table 12 Dimension Ratings	
Table 13 Features for Organization Dimension	
Table 14 Features for People Dimension	
Table 15 Features for Data Management Dimension	
Table 16 Features for Technology Dimension	
Table 17 Features Ratings for Organization Dimension	40
Table 18 Features Ratings for People Dimension	41
Table 19 Features Ratings for Data Management Dimension	42
Table 20 Features Ratings for Technology Dimension	43
Table 21 Final Ratings for All Features	45
Table 22 Features to be Included in AMMM	47
Table 23 Categories of Validation Panel Members	49
Table 24 Ratings for Dimensions in Delphi Study and Validation Process	49
Table 25 Ratings for Features in Delphi Study and Validation Process	
Table 26 Results of the Assessment Session	54

List of Figures

Figure 1 Phases of Maturity Model Development Framework (de Bruin, 2005)	7
Figure 2 Attribution Models vs. Reality	21
Figure 3 Attributes of CMM	24
Figure 4 Visualization of Assessment Result	55

1

1 INTRODUCTION

1.1 Problem Statement

The growing importance of Internet has provided more opportunities for organizations in improving marketing performance. More and more marketers are enabled to reach a significant number of target audiences digitally. New channels such as paid research, email marketing, display advertising, retargeting, etc. have emerged in the marketing world, facilitating the increase in the amount of potential customers. With the digital trend of marketing becoming more and more dominant, marketers tend to pay more attention in analyzing data available that is related to different marketing channels to understand customer behaviors and to correspondently design more effective and efficient marketing strategies.

Attribution Modeling is the process of collecting customer data and assigning credit to multichannel marketing activities which eventually lead to business goal achievement (Riordan-Butterworth, 2012). The technology attempts to define how each interaction a customer has along the customer conversion journey contributes to the customer's decision. In this way, it is possible for marketers to justify their marketing spend by answering questions like "Are my marketing channels worth the effort?" or "Should I increase the investment in paid search?" The ultimate goal of the application of attribution modeling technology is to measure the current marketing performance and increase return on investment. Numerous attribution models exist to measure the marketing performance of different channels. These models have different levels of complexity, including easily understandable Rule-Based (Heuristics) Attribution Models like Single Source Attribution Models which focus on a single touch point, and Multi-Touch Attribution Models which take into account the effects of various marketing channels simultaneously. More complicated Algorithmic Attribution Models that require advanced statistical techniques also draw attention from academic researchers and marketers. This kind of model is more difficult to understand but more accurate and reliable since it is based on real data that gives insights to marketers with respect to customer behaviors

Even though the importance of attribution modeling technique is commonly addressed, it remains a challenge for marketers to choose the right attribution models based on their abilities of application. In other words, when it comes to the utilization of attribution modeling technology, there are more considerations than just determining whether to use a model or not. Identifying the most suitable attribution model for the organization according to its capabilities is the key to success. If your organization is getting started with Attribution Modeling or is at a lower level on analytical capabilities, a Single Source Attribution Model is complicated enough to get the job done. As the organization grows, Single Source Attribution Model is not sufficient anymore to assign credits to various touch points based on

existing rules. Then it is probably more advisable to apply a Multi-Touch Attribution Model in this case. If the organization is already customer-centric and has applied data-driven algorithmic approaches to understand and predict customer behaviors, it is more pertinent to use the Advanced Algorithmic Attribution Model to deliver an accurate report about the effectiveness of specific channels.

In order to identify and implement suitable attribution models and thus gaining insights in strategic marketing actions, marketers and also business managers need to assess their capabilities in the utilization of attribution modeling techniques, regarding different dimensions like the culture of the organization, analytical technology and tools, expertise and infrastructure, etc. In this way, organizations can choose the right attribution model and make substantial improvement based on their current situation and their business goals. A maturity model can promisingly address the issue as it contributes to the assessment of the current effectiveness of an individual or an organization and supports identifying the capabilities they need to improve their performance (Becker, Knackstedt, & Pöppelbuß, 2009). A wide range of business management maturity models has been developed to support business processes in history. However, there is hardly any concrete model underlining the issue of the Attribution Modeling Maturity. Therefore, an Attribution Modeling Maturity Model (AMMM) was proposed in this study to help assess and improve the quality of attribution modeling capabilities of an organization and thereby its quality of marketing performance.

This study focuses on the topic of the assessment and evaluation of the maturity levels in the market in regards to the capabilities to use attribution modeling techniques. A theoretical model was developed and evaluated in this study to help solve this problem by synthesizing the existing knowledge about attribution modeling techniques with qualitative and quantitative data collected from experts in this area.

1.2 Research Objectives

The purpose of this thesis is to *develop and evaluate an Attribution Modeling Maturity Model to help assess the capabilities of an organization in the utilization of attribution models in the market*. The model is used to support the understanding of the abilities of an organization in applying attribution modeling techniques and thus identifying the strengths and weaknesses of the organization, which will ultimately help optimize marketing performance. Specifically, the aim can be narrowed down to the following objectives:

1. Understand and discuss the concept and scope of AMMM.

In order to develop the AMMM, we first need to illustrate why we need it, and why it is important to develop the model. This includes understanding the concepts of 'Attribution Modeling', 'Maturity Model' and conducting research on existing maturity models that are related to Attribution Modeling. The combination of scoping decisions will influence

all remaining phases in the development process since it helps identify the focus and audiences of the model and set the outer boundaries for model application.

2. Develop AMMM by identifying different maturity levels and corresponding dimensions and features.

After identifying the importance and purpose of the model, it is time to design and execute. The model needs to be documented before being put into practical use. Basic elements that form a maturity model include the maturity levels, its dimensions, which are defined as a cluster of related activities that work together to achieve a set of business goals (Curtis, Hefley, & Miller, 1995), as well as the common features which institutionalize a specific dimension.

3. Evaluate the validity and reliability of the maturity model.

Once the model is developed, it must be tested for validity and reliability. The dimensions and identified features need to be applied to another party to see if they are robust and would receive similar results as in the development process. If, unfortunately, the result of the validation has great deviation from the development process, it shows that the model is not reliable and should be modified before being applied to businesses.

4. Discuss the practical value of the model by applying it to real businesses.

If the result of validation test of the model is positive with acceptable amount of deviation, the model must be made available for practice. We need to expand the empirical basis and apply it to real business cases to check the generalizability. The result of the application process will indicate if the model is of practical value.

1.3 Research Questions

This thesis project includes research in both scientific and practitioner's domain in order to fulfill the objectives mentioned above. Based on these objectives, the research question for this study is defined as follows:

What elements are required in a maturity model to assess the maturity levels of organizations regarding their capabilities to apply attribution modeling techniques?

In conjunction with the specific objectives, the main research question can be further analyzed in the following sub-questions:

- 1 What is an Attribution Modeling Maturity Model (AMMM)?
 - 1.1 What is Attribution Modeling?
 - 1.2 What is a Maturity Model?
 - 1.3 What are the characteristics of AMMM?

3



- 2 What should be included in AMMM?
 - 2.1 What are the general levels and dimensions of the model?
 - 2.2 What are the specific features regarding each dimension that influence the Attribution Modeling Maturity level of an organization?
 - 2.3 Are dimensions and identified features valid and reliable to be included in AMMM?
- 3 Is the theoretical model valuable and repeatable for real businesses?

These sub-questions are designed to shape a high level representation of the concepts that need to be investigated in this study and the expected research processes which ought to be the major contributions for the objectives.

1.4 Thesis Structure

The structure of this thesis is as follows: Chapter 2 illustrates the methodologies used in this study, in association with specific research questions respectively. Chapter 3 reviews the literature about Attribution Modeling and Maturity Model, including overviews of existing attribution models and maturity models that are related to Attribution Modeling. This chapter is the foundation for the later steps of the development process which is discussed in Chapter 4. In Chapter 4, the scope and objectives of AMMM are introduced first, followed by a detailed explanation of the entire Delphi study process and the results of it. The validation of the model is also demonstrated in this chapter to check the validity and reliability. Chapter 5 contains the discussion of the application of the model in a real business case. And finally in Chapter 6, the study is concluded, including its limitations and further research potentials.

2 RESEARCH METHODOLOGY

This chapter provides information about the research methodologies that are linked to the research questions defined in the previous chapter. There are generally three methods in this research project in order to answer the research questions.

First of all, Literature Review was conducted to interpret and evaluate relevant researches that are available about attribution modeling techniques as well as maturity models. The result of this method is an overview of the current maturity models that are related to attribution modeling techniques, which serves as a starting point for the identification of general dimensions and levels of the Attribution Modeling Maturity Model. Secondly, the development of the Attribution Modeling Maturity Model follows the process of AMMM Development Framework which is developed by the researcher. It is a combination of the Maturity Assessment Model Development Framework proposed by de Bruin et al. (2005) and the Design Science Approach developed by Becker et al. (2009). During the development process, another important method has been chosen to draft the model. The Delphi Method is discussed separately here due to its significance to yield the potential results. The success of the application of this method is the foundation for the following validation and practical implementation stages.

 Table 1 represents the positioning of the methodologies in regards to the research questions

 and sub-questions that they are related to. Detailed implementations of the methodologies are

 discussed in the following sections.

Methodology	Focus (Research Question)	Descriptions
Literature Review Method	RQ 1.1, 1.2, 1.3 & RQ 2.1	Collect information about the maturity levels and dimensions that can be embedded in the model based on literatures.
AMMM Development Framework	RQ 2.1, 2.2, 2.3 & RQ 3	A framework defined by researcher based on the frameworks developed by de Bruin (2005) and Becker (2009). This includes three stages: problem definition, model drafting, and validation. The main approaches used here include qualitative and quantitative surveys, interviews, and data analysis.
Delphi Method	RQ 2.2	This method is considered as a valuable research tool when it comes to the development of a framework. The purpose is to gather a consensual opinion from a panel of experts in the related area. Delphi method is chosen here to identify numerous features of each dimension through at least three iterations of surveys and interviews.

Table 1 Focus and Descriptions of Research Methodologies



2.1 Literature Review Method

A literature review includes the current knowledge which provides substantive findings based on theoretical and methodological literatures about a particular topic (Bolderston, 2008). It is the basis for research in almost every academic area. Using a literature review helps collect information that is related to the specific field of study and thus creating a solid level of resources that contribute to further researches.

In this study, the main objectives to use a literature review are: (1) to provide theoretical background to support the research and contribute to the understandings of Attribution Modeling and Maturity Model; (2) to contextualize the study by identifying what others have found out and what can be used for reference and improvement. Based on these goals, literatures, including scientific literatures, international journals about Attribution Modeling and Maturity Models as well as the explanation of various attribution models regarding their advantages and disadvantages, are drawn to answer specific research questions (1.1 & 1.2). Existing maturity models that associate with Attribution Modeling domains are also taken into consideration when conducting literature review in order to answer sub-question 1.3. The keywords used to collect relevant literature include: 'attribution modeling', 'marketing intelligence', 'marketing analytics', 'marketing performance measurement' and 'maturity model'. Besides looking for literatures using these keywords, the snowballing method, proposed by Jalali and Wohlin (2012), which aims to identify articles that have cited the articles found in the research, is also used to extract information. The initial articles found through keyword searching are used as a starting point and are explored further to gain a wider view on the topic. With several iterations of this process, a complete image is established to picture the most relevant literatures for this study. The combination of keyword searching and the snowballing method is less time-consuming and contributes to a better selection of literature ultimately. The result of literature review is presented in Chapter 3 in details

2.2 AMMM Development Method

In regards to the development of the model, a generalized conceptual framework is used based on the Maturity Model Development Framework developed by de Bruin, Freeze, Kulkarni, and Rosemann (2005), as well as the Design Science Approach defined by Becker, Knackstedt, and Pöppelbuß (2009). These two approaches are chosen because they are well established in literatures and have proven to be applicable in practice.



2.2.1 Maturity Model Development Framework

De Bruin et al. (2005) posited in their study that it is of vital importance for organizations or institutions to evaluate what kind of model they want to develop. There are mainly three types of maturity models:

- 1. Descriptive: If a model is descriptive, the purpose of the model is to assess the current 'as-is' situation with no provision for the improvement of maturity or business performance.
- 2. Prescriptive: A prescriptive model provides emphasis on indicating the approaches to improve business performance and affect business value in a positive sense.
- 3. Comparative: The aim of a comparative model is to enable benchmarking across various organizations within disparate industries.

In the case of Attribution Modeling Maturity, the model is addressed to be Descriptive, which focuses on the identification of the current situation of an organization in its Attribution Modeling Maturity Level. However, the model can also be used in a prescriptive sense. This is because the organization can possibly achieve better performance by identifying what dimensions and features need to be improved to get to a higher maturity level. How an organization can gain both Descriptive and Prescriptive insights from the model will be discussed in detail in Chapter 5, the Application of AMMM.

Following the fundamental concepts regarding different types of maturity models, we now consider the steps announced by de Bruin et al. (2005) in their development framework. The six steps needed to develop a maturity model are illustrated below in Figure 1:





Table 2 gives a detailed explanation of the key tasks for researchers in each phase.

Table 2 Key Tasks to Develop a Maturity Model

Step	Key Tasks				
Scope	 Set the boundary and focus (dimensions) of the model Identify the key stakeholders who will assist in the developing process 				
Design	 Establish criteria which influence the design of the model Identify the needs of audience Define the appropriate documenting media which helps report the model to audience explicitly Determine respondents and area of application 				

Populate	 Identify domain components Establish critical success factors/features for each dimension Determine measurement units/instruments
Test	 Evaluate the model in regards to relevance and rigor Design interviews and surveys to modify the model with respect to validity, reliability, and generalizability
Deploy	 Deploy the model within the organization Apply the model to entities that are independent of the development process
Maintain	 Provide available resources for the application of the model Create a repository to keep track of the interventions and evolution of the model

2.2.2 Design Science Approach

In the study of Becker et al. (2009), a procedure model is designed as a manual to develop and evaluate well-founded maturity models methodically. They addressed eight criteria for the development of maturity models, which include substantial comparison with existing maturity models, iterative developing procedure, well-defined evaluation process, a variety of research methods, identification of problem relevance, problem definition, targeted presentation of results, and scientific, detailed documentation of the entire design process of the model.

Based on these criteria, a five-stage development procedure is designed:

Stage 1 – Problem Definition:

In this stage, both the targeted domain and audience are identified. In the meantime, the objective of the model must be demonstrated explicitly.

Stage 2 – Comparison of Existing Maturity Models:

The aim of this process is to review the shortcomings of previous models, and thus gaining references and facilitating further improvements of them.

Stage 3 – Determination of the Design Strategy:

Structures and contents of the new model, whether they are designed as an improvement of a specific existing model or a combination of several old models, should be defined in this stage.

Stage 4 – Iterative Maturity Model Development:

This development stage includes four sub-stages, including the design of levels of the model, the selection of designing approaches, identification of dimensions and their attributes in the model, and the validation of the results.

Stage 5 – Conception of Transfer and Evaluation:

Different forms of results are transferred into academic documentation in this stage in order to make the maturity model accessible to all previously defined user groups.

2.2.3 AMMM Development Framework

According to the two frameworks discussed above, identifying the focus and target group of the model is preliminarily needed. In the meantime, researches on existing maturity models are necessary to define the problem and accordingly work on the solutions. Besides, the comparison of existing models also serves as an essential reference to define the characteristics of AMMM. The development of the model itself needs to be executed in depth, from basic identification of dimensions and levels, to the recognition of detailed attributes or features associated with each dimension. What is equally important is the evaluation of the model. Concerning the applicability as well as the reliability of the developed model, it is of vital importance to test the validity before using it in practice. Finally, after the model is validated, it should be applied in real business cases to check the repeatability and generalizability. Based on the similarities and differences between these two frameworks, the final AMMM Development Framework can be divided into four main phases for this study:

Phase 1 – Problem Definition:

The overall problem is defined in this phase by comparing existing works related to AMMM, and correspondently identifying the characteristics of AMMM through an overview of these existing models. The characteristics of the AMMM include the focus/objectives of the model, the development stakeholders who assist throughout the development process, the target audiences who will benefit from the model, and precise methods as measurement instruments. After defining the elements for AMMM, general dimensions and levels should also be defined based on previous literature review in this field.

Phase 2 – Model Drafting:

The initial version of the AMMM is developed using the Delphi method, which aims at gaining consensus on the identification of features that should be included in the model. After several iterations of surveys and interviews, features specialized to different dimensions, which have received an acceptable level of consensus regarding their influence on Attribution Modeling Maturity, are ready to be tested. Details about the Delphi method are illustrated in section 2.3.

Phase 3 – Validation:

Before applying the AMMM to a real business case, the dimensions and features identified through Delphi study need to be validated externally. For this reason, the dimensions and features are presented to a group of people who are experienced with Attribution Modeling but are not included in the Delphi process. The result is compared to that of the Delphi study

9

to check the validity and reliability. After the validation process, rated dimensions and features identified in the Delphi study are finalized to be included in the model.

Phase 4 – Application:

The application process is included in both frameworks and is of vital importance to check the practical value of the maturity model. During the process, the documented model is implemented with measurement instrument and presented to its target group. The application process is discussed in detail in Chapter 5 after the drafting of the model.

2.3 Delphi Method

Delphi method is a structured technique which relies on interactive communication with a panel of experts (Okoli, Pawlowski, 2004). It is originally developed as a systematic method used in forecasting or policy-making. The main process of a Delphi study is to send out multiple rounds of anonymized questionnaires to a set of panel members who are proficient in the research area until consensus is reached. After each round, a 'facilitator' collects the results from the previous round including the questionnaires and the comments from the experts. In this way, when presented the results of the answers from other members of the panel in later rounds, experts are encouraged to revise their earlier answers. At the end, the range of the answers will decrease and converge into a generally agreed result.

Delphi method has been widely used for business forecasting and framework development (Loo, 2002). The principle behind this method is that the decisions from a structured group of people are more reliable and accurate than those from random, unstructured groups (Okoli, Pawlowski, 2004). Other research methods for concept development, for example, the Nominal Group Technique (NGT) and the Interacting Group Method (IGM), are also commonly used in history. Delphi method is chosen in this study because it offers solid advantages over other group methods. First of all, the idea generation process in this method is independent, individually based. The anonymity of the method adds richness to the data, since it helps eliminate the group pressure for the panel members as can easily happen with NGT or IGM (Needham, de Loe, 1990). Moreover, issues inherent in face-to-face group discussions, such as interpersonal conflicts, dominant personalities and communication problems are virtually nonexistent due to the fact that there are no direct interactions among the panel members (Hsu, & Sandford, 2007). Last but not least, due to the flexible and repetitive nature of the Delphi study, the researcher is enabled to collect more creative outcomes and maintain the focus of the study in the meantime.

The general planning of a Delphi method in this study is outlined as follows, based on the methodology designed by Okoli and Pawlowski (2004):



1. Problem Definition

Problem definition, aligned with the first step of AMMM Development Framework, is essential for the identification of the scope and the expected delivery of the study. It ensures that the structure of the first survey round, i.e. the general dimensions for the model, is investigated. This part is described in section 4.1, combined with Literature Review Method.

2. Candidate Selection

The criteria for determining who qualifies as panel members are established in this step. The study does not depend on a random group of people. The chosen experts must be qualified only if they have deep understandings of the issue. In order to identify the most qualified group, a Knowledge Resource Nomination Worksheet (KRNW) is established to help identify the most fruitful criteria for choosing the experts. Detailed process is discussed in section 4.2.1.

3. Conducting Delphi Rounds

There are in total three Delphi rounds in this study:

In round 1, an open-ended questionnaire is distributed to panel members with a clear identification of the objective of the study and expected information from the participants. Comments are also required in addition to question items, which enable experts to speak in their own words and provide as much information as possible. The process is discussed precisely in section 0.

In round 2, a quantitative survey based on the result from round 1 is presented to panel members. This survey includes the summarized features each expert mentioned and commented in the previous round and removes duplicated answers. The aim of this round is to collect the rating of each specific feature based on how much influence they have on Attribution Modeling Maturity. The result of this round is demonstrated in section 4.2.3.

Round 3 focuses on the areas where consensus has not yet been reached in the second round. A report on the results from round 2 is presented to experts and opinions towards the results are collected through one-to-one interviews to indicate to which extent a specific feature needs to be adjusted in order to reach the final consensus. The process and results of this round are presented in section 4.2.4.

4. Conclusion

Following the three iterative rounds, criteria are defined to select a group of features that should be included in AMMM. These features are ready for validation. But this is only executed if sufficient consensus is achieved. If not, another survey is needed to reason the disagreement and modify the features further until a higher level of consensus is established. Results of the Delphi study is illustrated in section 4.2.5.

3 LITERATURE REVIEW

In this chapter, the concept of Attribution Modeling Maturity is explored. Before developing a model regarding Attribution Modeling Maturity, we must first discuss the concept of 'Attribution Modeling' and why it is important to develop a model to assess Attribution Modeling Maturity. These aspects are discussed in this chapter to answer Research Question 1. It also serves as a start point for the design of maturity levels and dimensions of the model, which is discussed in detail in section 4.1.

3.1 Attribution Modeling

In order to understand the concept of Attribution Modeling, the history and development process are illustrated in the following section. Apart from that, existing attribution models are also discussed to help generate a global view of how attribution modeling works in the market. Challenges of the implementation of attribution modeling techniques are also addressed in the following section to facilitate a better understanding in what the organizations with the highest attribution modeling maturity levels need to solve.

3.1.1 Attribution in Marketing

Attribution Modeling is regarded as an essential method to help marketers interpret the impact of various marketing activities. It is the process to identify a series of customer 'touch points' which contribute to a desired business outcome, such as making a purchase, and assign credits to various marketing events (Riordan-Butterworth, 2012). Attribution Modeling is an effective approach for marketers to understand what combination of the marketing campaigns affect consumer engagement in what particular order. The purpose of marketing attribution models is to make it visible to marketers what influences customer, when, how and to what extend the interactions are made. This is a crucial process for an organization, who wants to become more customer-centric and optimize media spend for conversions, to achieve business goals.

Digital marketing started around 20 years ago when the power of Internet continued to grow in an exploding pace (D'Angelo, 2009). The advertising industry had from then embraced the digital trend and started searching for the most effective marketing campaigns. These campaigns are often launched across various channels, including both traditional channels such as TV, radio, direct mailing, magazines and digital channels like online display, social media, retargeting and so on. The advancements in technology have made it easier for marketers to measure marketing campaigns. Nevertheless, in the meantime, with a massive amount of data collected, marketers are put under great pressure to gain valuable insights from the data and create effective and efficient marketing events correspondently. When a customer makes a purchase decision, it's always a struggle for marketing experts to figure out which events have contributed to the customer's decision, and thus optimizing the marketing strategies.

Traditionally, marketers use only sales data to calculate the return of investments of a marketing campaign. However, the situation has now changed due to the interrelationships across various channels as well as the complexity of the customer journey. A customer may have numerous interactions with the brand before making a purchase. The lack of transparency about the degree to which each channel contributes to the business goal hinders the long-term development of the organizations (Anderl, Becker, Wangenheim and Schumann, 2013). Therefore, it is crucial to understand what role each channel plays throughout the customer conversion journey.

Attribution Modeling then came into being to assist marketers with the marketing mix. It contributes to the process of obtaining a full picture of what is happening along each marketing channel and to understanding the degree of influence each individual channel has on a customer's decision. However, even though more and more organizations are aware of the importance of Attribution Modeling due to the digital marketing trend, the development of attribution models stayed relatively static in the meantime (Shields, 2015). In spite of its practical relevance, the marketing attribution issue has only drawn the attention from marketing researchers (Rentola, 2014). Application of attribution models is not yet widely found in practice while acceptance and adaption of sophisticated attribution approaches require more than analytical rigor. Nonetheless, numerous studies and researches have already been continuously carried on, addressing the issue of the categorization of attribution models and their usage and impact on different types of organizations. These studies are regarded as a favorable starting point for this research, one of whose objectives is to categorize different attribution models based on their complexity. In this way organizations can be classified to choose the appropriate attribution model depending on their Attribution Modeling Maturity Level. Detailed information about categories of existing attribution models studies is demonstrated in the next section.

3.1.2 Existing Attribution Models

Attribution models exist with various degree of complexity. Simplistic models are justified for their understandability, whereas advanced models are meant to better illustrate the dynamics of marketing channels. In general, there are two most common types of attribution models, as displayed in Table 3.

Type of Model	Description
Heuristics Attribution Model	Distribute credit to different channels based on certain rules (heuristics), including Single Source Attribution and Multi-Touch Attribution Models.
Algorithmic Attribution Model	Investigate across different marketing channels, focusing on customer behaviors, with high requirements in statistical technologies.

Table 3 Types of Existing Attribution Models

Heuristic Attribution Models are rule-based, identified as a start towards understanding the marketing efforts. Depending on the number of channels the marketers choose, the heuristic model can be further divided into Single Source Attribution Models and Multi-Touch Attribution models. Most of the time the rules defined are subjective and not data-driven, which makes the heuristic models less reliable and effective. Algorithmic Attribution Models, though difficult to understand and implement, are more reliable and accurate since they are based on customer behaviors, which depend heavily on real data. With some overlaps observed between these two types of models, both of them have their pros and cons. In the following section, the two types of models are discussed in detail respectively.

Heuristics Attribution Model

Despite the fact that the heuristic model ignores considerable amount of valuable information, it is still predominantly used due to its understandability and easiness to implement. There are mainly two kinds of heuristic models in history. Single Source Attribution model, also known as Single-Touch Attribution Model, assigns all the credit to only one event, such as the first click, the last click, or the last non-direct touch. This kind of simple rule-based model fails to take all contributive elements into account and is thus generally considered less reliable and accurate (Miller, 2013), compared to other forms of attribution models. Yet this model is more descriptive and suitable for organizations where lower consideration process could be sufficient to achieve the analytic goals. As the organization grows, models with higher maturity levels are needed. Multi-Touch Attribution Model aims to track how a customer interacts with various marketing channels and his or her behaviors after each explosion of advertisements. Multi-Touch Attribution Model, which assigns credits to various touch points based on pre-defined heuristics, is one of the most popular attribution models when it comes to digital advertising (Shao, & Li, 2011). Most commonly used Multi-Touch Attribution Models include Linear Attribution Model, Time Decay Attribution Model, Position-Based Attribution Model and Customized Attribution Model. Table 4 illustrates the characteristics of the most common heuristics attribution models.

Category	Model	Focus	Pros	Cons
	Last Click	Last Interaction	 Easy to implement and understand Provide insights into later-stage channels that contribute directly to conversion 	 Low accuracy Lack of information about interactions in earlier stage Unfair assessment
Singlo	Last Non- Direct Click	Last Interaction Prior to Conversion	 Easy to implement and understand Avoid the troubles of direct data 	 Low accuracy Can cause undervaluation
Source First Click First Click First Interaction - Easy to imple understand - Effective in in channels in i customers	 Easy to implement and understand Effective in identifying influential channels in introducing customers 	 Low accuracy Insufficient credit to later stage touch points 		
	Assist	Intermediate Interaction	 Easy to implement and understand Relatively accurate in reporting the effect of intermediate interactions 	 Biased May cause double counts of conversions
	Linear	Every Touch Point	 Easy to implement Take into account every touch point instead of a single activity 	 Not take into account different effect of each channel
Multi-	Time Decay	Last Interaction	 Assign credits differently to each touch point Address the significance of the activities closer to conversions 	 Not able to address the impact of earlier interactions
Touch	Position Based	First Interaction and Last Interaction	 Take into account every touch point Address and optimize the impact of both the first and last interactions 	 Can cause undervaluation of channels with fewer credits
	Customized	Customized focus	 Take into account every touch point Relatively more accurate and reliable 	 Can be subjective and biased

Last Click Attribution Model is the most often used and the standard attribution model in all web analytics tools (Kaushik, 2013). Basically, it shows the advertising activities just before customers converted and assigns all the credit to the most recent interactions with them. The last click model is practical to measure the effectiveness of different channels that contribute to a direct conversion, such as landing pages. As simple and easy as it is to implement and understand, drawbacks obviously exist with this model as it does not show anything else that

also led to conversions. As a modified version of the Last Click Attribution Model, the Last Non-Direct Click Attribution Model gives 100% of conversion credit to the last marketing activity prior to the conversion. This activity can be anything, such as social media, online display, affiliate, etc., except for direct traffic. It follows the rationale that when a visitor comes directly to your website, which contributes to the direct traffic, he or she has already made a decision to convert. So the channel that pre-empts the direct visit, i.e. the last nondirect touch point, instead of the landing page, should take a great proportion of credits. When you use the Last Click Attribution Model, direct data is sometimes misleading because untagged or improperly tagged social ads and posts can also be classified as direct traffic rather than in its own category since this kind of data is difficult to be qualified (Kaushik, 2013). The Last Non-Direct Click Attribution Model avoids the troubles of direct data.

Unlike these two models mentioned above, the First Click Attribution Model, on the other hand, assigns 100% of the credit to the first interactions of the conversion path. Though it is useful for identifying the customers' decision-making process, it ignores the fact that the consideration of converting may not begin at the first impression (Rentola, 2014). As discussed by Benway (1998), banner blindness is developed intuitively as customers learned to avoid looking at banner advertisements. Thus, the first touch point, such as the banner advertisements, may not work on the customers at all. While some organizations are still using this model, others choose to focus on an intermediate stage of the conversion path. The Assists Attribution Model, or Last (insert marketing channel) Touch Attribution Model pays more attention to the identification of the marketing channels throughout the conversion path (Anderson, 2012). It is evident that a channel which is neither the first interaction nor the final touch point can still have significant influence on customers' decision-making process. Organizations also want reports to gain insights in how much the middle-stage channels of the customer journey contribute to the conversions. The upside of this kind of models is that the report of a certain intermediate marketing channel is usually relatively accurate. However, the downside is that each of the tools used is extremely biased and may overestimate the impact of the channel (Con, 2016). For example, if a customer clicks on Twitter on Monday and then Facebook the next day before converting, both Twitter's Last Twitter Touch model as well as Facebook's Last Facebook Touch model will claim all the conversion credit to themselves, which causes double counts of conversions.

To summarize, Single Source Attribution Models only assign credit to a single touch point. Thus, it is very important to figure out which marketing channel you want to award credit to. First click models are effective for building up your lead lists, whilst later touch attribution models, such as the last click model, last non-click model, as well as assist attribution model, are used to target existing leads. Due to its understandability and simplicity, the Single Source Attribution Model is often chosen by organizations that do not have focused resources or variables for more complex models. This is why a large amount of companies use this type of model in spite of the awareness of significant flaws the model may bring about due to inaccuracy and ignorance of insightful data. Multi-Touch Attribution Model, also known as Fractional Attribution Model, is designed to clarify the combined impact of multiple marketing channels (Shao, & Li, 2011). A straightforward way of distributing the credits is to evenly assign credits to each single touch throughout the customer journey. This approach is called Linear Attribution. The positive effect using Linear Attribution Model is that it emphasizes the reminder effect of advertisements (Rentola, 2014). Throughout the customer conversion journey, each advertisement works as a reminder and contributes to the final purchase process. This fact makes the model a promising alternative for Single Source Attribution Models. However, it shares similar disadvantages as the single source models since it does not take into account the uneven impact of different touch points.

To overcome the obstacles organizations always encounter when using the Linear Attribution Model, the Time Decay Attribution Model was proposed, which assigns the most credits to interactions closest to the conversion with the assumption that the closer to the converting process, the more effect the channel has on the conversion (Sheridan, 2016). However, the model only considers one point of view on customer behaviors and lacks the ability to identify the importance of the interactions which originally brought customers to the brand. It can also cause a low amount of credits for highly prominent touch points if they happened at an early stage in the customer journey, as in the same case with Linear Attribution Model. Another commonly used Multi-Touch Attribution Model is the Position-Based Attribution Model, which is also called U-Shaped Attribution Model (Con, 2016). This model tells the most holistic story about the lead generation process. As we can tell from the name, the Position-Based Attribution Model assigns credit based on the position of the channels in the customer journey, taking into account every single touch point, whenever a channel is at the beginning, the very end, or somewhere in the middle of the conversion funnel. Two key touch points are emphasized in this model: the first touch that introduced customers, and the last that closed the conversions. These two touches get the most credits while the other channels share the remaining credits equally. The advantage of this model lies in the assurance that every single touch point receives a part of the credit and it allows you to optimize the first and last interactions. However, as with the First Click and Last Click Attribution Models, assigning so much credit to the first and last touch points can be misleading, possibly bringing about unpractical credits to less-valued channels.

Last but not least, the Customized Attribution Model is the 'Holy Grail' of the attribution models which allows you to mold your own model and align it to specific business objectives (Kaushik, 2013). While it seems easier to rely on the readily available heuristics, you can simply improve your marketing attribution by making adjustments to the weight for each touch point and optimize the outcomes based on the specific customer conversion journey. With this model, you can layer into various factors that are important and influential to your business and thus personalizing and optimizing the marketing channels regarding the results of the model.

In general, the heuristic models discussed above, including both Single Source Attribution Models and Multi-Touch Attribution Models, are strictly based on pre-determined principles. Each model focuses on a specific type of organization and has its own pros and cons. Marketers have to be extra careful when sorting out the models to distinguish between highperforming and low-performing channels so that they can distribute the marketing investments in a more effective way. However, there is actually no space for marketers to gain insights from the massive amount of data using Heuristic Attribution Models since the rules are all based on assumptions. The results may be subjective and biased. To tackle the problem of understanding customer behaviors and eliminating bias, advanced Algorithmic Attribution Models should be considered.

Algorithmic Attribution Model

As a result of human interference in the usage of Heuristic Attribution Models, this category of attribution model is fairly subjective. Moving further up the maturity scale, a data-driven algorithm approach is needed. And then there came the Algorithmic Attribution Model, also known as Advanced Probabilistic Attribution Model. This model requires high-level machine learning and statistical modeling techniques to derive the probability of conversion driven by various marketing channels (Raab, 2011). In this way, it helps diminish inaccuracy caused by subjective assumptions used in Heuristic Attribution Models. Generally, according to Anderson (2012), the Probabilistic Model is used to weigh the value of each touch point relative to the others preceding the conversion. The key of the success of this model lies in the richness of the incoming data. If the data you collect is not solid enough, you may be correspondently not able to gain comprehensive insights from the data and thus bringing about unexpected flaws.

In the academic area of computational advertising, it has been a hot research topic to figure out how to take into account the synergetic effect of multiple advertising channels and assign credits to each of them based on well-founded data. A few data-driven models have been developed and studied extensively to solve the problem that existing rule-based multi-channel attribution models have and uncover the contributions from all relative touch points along the customer behavioral path.

One of the first approaches is developed by Chatterjee et al. (2003), aiming at the understanding of customer behaviors using binary logistic regression. In this study, customer behavior was modeled based on the click-proneness on advertisements, i.e. the probability of user clicking a banner advertisement. The result of his studies shows that the probability that a customer clicks a banner advertisement decreases with a function related to the number of advertisement exposures. Most of the time customers would react only to the first exposure to an advertisement, which indicates that repeated display advertisements exposures have no added impact on customers. As pointed out by Rossi and Albenby (2003), the drawback of this approach is that it does not consider multi-channel effect. Nottorf (2014) later extended

this approach to model customer behaviors across various marketing channels. A mixture model is used in his study to model the combination of multiple probability distribution components (Bishop, 2006). The major finding of his study is that in case of banner advertising, the proneness to click decreases as the number of ad exposure grows, while the probability of display video advertisements stays approximately the same as the number of exposure changes. Generally, Chaterjee (2003) and Nottorf (2014) focused on the prediction of customer behaviors, how customers would respond to various marketing channels, and the probability that the customers click on the advertisements. However, in the meantime, they ignored the importance of customer conversions. Except for predicting the clicking probability, the probability of converting is especially crucial.

Shao and Li (2011) proposed a bagged logistic regression model which takes into account customer conversion process and the cross-channel effects. The purpose of the model is to predict conversions based on the ads viewed by a user. The bagging technique ("bootstrap aggregating") they used overcomes the common problems with logistic regression (Rentola, 2014). In their study, the exposures of the advertisements were also counted to characterize their browsing path, as in the models developed by Chaterjee and Nottorf. Improvements were made by averaging the coefficients which helped mitigate the risk of overfitting and by applying the bagging technique to reduce the estimation variance of the model. Consequently, it contributes to assigning the credits to different marketing channels based on the parameters of the trained regression model. The only downside of this model is that higher order conditional probabilities are not used in this model, which at the end reduces accuracy. Based on their work, Dalessandro et al. (2012) extended the model and proposed a more complex, causal estimation attribution modeling methodology. The parameters used in the model were collected to measure the marginal value of each touch point directly. However, their model based on the causal parameters is quite complicate and difficult to interpret and implement.

Another frequently addressed algorithmic attribution modeling technology is the Markovian approach which models the customer conversion process as Markovian Graph. This was first introduced by Abhishek et al. (2012). They captured the customers' deliberation process along the customer journey by applying a dynamic hidden Markov model. Later, Anderl et al. (2013) developed a graph-based Markovian framework to estimate the transition probabilities across different channels and thus defining the optimal credit distributions. The greatest strength of this approach is that it does not require highly aggregated data. Therefore, customer behaviors can be captured more easily based on structural correlations in individual level data. However, only limited differences were found in their results between their approach and the first- and last-click models. Moreover, undervaluation of the display advertisements inevitably existed since they only used clicks, excluding impressions, in their data sets. Similarly, Xu et al. (2014) calculated average probabilities of conversion across multiple online marketing channels, claiming that the impact of display advertisements is underestimated compared to search ads when using conversion rate.

Multivariate time-series modeling method, which aims at estimating the relationship between the advertising impact and the conversion rates, derives the credits of each channel based on the simulated conversion volumes. Kireyev et al. (2016) proposed a multivariate time-series model to analyze the attribution dynamics of display advertisements and search engine marketing. This model they developed contains several individual time-series models, each of which interacts with one another. Impressions and clicks were modeled to check the spillover effects display ads have on search advertising. As with all the other existing models, this model has several disadvantages: firstly, display and research are the only two channels that are modeled; moreover, extension of the model into a site level is hardly possible; and lastly, the long-term effects of investment on a certain channel may be difficult to predict.

In spite of the fact that more and more attention is drawn in the academic area to develop advanced Algorithmic Attribution Models, there is still difficulty in the application of these models. Apart from that, there are some persistent problems to facilitate the maturity of attribution modeling techniques. In the next section, the challenges for Attribution Modeling will be discussed.

3.1.3 Challenges for Attribution Modeling

Despite the significance of tracking and evaluating the effectiveness across channels, only 54% of marketers have applied attribution modeling techniques in practice (Kennedy, 2015). This is because developing and applying a systematic attribution model is still a challenge. Although attribution modeling technology has experienced incredible progress over the years, it does not grow with digital marketing activities at the same pace. While contribution has been made by several attribution models to keeping track of various touch points throughout a conversion path, the inadequacy of the currently used models still exists. There are several commonly encountered issues when using attribution modeling techniques.

First of all, the attributed Return on Investment (ROI) of marketing channels is only an incremental part of the total ROI (Figure 2), which means that current attribution modeling techniques are facing the challenge to address the significance of offline channels. The idea behind Attribution Modeling is to assign credit for a conversion amongst different marketing channels preceding it. In this way, we can gain insights in the structured future investments correspondently. Whereas most companies nowadays use attribution models which only keep track of the online channels and their performance, various offline marketing efforts that are hardly possible to track are accordingly ignored. However, the digital marketing touch points that led directly to an individual conversion contribute only to an incremental part of the total return. Determining the influence that multi-channel marketing campaigns have on conversions will become an issue if we do not take into account the relative impact of offline channels. Some offline channels, such as TV or direct mailing, are effective in driving prospects to the online webshop, which is also an important factor to consider when

analyzing the conversions. Nonetheless, even if the importance of the offline channel effects is addressed among marketers, it is still quite challenging to take actions since data identification is not consistent across all sources. Whilst online marketers create opportunities for businesses to gain insights about customer behaviors through clicks, impressions, or traffic, this information is much more difficult to earn for offline channels. Therefore, how to connect online and offline channels is still crucial and remains challenging in order to represent the real ROI of all the marketing campaigns and events.



Figure 2 Attribution Models vs. Reality

Secondly, current attribution models are sometimes not accurate because it is rather problematic for businesses to predict and evaluate external factors. Marketing channels themselves are only partially influential to the effectiveness. There are some external factors, such as pricing, seasonality, economy, marketing campaigns launched by competitors, etc., that also have controlling effects on conversions and sales. Pricing, for example, with respect to competition, is known to have 20 to 25 times greater impact relatively on sales compared to the whole effect all advertising campaigns can have added together (Yamaguchi, 2014). Therefore, the efforts and investments an organization makes on various marketing channels can be biased or even wiped out if they are combined with discounts, promotions, which is quite often the case. This shows that the result of attribution models about the advertising effectiveness can be inaccurate when linked to unpredictable external factors.

Last but not least, another commonly addressed challenge with Attribution Modeling is the difficulty in tracking cross-device or cross-platform advertising exposures and effects. This is one of the biggest attribution challenges due to the massive usage of different devices such as TV, desktop, tablets, mobile phones, etc. (Olson, 2016). The gap prevails in attribution modeling techniques when it comes to measuring customer behaviors and interactions across screens and devices. It is demanding, or almost impossible, to maintain the unique customer ID and keep track of the customer journey across devices. There is no accurate way to identify the behaviors of the same user if he or she switches devices constantly. The reason is

that cookies, which are mostly used in the current attribution models to keep track of the touch points for a specific customer in his or her customer journey, are not interchangeable across devices. For instance, the cookies on your laptop cannot be transferred to your tablet or mobile phone and vice versa. Today, marketers struggle to solve this problem by analyzing aggregated data and accordingly trying to find correlations of customer interactions across channels. But regardless of the attempt, lack of adoption of statistical techniques to identify the actual contribution of each device and the interrelationship among them has limited the improvement of attribution modeling accuracy.

Facing all the challenges mentioned above, why are so many companies still struggling to use attribution models? Because marketers still see the hope and future of multi-touch attribution modeling techniques. As Avinash Kaushik (2013) addressed, "*every attribution model has built into its biases and opinions that often struggle to stand any intellectual scrutiny, or the simple laws of common sense.*" Every attribution Model, from the basic Heuristic Attribution Model to complicated Algorithmic Attribution Model, may bring about inaccurate results due to failing to consider some essential factors. What marketers can do is to test, predict, and compare the possible results, thus relatively improving the model to lead the marketing world closer to the "holy grail", which is the full interpretation of impact of various advertising efforts. The problem we are facing now is 'how can we choose or develop an attribution model that suits the organization most to achieve this goal'. In order to answer this question, we need to have a clear understanding about the current situation of the company in terms of its capability in the application of an attribution model, i.e. how well the organization is prepared for a certain level of attribution Modeling Maturity'.

3.2 Attribution Modeling Maturity

In the previous section we described the concept of 'Attribution Modeling', its utilization in marketing and the challenges marketers face in using the attribution models. In this section, we will introduce the concept of 'Attribution Modeling Maturity' and a 'Maturity Model', followed by an illustration of existing maturity models related to Attribution Modeling.

3.2.1 Definition

Maturity is defined to measure the capability of an organization in terms of its continuous improvement in a specific discipline (Mettler, 2011). An organization with a higher maturity level is more likely to improve in either the quality or the use of resources of the discipline that is measured. The concept of Attribution Modeling Maturity (AMM) is developed by the researcher to identify the capability of an organization in its application of attribution modeling techniques. The higher the AMM, the more capable the organization is to apply a higher level attribution model like the Advanced Algorithmic Attribution Model, while the

organization with a lower AMM is more suitable to apply a simple Heuristics Attribution Model.

What is a Maturity Model? Fowler (2014) defines a maturity model as a tool that contributes to the assessment of the current effectiveness of an individual or an organization and supports identifying the capabilities they need to improve their performance. According to Hamel (2009), a maturity model consists of significant factors for one or more disciplines and describes an evolutionary improvement path based on different levels of capabilities concerning the disciplines. Structured as a series of stages representing different levels of complexity and effectiveness, a maturity model assumes that any organization or individual in the field will pass along the levels in sequence as they become more mature. An Attribution Modeling Maturity Model (AMMM) therefore includes elements that present different features of an organization along the improvement path in terms of attribution modeling techniques.

There are two common approaches to implement a maturity model: the top-down approach, such as developed by Becker et al. (2009), which identifies a fixed number of maturity levels first before corroborating with specific characteristics (features) that support the assumptions about how maturity involves in the field; and the bottom-up approach, like the one defined by Lahrmann et al. (2011), which specifies distinct dimensions and assessment items first and determines the maturity levels afterwards to induce a more general view of the maturity model from ad hoc, immature processes to more disciplined and mature processes which involve higher quality and effectiveness. In this study, we choose the first approach to develop AMMM. The identification of maturity levels for AMMM is conducted first, based on the extensively used Capability Maturity Model. Detailed defining process of the maturity levels will be discussed in section 4.1. We now introduce the concept of the Capability Maturity Model.

Capability Maturity Model

Maturity models have proliferated across a variety of domains and are often derived from the generally acknowledged Capability Maturity Model (CMM). CMM focused on the area of software development process and was introduced and developed by the Software Engineering Institute (SEI) at Carnegie Mellon University. The model has gained worldwide acceptance and is applied later to many other fields such as business intelligence and process management and optimization.

CMM consists of five aspects including *Maturity Levels*, *Key Process Areas*, *Goals*, *Common Features* and *Key Practices*. These attributes of CMM are summarized in Figure 3 (Curtis, Hefley, & Miller, 1995). *Key Process Areas* are defined to establish a cluster of related activities that work together to achieve a set of business goals (Hamel, 2009). In this study, the key process areas included are illustrated as '*Dimensions*' to create easier interpretation

for readers and participants throughout the research process. *Common Features* covered in the model are identified as practices that institutionalize a certain dimension, including the ability and commitment to perform, the measurement and analysis, as well as the implementation verification (Hamel, 2009).



Figure 3 Attributes of CMM

Maturity levels are defined along the continuum of the model, including five different stages: *Initial, Repeatable, Defined, Managed* and *Optimizing*. **Table 5** gives a detailed explanation of each level.

Table 5 Maturity Levels of CMM

Maturity Level	Description
Initial	This level is also described as <i>Chaotic</i> when the processes are typically undocumented and facing dynamic changes, gravitating to an ad hoc and uncontrolled manner and result in an unstable and chaotic environment.
Repeatable	The processes in this level are repeatable and unlikely to be rigorous, but documented in a formal and sufficient way and are maintained during times of stress.
Defined	Standard and defined processes are established and embrace a degree of improvement over time. The organization becomes process driven and integrated to achieve better process performance.
Managed	Metrics are used to measure, control and understand processes. Management uses quantitative data to adjust and adapt the processes without pronounced losses of quality.
Optimizing	Focus is addresses on continuous improvement and optimization of process performance and capabilities through incremental technological changes and innovations.

Within each of these maturity levels, dimensions are characterized with a set of *Goals* that outline the states that must exist in order to implement the dimension in an effective and lasting way. In the meantime, *Key Practices* serve as the foundation, i.e. the infrastructure and the practices that provide effective support for the implementation and institutionalization of the area.

Apart from CMM, many other maturity models, such as Business Process Management Maturity Model, Change Management Maturity Model, Business Intelligence Maturity Model, Application Performance Management Maturity Model, etc., share similar objectives to define the sophistication of the measurement and analysis skills for an organization. However, maturity models have gained some bad reputation due to multiple reasons. Hamel (2009) argued that the commonly acknowledged drawbacks of maturity models include lack of formal theoretical basis, vague empirical support, encouragement of the change of goals into purely achieving a higher level of maturity instead of the mission of performance optimization.

Despite these concerns, maturity models are still popular among management since they offer a way for organizations to assess their current situation and make it easier for them to communicate and visualize their status and thus contributing to improvement. In business management, plenty of evidence has shown that maturity models are of vital importance as they allow for a better positioning for the organization and give directions in the next steps towards better performance. In terms of the marketing field, developing a maturity model to assess the position of an organization in applying attribution modeling techniques is decisive before actually putting an attribution model into practice. In the next section, we will present and discuss about existing maturity models that are relevant to this area and compare their similarities and differences so that we can use them as a reference to define the characteristics of AMMM.

3.2.2 Existing Maturity Models

Combining the concepts of a Maturity Model and Attribution Modeling, the Attribution Modeling Maturity Model (AMMM) is defined to categorize organizations into different levels based on how the organization has implemented industry-leading attribution analytics practices. In order to identify the characteristics of AMMM, information about current maturity models gathered from literatures is needed. However, there are hardly any maturity models that focus specifically on the capabilities of using attribution modeling techniques. Nevertheless, in areas related to Attribution Modeling, for example, marketing intelligence, marketing analytics, marketing performance measurement, as well as divisions like digital marketing and web analytics, more literatures are discovered. Therefore, in this study, overviews of current maturity models in these areas are used as a starting point for the development of AMMM. The models included in Table 6 are analyzed to discover the answers to Research Question 1.3 presented in Chapter 1. This leads to an overview of the levels and dimensions chosen in existing maturity models. Only models that have full documentation are included to ensure a better understanding and explicit comparison among these models.

Model	Designer	Time	Focus	Levels	Dimensions
Attribution Analytics Maturity Model	Borstein	2014	Attribution Analytics	1.Laggard 2.Follower 3.Leader	Tooling; Breadth of Measurement; Depth of Measurement; Process; People & Culture
Marketing Optimization Analytics Maturity Curve	Chertudi	2012	Marketing Performance	 1.Beginner 2.Intermediate 3.Export 4.Visionary 	Tracks; Metrics; Solution; Customer Benefit; Marketer Benefit; Organizational Benefit
Marketing Analytics Maturity Assessment Model	Blastam. com	2013	Marketing Analytics	0.Impaired 1.Iniitiated 2.Operational 3.Intergrated 4.Competitor 5.Addicted	Management, Governance, Adoption; Objective Definition; Scoping; Analytics Team, Expertise; Continuous Improvement Process, Analysis Methodology; Technology, Data Integration
Marketing Performance Management Maturity	Con	2017	Marketing Performance	1.Channel Performance 2.Revenue Performance 3.Predictive Performance 4.Proactive Performance	Strategy; Planning; Measurement
Marketing Performance Optimization Model	Allocadia .com	2017	Marketing Performance	 Static Transitional Progressive Proactive Optimized 	Executive Vision; Organizational Talent; Alignment; Data Visibility; Data Cleanliness; Technology Adoption

Table 6 Overview of Existing Maturity Models

Business Analytics Capability Maturity Model	Cosic, Shanks, Maynard	2012	Analytics Capability	0.Non-existent 1.Initial 2.Intermediate 3.Advanced 4.Optimised	Governance; Culture; Technology; People
TDWI Analytics Maturity Model	Halper, Stodder	2014	Analytics Capability	 1.Nascent 2.Pre-adoption 3.Early adoption 4.Corporate adoption 5.Mature/Vision ary 	Organization; Infrastructure; Data management; Analytics; Governance
Web Analytics Maturity Model	Hamel	2009	Web Analytics Capability	0.Impaired 1.Initiated 2.Operational 3.Integrated 4.Competitor 5.Addicted	Management, Governance, Adoption; Objective Definition; Scoping; Analytics Team, Expertise; Continuous Improvement Process, Analysis Methodology; Tools, Technology, Data Integration
Digital Maturity Model	Mulpuru, Gill	2015	Digital Marketing	 1.Repaire 2.Elevate 3.Optimize 4.Differentiate 	Culture; Organization; Technology; Metrics
Digital Maturity Model 4.0	Gill, van Boskrik	2016	Digital Marketing	 1.Skeptics 2.Adopters 3.Collaborators 4.Differentiators 	Culture; Organization; Technology; Insights

Following the descriptions of 10 maturity models that are related to the topic of Attribution Modeling provided in the table above, a general conclusion is given respecting the characteristics which will be used as a foundation for the development of AMMM. The comparison of chosen models provides us with a definitive understanding of the common factors that make up a maturity model. The table is structured based on the typology of design characteristics used in the Maturity Assessment Model Development Framework (de Bruin et al., 2005), including the time of design, model focus, maturity levels and the dimensions (key process areas).

These recently designed models (with the design time starting from 2009 to 2017) focus on different areas, but all models are either concerned with the maturity of marketing analytics technologies or marketing performance optimization. While some models measure the general maturity of the entire organization in its capability to improve marketing performance, some other models, such as the Digital Maturity Model designed by Mulpuru and Gill (2015),

measure specific area within the marketing process independently. In terms of maturity levels, most models in literature utilize five subsequent maturity levels or stages. The general characteristics of these maturity levels are summarized in *Table 7*. It is likely that an Attribution Modeling Maturity Model shares a similar scale in the number of levels, which also aligns with the Capability Maturity Model as discussed in section 3.2.1. The dimensions, given different names like 'Factors', 'Capability Areas', 'Components', etc., are commonly defined applicable in any sector. They are related to the competence of an organization, including strategy alignment, objectives, infrastructure, measurement, culture, human resource, technologies and so on. These dimensions can also be applied and adjusted for the application of marketing attribution modeling techniques specifically. In the next chapter, we will discuss about the levels and dimensions for the Attribution Modeling Maturity Model in detail based on the literature study.

Table 7 Characteristics of Maturity Levels in Existing Models

Levels	General Characteristics
1.Initial	Capabilities performed ad hoc, in isolated instances, or not implemented. Processes are disorganized and dependent on individual efforts.
2.Repeatable	Process thinking starts to emerge. Processes are formally defined. Traditional functions are still in place. Process discipline is not rigorous enough. Capabilities are implemented in a minority of organization units.
3.Defined	The organization becomes process driven and integrated. Processes are intra-departmental and intra-organizational. Well-defined standard processes are established and subject to some advancement.
4.Managed	Processes are measured, controlled and understood using quantitatively integrated data. Capabilities are implemented enterprise-wide.
5.Optimizing	There is focus on continuous improvement, optimization, innovation of processes and capabilities. Feedback from current processes is monitored. Innovative processes are introduced to serve the organization's visions in a better sense.
4 DEVELOPMENT OF AMMM

As described earlier, a generalized conceptual framework is used, based on the Maturity Model Development Framework by de Bruin et al. (2005), and the Design Science Approach defined by Becker et al. (2009), to develop the Attribution Modeling Maturity Model. In this chapter, we will follow the steps of the AMMM Development Framework which is described in section 2.2 and develop the maturity model. First of all, following the step of Problem Definition, the characteristics of the model will be discussed in section 4.1, aligned with the identification of the general maturity levels and dimensions. Features in association to each dimension will be identified using Delphi Method. Detailed development process and results regarding the Delphi rounds will be illustrated in section 4.2. Lastly, the validation process of AMMM will be presented in section 4.3.

4.1 Problem Definition

The development of a maturity model most of the time starts by defining the problem. For this purpose, both the target domain, i.e. the objective and scope, and the target group, i.e. the audiences of the maturity model, need to be determined. In the meantime, according to Becker et al. (2009), the measurement instrument must also be clearly demonstrated as one of the first steps to develop a maturity model.

As discussed in previous chapters, the aim of the Attribution Modeling Maturity Model is to identify and explore the strengths and weaknesses of an organization in its abilities to implement attribution modeling technologies, and thus gaining insights in strategic marketing actions and improving marketing performance accordingly. So the focus of the model is to define different maturity levels of Attribution Modeling application. Since there is lack of literatures about how to choose and apply a suitable attribution model to an organization based on its capabilities, it is responsible for marketers and also business managers to assess the maturity level of the organization so that they can correspondingly create and use an appropriate attribution model to measure their marketing performance. Therefore, the audience of the model should be the management and executives, i.e. marketers, of the organization who have a better understanding of the marketing strategies and can react more effectively to the results of the assessment. During the development process, experts including both academia and practitioners are invited to provide their opinions. They are determined as the development stakeholders throughout the Delphi study process. In terms of the measurement instrument, qualitative and quantitative surveys are chosen in this study to evaluate the elements in the model and eventually assess the Attribution Modeling Maturity of an organization. Table 8 gives an overview of the characteristics of AMMM.

Table 8 Characteristics of AMMM

	Focus	Development Stakeholders	Audience	Measurement Instrument
AMMM	Elements that determine Attribution Modeling Maturity	Academia; Practitioners	Marketers; Business managers	Qualitative and Quantitative Surveys

Following the establishment of the model's characteristics, we must now establish criteria to define the maturity levels. The comparison of existing maturity models that are related to Attribution Modeling in section 3.2.2 has shown that most models are composed out of five distinct maturity levels. Combined with the Capability Maturity Model, we propose the same general structure for the AMMM. With general characteristics of each level defined in Table 7, we can translate them into five levels specific to AMMM, namely *Initial, Operational, Integrated, Managed* and *Optimizing*. In each different maturity level, the organization is 'qualified' or capable of a certain type of attribution models, ranging from basic Heuristics Attribution Model to Advanced Algorithmic Attribution Model:

1. Initial:

Attribution Modeling is acknowledged and used on an ad hoc basis. The organizational culture is not data-driven enough to support the efforts for attribution modeling. Objectives of the utilization of attribution models are not well communicated throughout the organization. *In this level, the organization is not capable to apply any attribution models.*

2. Operational:

Attribution Modeling capabilities are implemented in a minority of organization units. Investments are made in analytic technologies and tools. Various metrics are used to optimize the performance but the resources (data, people, expertise, etc.) are limited. *In this level, the organization is suitable to implement Single-Source Attribution Models*.

3. Integrated:

There is an integrated culture regarding Attribution Modeling. The importance of Attribution Modeling is addressed throughout the organization. Employees have general understanding of the concept. Attribution Modeling processes are well defined and documented. Dashboards are designed to align with strategic business objectives. And data is managed and integrated with all marketing channels taken into account. *In this level, Multi-Touch Attribution Models are most applicable for the organization.*

4. Managed:

The Attribution Modeling processes are measured, controlled and understood using integrated data. Attribution Modeling skills and technologies are acknowledged enterprise-wide. Both online and offline data are correlated into a global view in order to better identify

and understand customer behaviors. Insights and recommendations of the attribution models reach the CXO level. Advanced Algorithmic Attribution Models are suitable for organizations which are at this level, since they are fully prepared for customized data analysis.

5. Optimizing:

Analytics programs are executed smoothly with highly tuned infrastructure, well-established programs and data governance strategies. The organization results in a visionary stage with healthy and agile analytics culture and focuses on continuous improvement and optimization of analytical tools and technologies, data management and attribution modeling capabilities. *In this level, the organization focuses on the optimization of the Advanced Algorithmic Attribution Model facing the current 3 challenges (as discussed in section 3.1.3).*

After identifying the maturity levels, we need to define the dimensions. Based on the research on existing maturity models, four dimensions which are most commonly addressed in these models are chosen to measure Attribution Modeling Maturity. The dimensions are described in detail in Table 9.

Table 9 Dimensions for AMMM

Dimension	Description
Organization	Organization is defined to check the organizational strategies, culture, structure and resources regarding the application of Attribution Modeling techniques. It is identified as the mechanism for managing the use of analytics resources and the accountabilities for the organization to align marketing analytics initiatives with organizational objectives. More specifically speaking, this dimension consists of features like organizational visions and missions, complexity of marketing performance measuring process, architecture and strategic marketing plans, etc.
People	This dimension is closely related to human resources in terms of Attribution Modeling techniques. It is defined as the individuals and groups who continuously enhance and apply their attribution modeling skills and knowledge to improve the maturity of the organization in the application of attribution models. Aligned with attribution modeling initiatives, people are considered to be knowledge intensive in technical, business, and managerial areas. Example features of this dimension include awareness of the issue, understanding of the concept, expertise, experience, motivation, etc.
Data Management	This dimension refers to the development and use of data that is needed for attribution models. It aims to answer questions like 'how extensive are the variety, volume, and velocity of data ready to be used in attribution models', 'how does the organization manage the data regarding big data issues', 'how customer-centric is the organization's data to support analytical processes', etc. The management of customer-centric, integrated data resource, in regards to data quality, and the conversation of data into insightful information by reporting and visualization systems are also

Included in this dimension.TechnologyTechnology is defined as tools and techniques that support and enable the
application of attribution models. Different levels of attribution models
require different complexity in the tools and techniques, including digital
analytics tools, techniques based on the breadth of the measurement (if
multiple digital channels and offline channels are included in the analysis or
not), software and information systems integrity, and more advanced
statistical analysis tools that are used to discover patterns, predict trends
and optimize business processes in the application process of high level
Algorithmic Attribution Models.

4.2 Delphi Study

Delphi method is widely used for gathering data from respondents within their domain of expertise. It has been proven as a popular approach in various fields of study such as program planning, policy determination and framework design. The main advantage of this method is that it contributes to the development of a wide range of alternatives, and helps explore underlying assumptions to make it possible to expose correlate judgments on a topic, spanning a wide dimension of disciplines.

The technique is designed in this study as a group communication process which aims to achieve a convergence of opinions on the dimensions and features that determine Attribution Modeling Maturity. In the consensus-building process, three rounds of surveys and interviews are delivered to collect data from a panel of selected experts. As discussed in section 2.3, the first round of the Delphi study includes open-ended questions to collect opinions from panel members about dimensions and features for AMMM. Second and third rounds serve to summarize and formulate the results from former rounds into a series of more specific questions and work towards consensus. The following sections illustrate the entire process of the Delphi study, including the candidate selection process, the activities and results from the three Delphi rounds and the final conclusions from the Delphi study.

4.2.1 Candidate Selection

The Delphi method is defined to facilitate a group consensus which is formed within an expert panel. Therefore, candidate selection is critical and cannot be overlooked. The result of the Delphi study will only be reliable if panel members are chosen carefully since it is the respective disciplines of the panel members that determine the qualifications and criteria of the model.

In order to prevent overlooking any important class of experts, we need to categorize the potential experts before identifying them. A Knowledge Resource Nomination Worksheet

(KRNW) is designed here for the purpose of identifying the most appropriate expertise areas, disciplines and skills, as well as the departments within an organization that are related to the topic (Okoli, Pawlowski, 2004). Table 10 displays the KRNW for this study.

Expertise Areas	Disciplines/Skills	Departments
 Marketing Performance Measurement Marketing Analytics Attribution Modeling Data Science Marketing Intelligence 	 Analytical Skills Data Analysis Strategic Planning Marketing Skills Customer Relationship Management 	 Academia Marketing Data Governance Management Finance

Obviously, intense data science knowledge is needed to analyze customer data regarding various marketing channels. In this way, the organization can have a better understanding of their marketing performance and is thus capable to reward credits to different touch points. However, Attribution Modeling is not only about data analysis. The expertise areas related to this topic also include decision-making and strategic-driven fields like marketing performance management and marketing intelligence which aim to drive accurate and confident business decisions. Everyday information related to an organization's market is gathered and analyzed for the purpose of determining market opportunities, market penetration strategies and development metrics.

Concerning the accomplishment in these areas, there are several critical skills that panel members for this study must share to give insightful opinions throughout the Delphi processes. First of all, successful marketers and attribution modeling experts must have analytical minds. Knowing the value of the vast amount of available data is an important asset, together with the capability to reveal about customer behaviour from the data and thus gaining insights in the efficacy of various marketing approaches. The experts should also be able to look beyond the data, pick up the patterns and trends from it and create more successful marketing strategies. Apart from that, experience with various marketing activities is also needed so as to give more insights to features that influence the Attribution Modeling Maturity level of an organization, since the AMMM aims ultimately at the assessment and improvement of marketing performance. Specifically, marketing skills like content marketing, mobile marketing, online marketing, social media marketing, etc. can all contribute to the process of evaluating the Attribution Modeling Maturity. In the meantime, to answer the question how mature an organization is in its attribution modeling techniques, we also look for experts who have experience with Customer Relationship Management (CRM), which serves as an essential process to organize and manage a customer's various interaction with a company. CRM skills aligned with all the marketing skills and analytical skills will contribute to a strategic data-driven atmosphere for the entire marketing attribution modeling

process. Therefore, we need to take into account these skills when choosing the panel members for this study.

In terms of the departments that the panel members come from, they can be easily determined with specific expertise areas and skills identified. Marketing and data governance teams are obviously supportive in the process of Attribution Modeling. Experts from the finance department should also be included as marketing performance is closely related to sales information which demonstrates the return on investment in different marketing channels. Moreover, we should also look for experts from the management who have a global view of how to improve marketing performance and are likely to tell how mature the organization is in applying attribution modeling techniques generally. Besides, it is also very significant to get support from academia, which serves as a strong theoretical foundation for this study.

After identifying the categories of the panel members, we need to populate the KRNW with names. We first go through a personal list of contacts and fit as many names as possible into the appropriate categories. And then ask potential participants to nominate other panel members in the same category. Before finalizing the list of the experts, according to Akins et al. (2005), we need to pay attention to several criteria that apply to member selection on all Delphi panels no matter what topic or problem is addressed. Whether the panel member is interested in the research topic is one of the important criteria. It is obvious that for a survey which acquires subjective answers, the interest of participants is very essential towards project completion. Moreover, panel participation may vary from round to round. Interest of the panel member increases the possibility that the expert stays along the entire process. For this reason, the interest of all potential panel members should be checked before invitations are sent out. This can be done by checking an academic publication record, a membership in a professional society dedicated to the topic of Attribution Modeling or related areas, or through networking websites like Linkedin.

The nomination and interest checking process resulted in 10 potential respondents to contact for the Delphi study. All potential participants were explained about the process and the purpose of the Delphi study either through email or face-to-face conversation. At the end 6 out of 10 people agreed to participate in the research process. Table 11 presents an overview of the categories of the 6 respondents.

Departments	Number of Respondents
Academia	1
Marketing	2
Data Governance	1
Management	1
Finance	1

Table 11 Categories of Delphi Panel Members



4.2.2 First Iteration

The Delphi method prescribes that the first round of the study should be open-ended to enable more creative answers and collect a variety of opinions. The objective of the first round is to gather a list of features that the panel members deem influential to Attribution Modeling Maturity. A minimal level of structure was provided in the survey to guide the participants to the right direction. This was done by asking them to fill in features based on four high-level dimensions: Organization, People, Data Management, and Technology, which were chosen beforehand based on the research of existing maturity models related to Attribution Modeling. The definition and descriptions for each of the dimensions are illustrated in section 4.1 and were also provided to the panel members in the first questionnaire. Before filling in the features, respondents were asked to first rate the overall importance of each dimension on a Linkert scale from 1 to 10, where 1 shows that this dimension is not important at all to illustrate the Attribution Modeling Maturity level of a company, whilst 10, on the other hand, claims that the dimension is very influential to the maturity level. The responses from panel members in this round, including the dimension ratings and comments as well as the features provided, are presented in Appendix I.

Seeing from the general dimension ratings, as shown in **Table 12** below, it is apparent that Organization and People dimensions were rated relatively high by all panel members, whereas Data Management and Technology dimensions received more differentiated scores with greater deviations. However, Data Management is generally deemed the most important dimension for defining the Attribution Modeling Maturity of an organization. Technology, on the other hand, as the lowest rated dimension, is considered the least prominent. Some participants think that Technology is as important as other dimensions while others think that Technology itself cannot help deliver a promising result for an organization without the combination of other dimensions. Generally, Technology is regarded less influential compared to other three dimensions.

Dimension	Avg.	Std. dev.
Organization	7	0.63
People	7	1.10
Data Management	8.33	1.21
Technology	6	1.41

Table 12 Dimension Ratings

In terms of features provided within each dimension, the data collected in this round presented a great variety of opinions. In order to achieve consensus at the end, we need to ask the respondents to rate all the given features in the next round. Therefore, the collected data in this Delphi iteration must be structured and summarized into a list of features which are more understandable with more clearance. In this round, the features for each dimension are outlined as follows:

Organization

Organization is defined for Attribution Modeling in this study as the mechanism for managing the use of analytics resources and the accountabilities for the organization to align marketing analytics initiatives with organizational objectives. In the first questionnaire, panel members identified features for this dimension in different perspectives, including how the organization deals with possible changes, how the importance and necessity of the application of attribution models are addressed, organizational structures, strategic plans and actions, processes related to Attribution Modeling, and so on. Table 13 shows the features collected in the first questionnaire for this dimension.

Organization Adaptability Is the organization open to make a change if the market demands a different approach? What approaches does the organization use facing changes, waterfall or Change Capability agile? Vision Does the organization understand their challenges in marketing performance measurement? Marketing How much attention does the organization pay to marketing Accountability performance measurement? **Awareness** Is the organization aware of the importance of attribution modeling? Urgency Does the organization feel the urge to develop an attribution model? Strategy Does the organization have a strategic plan that includes attribution modeling technologies to analyze its marketing efforts and allow it to make data-driven decisions? Culture Is it clear to everyone in the organization that they should work together in order to deliver the best results throughout the attribution modeling process? Process Is the marketing analysis process conducted daily, monthly, or quarterly? Hierarchy How hierarchical is the organization? Do departments work in silos or integrally? Structure Are teams diverse enough to understand what different customers really Diversity need? **KPI Quality** How are the KPIs defined? Integrally, regarding all marketing channels in a global view, or separately, focusing on specific areas? Variety of What channels is the organization proficient to measure? Only several digital channels, or all digital channels? Does it also include offline measured channels channels and cross-device interactions? **Business and** How well is business aligned with IT? **IT** alignment Statistical Is statistical significance indicated within the organization? Significance

Table 13 Features for Organization Dimension

Resource	Are there enough money and resources invested for the attribution
	modeling process?

People

This dimension is defined as the individuals and groups who continuously enhance and apply their attribution modeling skills and knowledge to improve the maturity of the organization in the application of attribution models. The features of this dimension consist of personal capabilities and characteristics that contribute to the attribution modeling process, as well as their skills in technical, business and also managerial areas. **Table 14** presents the features panel members provided for this dimension.

People Flexibility Are people willing to change their ways of working and adapt to the demands of the changing markets? Vision Do people have a clear vision of the challenges they face in developing an attribution model? **Awareness** Are people aware of the importance of attribution modeling? Understanding Do people have a clear understanding of attribution modeling or marketing performance measurement processes? Accountability Do people have clear ownership of tasks and challenges for attribution modeling? Openness Are people who work with data willing to have open discussions about their unique findings when analyzing the data? Dedication Are people willing to dig deep into data and deal with unexpected results throughout the analyzing process? Positioning Are people who work on attribution models on the right positions to involve and influence the management decision-making? Cooperation Are people from within the marketing team and other departments willing to cooperate when help is needed in the attribution modeling process? Are there experienced attribution modeling specialists in the Experience organization to guide the team throughout the attribution modeling processes? Data Science Are there people in the Attribution Modeling Team who are proficient Knowledge in statistical modeling or data mining techniques? Digital Are there people who have digital/online marketing skills to help with **Marketing Skills** the attribution modeling processes? (These skills may include: data analysis, search engine optimization, pay-per-click analysis, social media marketing skills, email marketing skill, mobile marketing skills,

content marketing skills, marketing automation, etc.)

Table 14 Features for People Dimension

Data Management

Data Management is defined to identify the capabilities of the organization regarding all issues related to data, including reliability, processing, integration and accessibility. Apart from that, how customer-centric the data is aggregated is also an important perspective in this dimension since keeping track of customer behaviors is of vital significance for the success of attribution modeling process. Therefore, the resources and aggregation process of data should also be included. The answers provided by panel members in this questionnaire covered not only all these perspectives but also managerial aspects like Data Governance, Data Quality Management, reduction of Data Silos, etc. The features for this dimension are illustrated in Table 15.

Data Management			
Reliability	Are there data collection and analysis methods documented in the organization to ensure data reliability?		
Robustness	Is the data-source 'future-ready' and will it stay reliable in a long term?		
Uniqueness	Is the data customized (consistent with the specific marketing strategies of the organization) and possible to facilitate unique findings?		
Availability	Is the data available, easily and quickly retrievable throughout the attribution modeling process?		
Preparation	Is there enough preparation like explanation of the necessity and importance to encourage data management in the organization in regards to attribution modeling?		
Accuracy	Is there reasonable assurance that the data collection methods for attribution modeling do not produce systematically biased data?		
Variety	Does the data collected include information about all marketing channels from every source (clicks, impressions of each ad, conversions, online and offline data, etc.)?		
Customer- Centricity	Does the data used for attribution modeling include information about behaviors of each single customer? Does it include all touch points throughout a customer journey?		
External Factors	Does the organization take into account external factors (such as seasonality) during the attribution modeling processes?		
Data Integration Platform	Is there a platform for the organization to integrate a large amount of data? A data warehouse or data lake?		
Data Governance	Is there a clear policy to govern the data?		
Data Quality Management	Are there systems and processes in place to measure data quality, regarding Validity, Reliability, Timeliness, Precision and Integrity?		
Data Aggregation	Is the data aggregated with the same format for analyzing?		
Data Silos	Is data for different channels collected in silos or integrally?		

Table 15 Features for Data Management Dimension

Technology

Technology is defined as tools and techniques that support and enable the application of attribution models, including digital analytics tools, data mining tools, information systems, and also advanced modeling technologies. According to the result of the questionnaire, in order to help people understand and use the technologies more easily, the preparation and quality of technology application are also deemed important in this dimension. Although it was considered the least important for Attribution Modeling, there is still a considerable amount of features that the panel members provided. Table 16 presents the features for this dimension.

Technology				
Flexibility	Is the attribution modeling technology capable to change processes?			
Robustness	Does the attribution modeling technology work anytime you need it in a long term?			
Roadmap	Is there a clear vision of what technologies are needed for the organization in the future regarding the changing markets?			
Knowledge Base	Is there a knowledge base system in the organization to train analytics staff sufficiently to use the attribution modeling technologies?			
Accountability	Is there a specific individual who is in charge of the attribution modeling technology?			
Completeness	Is there a complete technology solution or is the organization still doing some repetitive tasks?			
Advancement of Analytics Tools	How advanced are the analytics tools that the organization uses? Does the organization use only Google Analytics, or tools that track detailed purchase path information like eBay Attribution, or is it outsourced to some attribution modeling consultancy firms to work on the data.			
Statistical Modeling Techniques	Are there any statistical modeling techniques used to identify trends and customer behaviors?			
Data Mining Tools	Does the organization use data mining tools to deal with large volumes of data?			
Attribution Modeling Technology	Are there already attribution models used? If yes, what level? Rule-based, or algorithmic models?			

Table 16 Features for Technology Dimension

At the end of the first Delphi iteration, sufficient opinions provided by panel members are collected. Features summarized above are ready for the next round towards consensus. The second iteration is discussed in the following section.

Master Thesis Z.Liu

4.2.3 Second Iteration

In the second iteration, the features collected in each of the dimensions from the first iteration were presented to panel members. Respondents were asked to rate each feature with a five-point Likert scale to show their agreement on the importance of them. This allows the researcher to identify the most affecting features that should be included in the Attribution Modeling Maturity Model. The higher the feature is rated, the more influential this feature is indicated to Attribution Modeling Maturity. For example, a 5 point for 'Adaptability' in the Organization dimension means that Adaptability is a very important feature to show the Attribution Modeling Maturity level of an organization. The higher the adaptability, the more mature the organization is in applying an attribution model. Contrarily, a 1 point for 'Adaptability' means that this feature is not related to Attribution Modeling Maturity at all. Being highly adaptable does not mean that the organization is mature enough to create an advanced attribution model. And the organization can still create a nice and mature model no matter how adaptable it is. After the panel members give ratings to all the features, they are ready to be included in the third round for further consensus. The raw data collected in the second iteration is provided in Appendix II.

In Table 17 below, the features for Organization dimension and their average ratings are displayed in a descending order. Here we notice that most features in this dimension received scores higher than 3.00. Process, Diversity and Hierarchy, which received lower ratings, were deemed less consistent to indicate the Attribution Modeling Maturity. One of the panel members noted that these features are important for the overall growth of the organization but not necessarily influential on the capability of the application of an attribution model. On the contrary, Vision was the highest rated feature. This indicates that knowing the challenges the organization has in measuring marketing performance is rather crucial for the organization in order to apply an attribution model. As a panel member addressed in the comments, having a clear Vision is a precondition in order to gain a high ranking of Attribution Modeling Maturity. In the meantime, the Variety of Measured Channels, also with the highest score of 4.50, was considered a strong indicator. This is because, according to the panel members, more marketing channels you measure, the more accurate the result of an attribution model can be.

Organization	Avg.	Std. Dev.
Vision	4.50	0.84
Variety of Measured Channels	4.50	0.55
Marketing Accountability	3.83	0.98
Urgency	3.67	0.82
Awareness	3.50	0.84
Strategy	3.50	0.55

Table 17 Features Ratings for Organization Dimension

Business and IT Alignment3.331.03KPI Quality3.170.98Statistical Significance3.170.75Resource3.171.17Adaptability3.000.00Change Capability3.000.63Culture3.000.89Structure2.671.21Diversity2.330.82Hierarchy2.001.10			
KPI Quality3.170.98Statistical Significance3.170.75Resource3.171.17Adaptability3.000.00Change Capability3.000.63Culture3.000.89Structure3.000.89Process2.671.21Diversity2.330.82Hierarchy2.001.10	Business and IT Alignment	3.33	1.03
Statistical Significance3.170.75Resource3.171.17Adaptability3.000.00Change Capability3.000.63Culture3.000.89Structure3.000.89Process2.671.21Diversity2.330.82Hierarchy2.001.10	KPI Quality	3.17	0.98
Resource3.171.17Adaptability3.000.00Change Capability3.000.63Culture3.000.89Structure3.000.89Process2.671.21Diversity2.330.82Hierarchy2.001.10	Statistical Significance	3.17	0.75
Adaptability 3.00 0.00 Change Capability 3.00 0.63 Culture 3.00 0.89 Structure 3.00 0.89 Process 2.67 1.21 Diversity 2.33 0.82 Hierarchy 2.00 1.10	Resource	3.17	1.17
Change Capability 3.00 0.63 Culture 3.00 0.89 Structure 3.00 0.89 Process 2.67 1.21 Diversity 2.33 0.82 Hierarchy 2.00 1.10	Adaptability	3.00	0.00
Culture 3.00 0.89 Structure 3.00 0.89 Process 2.67 1.21 Diversity 2.33 0.82 Hierarchy 2.00 1.10	Change Capability	3.00	0.63
Structure 3.00 0.89 Process 2.67 1.21 Diversity 2.33 0.82 Hierarchy 2.00 1.10	Culture	3.00	0.89
Process 2.67 1.21 Diversity 2.33 0.82 Hierarchy 2.00 1.10	Structure	3.00	0.89
Diversity 2.33 0.82 Hierarchy 2.00 1.10	Process	2.67	1.21
Hierarchy 2.00 1.10	Diversity	2.33	0.82
	Hierarchy	2.00	1.10

In the People dimension, all features were also rated relatively high (all above 3.00). However, the standard deviations were also great compared to the Organization dimension. Among these features, Experience, with a moderate deviation, was rated as the most important feature to indicate Attribution Modeling Maturity. Evidently, as pointed out by several participants, people who are experienced in data analysis or marketing performance measurement are needed to deliver a good attribution model for the organization. Understanding of Attribution Modeling and Data Science Knowledge were also highly rated. Openness, which received the highest deviation, is also rated fairly high. The reasons given argued that the more open people are in their opinions and findings, the more valuable insights they will get from the discussion, and correspondently, the more mature the attribution model is. Ratings for all features in this dimension are provided in Table 18 below.

People	Avg.	Std. Dev.
Experience	4.50	0.55
Understanding	4.17	0.98
Data Science Knowledge	4.00	1.10
Vision	3.83	1.17
Dedication	3.83	0.75
Cooperation	3.83	1.17
Awareness	3.33	0.82
Openness	3.33	1.51
Positioning	3.33	1.03
Digital Marketing Skills	3.33	1.21
Flexibility	3.17	0.75
Accountability	3.00	0.89

Table 18 Features Ratings for People Dimension

Data Management dimension received a diverse range of ratings in its features, as we can see from Table 19. Quality of data collected was addressed by most participants. Reliability, Availability, Accuracy and the management process of it (Data Quality Management) received high ratings with little deviation. Robustness, on the other hand, was rated the lowest. One of the panel member argued that an organization does not have to and is not possible to predict marketing trends in the future, which makes it not necessary to be 'futureready' with its data. Customer-Centricity, though rated relatively high, received a great deviation. Some participants claimed that being customer-centric is the foundation of the development of an attribution model, and without individual customer data, an attribution model is not mature to show the complicated effects of various channels. Others held the opinion that customer-centricity is the organizational big line. An attribution model can still be successful with general customer segmentations instead of individual customer data. This feature aligned with Variety, which also received a high deviation of 1.60, should be especially discussed in the third round in order to achieve consensus.

Data Management	Avg.	Std. Dev.
Reliability	4.83	0.41
Availability	4.17	0.75
Accuracy	4.17	0.75
Data Quality Management	3.50	0.84
Uniqueness	3.33	0.82
Customer-Centricity	3.33	1.63
Data Silos	3.33	1.03
Variety	3.17	1.60
Data Integration Platform	3.00	1.41
External Factors	2.83	1.33
Robustness	2.67	1.37
Preparation	2.67	0.52
Data Governance	2.67	0.52
Data Aggregation	2.67	0.82

Table 19 Features Ratings for Data Management Dimension

In the Technology dimension, there were also great deviations for certain features. Table 20 below shows the averaged ratings for all features in this dimension. Apparently, Statistical Modeling Technique was deemed very important, followed by Advancement of Analytics Tools, Data Mining Tools, and Attribution Modeling Technology. In terms of the management of these technologies, Knowledge Base got a great deviation. Most respondents held similar views that an organization needs not only the technology, but also the right implementation and usage of the technology. A Knowledge Base that aims to make the technology right when needed is very important for the success of an attribution model. One panel member had an opposite opinion and stated that as long as people who use the

technologies know what they are handling, a Knowledge Base is irrelevant to Attribution Modeling Maturity. This feature, along with Roadmap, Completeness, and Flexibility, which also received high deviations, should be further discussed in the next round.

Technology	Avg.	Std. Dev.
Statistical Modeling Techniques	4.00	0.89
Advancement of Analytics Tools	3.83	1.17
Data Mining Tools	3.83	0.75
Attribution Modeling Technology	3.83	0.98
Accountability	3.67	0.82
Knowledge Base	3.50	1.38
Robustness	3.33	0.82
Roadmap	3.33	1.21
Completeness	3.17	1.17
Flexibility	2.83	1.17

Table 20 Features Ratings for Technology Dimension

To summarize, the second iteration of the Delphi study provided valuable input for ranking the features within each dimension based on their importance perceived by panel members. In some dimensions, the features were rated closely to each other, while in others, the features were rated very differently. Meanwhile, there was also variation in general ratings of the four dimensions. Specifically, features in the People and Technology dimensions were rated generally higher than features in the other two dimensions. Generally, the third iteration is needed to result in a consensus about the importance of each feature and determine which ones should be included in the AMMM.

4.2.4 Third Iteration

After the second Delphi round, we have collected a variety of opinions from panel members about the importance of different features, depending on how influential they are on Attribution Modeling Maturity. In the third iteration, the purpose is to arrive at a higher level of consensus regarding the importance of the features. This was done by interviewing panel members to see if they agree with the results of the second questionnaire and if they want to adjust their ratings to reach consensus with other panel members.

The result of the second iteration was presented to participants, with the average rating and standard deviation of each feature. Panel members were first asked to give reasons to why they provided the specific ratings for features which received high deviations. In this way, participants can understand the reasoning behind the ratings better and it helps eliminate biases that occurred because of unique personal experience. The next step in this round is for

participants to decide if he or she would adjust the rating to receive the final consensus. All comments provided by panel members in the interviews and the ratings after adjustment are presented in Appendix III.

At the end of the interviews, several ratings were adjusted. Specifically, most discussions were done about features in the Data Management dimension, where the highest deviations were. All panel members discussed with the researcher about Customer-Centricity which was quite controversial according to the result of the second round. As we have already mentioned in the previous section, some respondents argued that Customer-Centricity is an organizational goal which has little influence on Attribution Modeling Maturity, while others claimed that without Customer-Centricity an attribution model can never be customized or mature. In the third round interviews, panel members discussed with the researcher and agreed on the point that Customer-Centricity should be rated relatively higher. The reason is that only if single customer data is analyzed in the attribution modeling process, is the organization capable to tell how different marketing channels influence customer behaviors. And that is the ultimate goal of a mature attribution model. Another feature that was discussed profoundly during the interviews is External Factor. Some panel members argued that External Factor is not important for the development of a mature attribution model since it is already embedded in your data and it does not determine if a model is mature or not. However, some panel members claimed that, as mentioned in section 3.1.3, taking into account external factors is a great challenge when developing an attribution model. It is true that even an immature attribution model may include external factors, but how an organization deals with the external factors is what matters. Therefore, experts agreed after the interviews that External Factor is a fairly strong indicator for Attribution Modeling Maturity.

Apart from the Data Management dimension, Completeness of Technology dimension is also under lively discussions in the interviews. Some panel members claimed it not so important in the second round due to the fact that no matter how complete the technology solution is, there must be repetitive works done to check the accuracy. However, these panel members agreed at the end that without the completeness of attribution modeling technology, the organization is more likely to make mistakes and the findings of the model can be flawed. Therefore, the ratings for this feature were adjusted higher after the interviews. There was also slightly some adjustment of ratings in other dimensions after the third round. Several features in the Organization dimension were adjusted with lower ratings, while some features in the People dimension were rated higher, resulting in lower deviations and higher level of consensus.

Table 21 displays the final ratings and the weighted ratings for all features after three rounds.We can see from this overview that after the interviews, there were more moderate deviationswith most of them under 1.00, compared to the result from the second round. This indicates

that sufficient consensus has been reached in regards to the dimensions and features that influence Attribution Modeling Maturity.

			Std.	Weight
Dimension	Feature	Avg.	Dev.	ed Avg.
Data Management	Reliability	4.83	0.41	40.26
Data Management	Availability	4.17	0.75	34.71
Data Management	Accuracy	4.17	0.75	34.71
Data Management	Variety	4.00	1.10	33.32
Data Management	Customer-Centricity	4.00	0.89	33.32
Organization	Vision	4.50	0.84	31.50
Organization	Variety of measured channels	4.50	0.55	31.50
People	Experience	4.50	0.55	31.50
People	Data Science Knowledge	4.33	0.52	30.33
People	Understanding	4.17	0.98	29.17
Data Management	Data Quality Management	3.50	0.84	29.16
Data Management	Data Silos	3.50	0.84	29.16
People	Vision	4.00	0.89	28.00
People	Cooperation	4.00	0.89	28.00
Data Management	Uniqueness	3.33	0.82	27.77
Data Management	External Factors	3.33	1.03	27.77
Data Management	Data Integration Platform	3.33	1.03	27.74
People	Dedication	3.83	0.75	26.83
People	Digital Marketing Skills	3.83	0.75	26.83
Organization	Marketing Accountability	3.83	0.98	26.81
Organization	Awareness	3.83	0.41	26.81
Organization	Urgency	3.67	0.82	25.67
People	Openness	3.67	0.52	25.67
Data Management	Robustness	3.00	1.10	24.99
People	Positioning	3.50	0.84	24.50
Organization	Strategy	3.50	0.55	24.50
Technology	Knowledge Base	4.00	0.63	24.00
Technology	Advancement of Analytics Tools	4.00	0.89	24.00
Technology	Statistical Modeling Techniques	4.00	0.89	24.00
Organization	Business and IT alignment	3.33	1.03	23.33
People	Awareness	3.33	0.82	23.33
Technology	Data Mining Tools	3.83	0.75	23.00
Technology	Attribution Modeling Technology	3.83	0.98	23.00
Data Management	Preparation	2.67	0.52	22.24
Data Management	Data Governance	2.67	0.52	22.24
Data Management	Data Aggregation	2.67	0.82	22.24
Organization	Statistical Significance	3.17	0.75	22.19
Organization	KPI Quality	3.17	0.98	22.17

Table 21 Final Ratings for All Features

Organization	Resource	3.17	0.75	22.17
People	Flexibility	3.17	0.75	22.17
People	Accountability	3.17	0.75	22.17
Technology	Accountability	3.67	0.82	22.00
Organization	Adaptability	3.00	0.00	21.00
Organization	Change Capability	3.00	0.63	21.00
Organization	Culture	3.00	0.89	21.00
Organization	Structure	3.00	0.89	21.00
Technology	Robustness	3.33	0.82	20.00
Technology	Roadmap	3.33	1.21	20.00
Technology	Completeness	3.17	1.17	19.00
Organization	Process	2.50	0.84	17.50
Organization	Diversity	2.33	0.82	16.33
Technology	Flexibility	2.67	0.82	16.00
Organization	Hierarchy	1.83	0.75	12.83

4.2.5 Results

After three iterations of questionnaires and interviews, we resulted in a final consensus on the features and their importance regarding the influence they have on Attribution Modeling Maturity. In order to determine the features that should be included in AMMM, we must also take into account the weights of the dimensions. It is obvious that features with the same ratings in different dimensions may have different effect on the maturity level of an organization. It is essential to rank the features also based on the importance of the dimension they belong to. Therefore, we create an overall ranking of all features using a weighted rating. **Table 21** above presents the weighted ratings for each feature in a descending order.

The weighted ratings are the results of the feature ratings multiplied by the dimension ratings from the first round (Table 12). For example, the feature 'Reliability' from the Data Management dimension received a feature rating of 4.83, multiplied by the dimension rating, which is 8.33, resulting in a weighted rating of 40.26. The weighted ratings for all features rank from 10 to 50. A feature with a weighted rating of 10 is the least important to indicate the organization's Attribution Modeling Maturity Level, while a feature rated 50 is the most influential to indicate the maturity level and must be included in AMMM. With the overall ratings of each feature, it is very insightful for the researcher and panel members to provide necessary input for AMMM.

Now that we know the weighted rating of each feature, we must further determine which of these features must be included in AMMM based on their ratings. When selecting features relevant to AMMM, we must take into account certain criteria. First of all, features selected at the end must be able to provide a holistic view of the Attribution Modeling Maturity Level of the organization, which means that the features included should cover all the four

dimensions that are deemed important for Attribution Modeling Maturity. This allows the organization to measure their capabilities in different areas and thus contributing to final improvement in general in these areas. Secondly, the selected features must have sufficiently high scores that reflect a great level of importance. This is the main objective of the second and third rounds of the Delphi study: to distinguish less important features from influential ones. Last but not least, regarding the complexity of the model, the total number of features should not be either too high or too low. Too many features may hinder the audience from assessing themselves using the model, whilst an insufficient amount of features will possibly cause omission of important factors.

Based on these criteria mentioned above, the threshold rating for features to be included in the maturity model was set at 24.00. This created a general balance in the number of features from each dimension. Setting the threshold score at 24.00 yields a total of 29 features, consisting of 11 features from Data Management dimension, 9 from People dimension, 6 and 3 features from Organization and Technology dimensions respectively. The ratings of each single feature are all above 3.00, which indicates relatively high importance of the features according to their influence on Attribution Modeling Maturity. In order to meet the criterion of a reasonable level of complexity, the total amount of features should be decreased. This was done by combining certain features in each dimension which received similar ratings and are relevant to each other. Specifically, for instance, Variety and Customer-Centricity from the Data Management dimension both received a score of 4.00. Regarding their definitions, they are both concerned with the effectiveness of customer journey and the identification of customer behaviors. Therefore, these two features can be combined in the application process as one feature. Similarly, Marketing Accountability and Awareness from Organization dimension, both of which focus on the attention and awareness of Attribution Modeling, can also be combined into one feature. After the reallocation of all features, we result in a total number of 25 features at the end, as displayed in Table 22 below, sorted in a descending order based on their weighted ratings. The distribution of numbers of features mostly aligns with the rating of each dimension, with 9 features in Data Management dimension, 8 in People dimension and 5 and 3 in Organization and Technology dimension, respectively. The higher the dimension is rated, the more features it consists of. These 25 features were identified as important elements that eventually form the AMMM. But before using them in practice to measure the maturity level of an organization in its attribution modeling ability, we need to test the result from this Delphi study to check if it is reliable. The validation process is illustrated in the following section.

Table 22 Features to be Included in AMMM

Dimension	Features	
Organization	1. Vision	4. Urgency
	2. Variety of measured channels	5. Strategy
	3. Marketing Accountability	

People	1. Experience	5. Cooperation	
	2. Data Science Knowledge	6. Dedication	
	3. Understanding	7. Digital Marketing Skills	
	4. Vision	8. Positioning	
Data Management	1. Reliability	6. Data Integration Platform	
	2. Availability	7. Uniqueness	
	3. Accuracy	8. External Factors	
	4. Customer-Centricity	9. Robustness	
	5. Data Quality Management		
Technology	1. Knowledge Base		
	2. Advancement of Analytics Tools		
	3. Statistical Modeling Techniques	S	

4.3 Validation

Before applying the AMMM to real business cases, the dimensions and features identified in the Delphi study need to be validated externally. According to de Bruin (2005), a maturity model must be tested for its validity and reliability after it is designed and developed. Once the initial maturity model has been judged complete, which means that an acceptable final consensus, regarding the importance of features, is reached, an external validation test can be initiated in order to improve the convergence of the opinions that the model is accurate and repeatable. This was done by seeking agreement within a selected group of domain experts who were chosen using the same way as discussed in section 4.2.1.

In the validation process, participants were asked to first rate the four different dimensions on a scale of one to ten. What follows was to review the features identified from the first round of the Delphi study and rate them with a 5-point Likert scale, based on how influential the feature is to Attribution Modeling Maturity. What is different with the Delphi study is that the experts included in the validation process were not involved in the entire Delphi process. Moreover, experts for the validation process come from a wider range of departments and industries compared to those that are included in KRNW (Table 10). By using a different group of experts that share characteristics and skills with the panel members of the Delphi study, we ensure that they have the expertise in the area of the study and can provide insightful opinions for what should be included in AMMM. In the meantime, a wider range of their functions and positions helps reduce biases generated by personal experiences since they come from different industries and their opinions are not influenced by other participants throughout the process. There were in total 10 experts from various industries and functioning areas that participated in the validation process. The industries where they are from as well as their departments and functions are displayed in Table 23 below. All of the 10

panel members are experienced with attribution modeling technologies and marketing performance measurement.

Expert	Industry	Department	Function
Α	Mobile	Marketing	Marketing Intelligence
	Communications		Specialist
В	Education	Academia	Professor
С	Industrial Engineering	Sales & Marketing	Marketing Intelligence Officer
D	IT	Data Science	Data Analyst
E	Banking	Sales & Advice	Consultant Marketing
			Intelligence
F	Insurance	Online Marketing	Marketing Intelligence Analyst
G	Publishing	Marketing/Academia	Marketing Intelligence
			Manager/Professor
Н	Consulting	Management Consulting	Digital Consultant
I	Data Management	Data Management	Marketing Intelligence Director
J	Marketing and	Data Analysis	Marketing Analyst
	Advertising		

Table 23 Categories of Validation Panel Members

By comparing the results of the validation survey with the results of the Delphi study, it is possible to evaluate the reliability and validity of the dimensions and features identified in previous sections. If the results of the validation process differentiate from the Delphi study in an unacceptable level, further research is needed in order to determine if the specific elements are ready to be used in practice or if they should be excluded in AMMM. For the purpose of validation, we first compare the dimension ratings of the Delphi expert panel with validation expert panel. Table 24 below displays the scores of the four dimensions given by both the Delphi sample and the validation sample, aligned with the standard deviations.

Dimension	Delphi Study Validation Process			ess
	Avg.	Std. Dev.	Avg.	Std. Dev.
Organization	7.00	0.63	7.60	1.07
People	7.00	1.10	8.50	1.08
Data Management	8.33	1.21	8.20	1.03
Technology	6.00	1.41	6.00	0.67

Table 24 Ratings for Dimensions in Delphi Study and Validation Process

In the validation session, the Technology dimension still received the lowest score. Participants gave reasons for this result, claiming that Technology could be beneficial for the development of an attribution model, but an organization which has mature attribution modeling technology may not necessarily be able to develop a decent attribution model. This indicates that Technology is not as crucial as other dimensions to determine the Attribution Modeling Maturity Level. Data Management, which received the highest rating of 8.33 in the Delphi study, got a relatively high score in the validation process. Reasons were given for this high rating that a mature attribution model relies heavily on good data and effective data management process. Without effective and institutionalized data management, it is very difficult for an organization to develop a decent attribution model. Organization dimension received similar rating as in the Delphi study, ranking the third place of the four dimensions. The greatest difference in dimension ratings between the two processes lie in People dimension. Generally, during the Delphi Study, People dimension received a moderate standard deviation with ratings ranging from 5 to 7, while most experts who participated in the Validation process rated this dimension with higher scores (7-10). It was claimed in the validation survey that experts in the field of Attribution Modeling are the foundation to the development of a mature attribution model. People who understand Attribution Modeling options, implementations and results are very critical for the success of the model, but they are also very difficult to find. From these results, we gather that Technology is deemed the least important by experts and that the dimension ratings from the Delphi study are generally reliable.

After identifying the consensus of dimension ratings between the two processes, we need to ascertain if there are any significant rating differences between the Delphi panel and the validation panel, for specific features within each dimension. This was done by comparing the average scores of each feature from the Delphi study with the average scores from the validation process. In the table below we display the comparison result of the average scores and standard deviations of the 25 features that were determined, after three rounds of Delphi study, to be included in AMMM.

Dimension	Features	Delphi Study		Validation Process	
		Avg.	Std. Dev.	Avg.	Std. Dev.
Organization	Vision	4.50	0.84	4.20	0.79
	Variety of Measured Channels	4.50	0.55	4.00	1.05
	Marketing Accountability	3.83	0.98	4.10	0.88
	Urgency	3.67	0.52	3.60	1.17
	Strategy	3.50	0.55	3.90	0.57
People	Experience	4.50	0.55	4.80	0.42
	Data Science Knowledge	4.33	0.52	4.40	0.84
	Understanding	4.17	0.98	3.50	1.18
	Vision	4.00	0.89	3.70	1.16
	Cooperation	4.00	0.89	3.60	0.84
	Dedication	3.83	0.75	3.80	0.92

Table 25 Ratings for Features in Delphi Study and Validation Process

	Digital Marketing Skills	3.83	0.75	3.80	0.63
	Positioning	3.50	0.84	3.20	1.32
Data	Reliability	4.83	0.41	4.40	0.84
Management	Availability	4.17	0.75	4.30	0.95
	Accuracy	4.17	0.75	3.50	1.27
	Customer-Centricity	4.00	0.89	3.80	1.03
	Data Quality Management	3.50	0.84	3.40	0.97
	Data Integration Platform	3.50	0.84	3.70	1.16
	Uniqueness	3.33	0.82	3.20	0.79
	External Factors	3.33	1.03	3.00	1.25
	Robustness	3.00	1.10	3.00	0.94
Technology	Knowledge Base	4.00	0.63	4.00	0.94
	Advancement of Analytics Tools	4.00	0.89	3.40	0.97
	Statistical Modeling Techniques	4.00	0.89	3.40	0.97

As can be gathered from Table 25, there is an overall consensus between the result from the Delphi process and that from the validation process. Most features showed differences lower than 0.5 points. The features with differences larger than 0.5 points were generally rated lower by panel members from the validation process. The reason for this is not exactly clear, as no additional comments were provided. However, it must be noted that these features were originally provided by panel members from the Delphi study. Certain features may be rated higher as experts tend to be more positive about the features that are identified by themselves, which may possibly bring about overall higher ratings for all features. In contrast, for experts from the validation process, they are likely to rate these features in a less subjective way and thus providing lower ratings in general. Despite these differences in score, we can conclude that the result from the validation process supports the importance of the features as determined in the Delphi study, which contributes to answering Research Question 2.3: '*Are dimensions and identified features valid and reliable*'.

After the validation process, we can conclude that the features identified to be included in AMMM from the Delphi study are reliable and ready to be put into practice. The measurement criteria for each of the features will be established in the application process in Chapter 5 hereafter.

5 APPLICATION OF AMMM

The Attribution Modeling Maturity Model is developed in this research based on the results of the Delphi study, combined with the results from literature review about existing maturity models related to Attribution Modeling and marketing performance measurement. In this chapter, the complete model is applied in practice. This was done by assessing the attribution modeling maturity level of a real business using an Attribution Modeling Maturity Assessment Survey, which is based on the model. With the assessment result of the survey compared with the practical situation as generally perceived by employees from the organization, the validity and generalizability of this model can be evaluated. The following sections illustrate the practical application process of the model as well as the results of it.

5.1 Application Process

Now that the features and maturity levels of the AMMM are established, as displayed in **Table 22** and in section 4.1, we must apply the model in practice using a measurement instrument, which comprises a straightforward representation of the features found in the model. As discussed in section 4.1, qualitative and quantitative surveys are used for AMMM to measure the features and eventually the attribution modeling maturity levels.

In this application process, we developed an Attribution Modeling Maturity Assessment Survey that includes 7 questions in total to evaluate the 25 features. There are in general three different types of questions: Statement, Multiple-Choice, and Single-Choice. Four of the 7 questions are Statement questions which require respondents to state to what extent they agree with the statement that indicates a high attribution modeling maturity level of an organization. The degree of agreement is rated on a scale from one to five, indicating Completely Disagree, Slightly Disagree, Do not Agree/ nor Disagree, Slightly Agree, and Completely Agree, respectively. The more they agree with the statement, the higher score the organization is rated in the correspondent feature, the more likely that the organization has the capability to create a mature attribution model, such as the Advanced Algorithmic Model. These four questions cover 22 features in total in all of the four dimensions. Apart from that, two other questions are Multiple-Choice questions. Each answer item of the questions is an add-up for the maturity level of the organization in its attribution modeling capabilities. In this case, the more items the respondents choose, the more mature the organization is indicated in its attribution modeling capabilities. Scores are also given according to the amount of answer items they choose with 1 attached to none, 2 attached to less than half of the total amount, 3 attached to half the amount, 4 attached to the volume from half the amount to exactly the total amount, and 5 attached to more than the total amount (there is an 'other' option for participants to specify their own answers in both of the two questions). The one last type of question, the Single-Choice question, is for participants to choose only one answer from a list of answer items which reveal the attribution modeling maturity level in an

ascending order with ratings from 1 to 5. Participants are asked to choose the highest level one from the answer items, which is consistent to their situation and best demonstrates their maturity level. With these three types of survey questions, all of the 25 features identified in section 4.2.5 are included in the self-assessment survey. The entire survey content can be found in Appendix IV. The correlations between each survey item and features are also attached.

This self-assessment survey was launched online and sent to employees in an organization where one of the respondents participated in the Delphi process. Six employees of the organization, from the management, attribution modeling team, marketing team, financial team, as well as the data analytics team, including the panel member from the Delphi study, participated in the survey. They were explained in advance about the theoretical foundations, the research objectives and the whole process of the development of AMMM. The purpose is primarily to familiarize the participants with the content of the model, especially the 25 features identified in the Delphi study. After the result of AMMA survey was collected, an hour-long assessment session was followed to gather consistent opinions from participants about their answers to each survey item. In this way, the researcher was enabled to rate each feature with one single score, based on the real situation of the organization. During the assessment session, the characteristics of each maturity level were first explained and the participants were asked to choose the maturity level of their organization based on the descriptions and their current situation. The result of the survey was later shown to the participant for group discussions among the employees and achieve consensus. The resulting judgment of the maturity level as well as all the 7 questions was recorded by the researcher.

After collecting the ratings for all the 25 features, the researcher has to calculate the weighted average ratings for each dimension and furthermore, the attribution modeling maturity level of the assessed organization. It is obvious that, concluded from previous researches, the importance of features varies mightily in each dimension, which means that some features are evidently more influential than others. For instance, Reliability and Robustness in Data Management dimension, which received importance ratings of 4.83 and 3.00 respectively at the end of the Delphi study, may have a big difference in their influence on Attribution Modeling Maturity level of an organization. If an organization gives a score of 1 to data Reliability, it tends to have a generally low level of Data Management maturity regarding Attribution Modeling, even if it scores 5 in data Robustness. This is because Reliability is deemed more influential to the success of an attribution model. Hence, based on the importance ratings resulted from the Delphi study, as displayed in Table 21, we assign weights to every feature and calculate the weighted average ratings for all dimensions. The results are displayed and analyzed in the next section.

5.2 Results

At the beginning of the assessment session, participants discussed about the maturity levels of their organization based on their experience and knowledge of the organization in the four dimensions. The participants judged the overall attribution modeling maturity level of their organization at Level 2: Operational. It was claimed by the employees that the organization does have a data-driven culture in general with Attribution Modeling included in a long-term strategic plan. However, most individuals in the company are either not involved in the attribution modeling process or are not aware of the importance of an attribution model, though the urgency to develop an attribution model is addressed in the marketing analytics group. Despite the fact that they are capable to analyze the effects of various marketing channels using different analytics tools, they agreed that they still face challenges in the understanding and executions of attribution modeling techniques. There is still a long way to go for the organization before they are able to develop a customized mature attribution model.

After a general identification of the maturity level, a group discussion was followed about the ratings of features that were assessed in the survey by participants individually. The recorded scores for each feature as well as the weighted average ratings for each dimension are provided in Table 26.

Dimension	Feature	Weight	Score
Organization	Vision	4.50	1
	Variety of Measured Channels	4.50	3
	Marketing Accountability	3.83	3
	Urgency	3.67	5
	Strategy	3.50	5
	Weighted Average		3.27
People	Experience	4.50	2
	Data Science Knowledge	4.33	2
	Understanding	4.17	4
	Vision	4.00	2
	Cooperation	4.00	4
	Dedication	3.83	5
	Digital Marketing Skills	3.83	3
	Positioning	3.50	5
	Weighted Average		3.31
Data	Reliability	4.83	1
Management	Availability	4.17	2
	Accuracy	4.17	2

Table 26 Results of the Assessment Session

	Customer-Centricity	4.00	2
	Data Quality Management	3.50	1
	Data Integration Platform	3.50	1
	Uniqueness	3.33	4
	External Factors	3.33	5
	Robustness	3.00	2
	Weighted Average		2.14
Technology	Knowledge Base	4.00	1
	Advancement of Analytics Tools	4.00	1
	Statistical Modeling Techniques	4.00	2
	Weighted Average		1.33

After calculating the weighted average of each dimension, we can now identify the maturity score of the organization by calculating the average rating of the four dimension scores, which resulted at 2.51. Figure 4 presents the visualized maturity scores of the four dimensions resulting from the application process.



Figure 4 Visualization of Assessment Result

It is interesting to note that the result of the assessment session comes close to the general rating of the maturity level given by the employees prior to the group discussion. The minor difference between these two results may come from biased assessment, since people tend to be more positive and subjective when it comes to self-assessment. Apart from that, the employees involved in this session commented that the overall result correlated with their apprehension of organizational maturity level. Moreover, the participants claimed that the features included in the model, which provided a great deal of discussion points respecting improvement opportunities, were highly important and consistent to their current situation.

Dimensions with different averaged ratings also aligned with their strengths and weaknesses in regards to the area of Attribution Modeling, with People dimension the most achieving and Attribution Modeling Technology the least performing. It was also noted by the employees that through this assessment process, they had a better view of what and where they need improvement and, based on their organizational business goals, what the next steps are in order to achieve a higher attribution modeling maturity level.

Another interesting fact is that the result of the application process aligns with the general state of Attribution Modeling Maturity currently in the market. Various researches have shown that despite the variety of existing attribution models, either rule-based or algorithm-based, single-touch or multi-touch, the most used ones remain similar in different organizations. In 2016, the five widely used attribution models in the market are the First-Touch, Last-Touch, Linear, Time Decay and Position-Based Attribution Models (Con, 2016; Sheridan, 2016). Referring to the maturity levels defined in this study, as shown in section 4.1, we can conclude that most organizations in the market are at level 2 or 3 regarding their Attribution Modeling Maturity. This alignment with the application result further indicates that this model is reliable and of practical value.

In summary, this application of AMMM shows that the model is effective in assessing the attribution modeling maturity level of an organization. In section 4.3, the features and dimensions were validated among a group of attribution modeling experts. This application process further validated the model by testing it in a practical setting. In future application processes, clearer instructions must be provided so that the features are judged in a more objective sense to avoid self-serving bias¹. In the next chapter, limitations of the study and opportunities for further research and improvement will be discussed.

¹ According to Myers and Twenge (2015), people tend to ascribe success to their own abilities but failure to



6 CONCLUSIONS

This research project was performed to develop and evaluate a model to facilitate the assessment and improvement of Attribution Modeling Maturity for an organization. Attribution Modeling is the technology which aims to deal with customer data and assign credits to various marketing touch points based on their effectiveness. Literature shows that Attribution Modeling is becoming more important for organizations and marketers to measure their marketing performance. However, many organizations are still not proficient enough in this area. Even if they are equipped with skilled people and advanced technologies, it is still challenging for them to choose the right attribution model that applies the best to them based on their capabilities. In order to support the identification of their strengths and weaknesses in Attribution Modeling and thereby contributing to the improvement of marketing performance measurement, the development of an Attribution Modeling Maturity Model was proposed. Concerning the fulfillment of the objective of this research project, three main research questions and six sub-questions were formulated. The answers to these questions and sub-questions are provided in the following section. Limitations and future research requirements are also illustrated in this chapter in section 6.2 and 6.3.

6.1 Research Questions

After the entire research process, we are able to answer the research questions displayed in section 1.3. The answers to these questions are provided hereafter:

RQ 1 What is an Attribution Modeling Maturity Model?

To answer this question, we first need to figure out the concepts of Attribution Modeling and Maturity Model. Based on the literature review, we understand that Attribution Modeling is the process to assign credits to various marketing channels by analyzing customer data and identifying the effectiveness of a series of customer touch points which contribute to desired business outcomes. A maturity model, according to Fowler (2014), is a tool that helps organizations or individuals assess their current capabilities in a certain area for performance improvement. Therefore, as explained in section 3.2.1, an Attribution Modeling Maturity Model (AMMM) is a model, which includes elements that present different features of an organization along the improvement path in terms of Attribution Modeling capabilities, for the purpose of performance assessment and improvement.

RQ 2 What should be included in AMMM?

Based on a meta-analysis of 10 existing models related to the area of Attribution Modeling and the typology of de Bruin et al. (2005), the characteristics of AMMM were established in section 4.1. The model focus, development stakeholders, audience and measurement instrument were identified. As can be concluded from the analysis of these existing models, most models share a common structure. AMMM was later developed with the same structure, which consists of 5 distinct maturity levels, 4 different dimensions and 25 features in total. In terms of the validity and reliability of the elements of the model, which was considered in sub question 2.3, the model was evaluated by presenting the four dimensions and identified features to a different panel of experts in the validation process. The results of the validation process were compared with the Delphi study that originally identified the features. Small differences were shown in the comparison result and there appeared a sufficient level of consensus between the two panel groups. This indicates that the dimensions and features of the maturity model are valid and reliable to be put into practice.

RQ 3 Is the theoretical model valuable and repeatable for real businesses?

After the establishment of measurement criteria for each feature and dimension, the model was applied in a practical setting. The result of the assessment process generally corresponds with the employees' perception of the attribution modeling maturity level. Accordingly, we can conclude that AMMM provides a representative measurement of Attribution Modeling Maturity Level and can give insightful recommendations for improvement in real business cases.

After answering the above three questions, we are able to answer the main Research Question for this research: *What elements are required in a maturity model to assess the maturity levels of organizations regarding their capabilities to apply attribution modeling techniques?*

Through literature review, meta-analysis and Delphi study, we collected data from a group of experts in the area of Attribution Modeling, regarding the elements that are required to assess the attribution modeling capabilities of an organization. After a validation test and a practical application, the Attribution Modeling Maturity Model is deemed reliable, which comprises three main elements: maturity level, dimension and feature, to evaluate the performance of attribution modeling of an organization and give suggestions about suitable attribution models and improvements. The final model contains 5 maturity levels: Initial, Repeatable, Defined, Managed, Optimizing, 4 dimensions: Organization, People, Data Management and Technology, and 25 features, as displayed in Table 22. A measurement instrument is used to assess each feature, dimension and eventually, the maturity level. And based on the AMMM, the organization which assesses itself is enabled to highlight where there is lack of proficiency and efficiency and where the improvement is needed in order to reach its business goals.

6.2 Limitations

In order to ensure its academic validity and practical relevance, this research project was conducted with intense consideration. However, there are still several limitations of this study. These limitations are illustrated in this section hereafter.

First of all, Delphi study was chosen as a main methodology for this study since it is deemed beneficial when researchers seek combined views to improve decision making and deal with complex issues (Okoli and Pawlowski, 2004). And that is preliminarily the objective of this study: to collect opinions from a group of experts in Attribution Modeling and help assess Attribution Modeling Maturity. However, there are a number of criticisms regarding the Delphi method. The most concerned risk of using a Delphi study is the accuracy as well as the validity of the outcomes. In this study, there were in total 6 experts involved, from academia, marketing team, data governance group, finance team and also the management, throughout the Delphi process. This was considered as a sufficiently sized group of experts that enabled the collection of relevant data since all the 6 experts are experienced with Attribution Modeling and are concerned in different points of view. However, there is a possibility that the experts involved in the Delphi study come from organizations which lie in similar maturity levels and may be biased towards features that are proved to be the most challenging at these levels. During the third round interview of the Delphi study, the researcher found out that most of the experts concern the basic level of Attribution Modeling issues, which resulted in a focus towards Organization and People dimensions in the current model. Once higher levels of maturity are reached generally in the market, the focus may shift to other features and dimensions. Therefore, it is necessary in the future research to validate the model in various organizations with different maturity levels to ensure the relevance of the features and dimensions identified in the current model.

Secondly, respecting the generalizability of this maturity model, another possible issue is that the application process was conducted only once in a specific organization. Due to time and resource limitations, the AMMM was only tested in a middle-sized organization where one of the panel experts is from. In regards to organizational characteristics, it is obvious that bigger or smaller companies may receive quite distinctive feature and dimension ratings in their self-assessment session. In the meantime, we must note that different types of organizations in various industries may not have the same focus on their attribution modeling strategies. The highest level of maturity may not be desirable by every organization and the advantages of achieving the highest level may not outweigh the investments and efforts required for some companies. Thus, it is significant to test AMMM more times in organizations with disparate characteristics to evaluate its validity. In this case, we are able to decide if the model is practically valuable and if it is ready to be generalized.

Lastly, in terms of the scope of the study, the model is also limited in a Dutch setting, since the panel experts are all from the Netherlands and the entire development and application processes were both conducted in a Dutch setting. The limited use of the model in practice does not yield sufficient evidence that the model is still applicable in an international setting. Besides, as mentioned in section 2.2.1, the model is addressed to be Descriptive with respect to the stage of development, which focuses on the identification of the current situation of an organization in it Attribution Modeling Maturity. However, the aim to be also prescriptive does not appear in a generalized sense. This means that there are not yet effective suggestions for improvement given by the model after the self-assessment. Recommendations for organizations can only be delivered by the researcher based on the situation of the organization and its business goals at the current stage. More efforts are needed in order to provide a prescriptive model with automated, systematic suggestions.

Taken into account the three main limitations of this study, we will discuss about the opportunities for future research in the next section.

6.3 Future Research

Regarding the limitations described in the previous section, there are various avenues to further develop and test the model and improve its validity and generalizability.

Basically, the features identified in the Delphi study can be operationalized further to increase their validity. Specifically, the current measurement instrument, which measures each feature using one single survey item, can be developed with more variances concerning each specific feature. Criteria and definitions should be documented for measurement. The online survey can also be further developed as a self-assessment tool which allows the results to be shown automatically after the assessing procedure. Moreover, in order to achieve the goal of being prescriptive, the model (the self-assessment tool) should include formulation of specific interventions or best practices for each feature so that the organizations can receive suggestions about the low-rated features, which would assist in the improvement of their maturity level. This would ensure user convenience and also more importantly the precise and consistent assessment of each feature, dimension and Attribution Modeling Maturity Level eventually. Extensive testing and researches in the measurement instrument as well as practical interventions are required to improve the current maturity model.

Furthermore, to ensure the generalizability of the model, it should be further tested in different types of organizations with the purpose of gaining insights in the effects of organizational characteristics, such as company size, attribution modeling group size, industry, organizational focus, etc. Apart from that, gathering data from organizations at various Attribution Modeling Maturity levels will also help distinguish relevant features at higher levels from those at lower levels. Additionally, improvement can also be made by doing research and applying the model in an international setting to evaluate its generalizability in a global sense.

References



Riordan-Butterworth, B. (2012). Attribution Primer. *IAB Attribution Working Group*. Retrieved from https://www.iab.com/.

Becker, J., Knackstedt, R. and Pöppelbuß, J. (2009). Developing Maturity Models for IT Management. *Business & Information Systems Engineering*, 1(3), pp.213-222.

Curtis, B., Hefley, W. E., & Miller, S. A. (1995, September). *Overview of the Capability Maturity Model*. Retrieved March 18, 2017, from http://resources.sei.cmu.edu/library/asset-view.cfm?assetID=12275

De Bruin, T., Freeze, R., Kulkarni, U., & Rosemann, M. (2005). Understanding the main phases of developing a maturity assessment model. In *ACIS 2005 Proceedings* (p. Paper 109). Retrieved from http://eprints.qut.edu.au/25152/

Bolderston, A. (2008). Writing an Effective Literature Review. *Journal of Medical Imaging and Radiation Sciences*, *39*(2), 86-92. doi:10.1016/j.jmir.2008.04.009

Jalali, S., & Wohlin, C. (2012). Systematic literature studies: database searches vs. backward snowballing. In *Proceedings of the 2012 6th ACM_IEEE International Symposium on Empirical Software Engineering and Measurement (ESEM)* (pp. 29–38). http://doi.org/10.1145/2372251.2372257

Okoli, C. and Pawlowski, S. (2004). The Delphi method as a research tool: an example, design considerations and applications. *Information & Management*, 42(1), pp.15-29.

Loo, R. (2002). The Delphi method: a powerful tool for strategic management. *Policing: An International Journal of Police Strategies & Management*, 25(4), 762-769. doi:10.1108/13639510210450677

Needham, R.D. and de Loe, R.C. (1990), The policy Delphi: purpose, structure, and application, *The Canadian Geographer*, Vol. 34 No. 2, pp. 133-42.

Hsu, C., & Sandford, B. A. (2007). The Delphi Technique: Making Sense Of Consensus. *Practical Assessment, Research & Evaluation, 12*(10). Retrieved from http://pareonline.net/getvn.asp?v=12&n=10

D'Angelo., F. (2009, October 26). *Happy Birthday, Digital Advertising!* Retrieved March 18, 2017, from http://adage.com/digitalnext/post?article_id=139964

Anderl, E., Becker, I., Wangenheim, F. V., & Schumann, J. H. (2014, October 18). *Mapping the Customer Journey: A Graph-Based Framework for Online Attribution Modeling*. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2343077

Shields, R. (2015, May 26). *Overcoming the Challenges of Attribution Model Progress*. Retrieved March 20, 2017, from

https://www.exchangewire.com/blog/2015/05/26/overcoming-the-challenges-of-attribution-model-progress/

Con, J. (2016, July 15). *All 11 Marketing Attribution Models, Explained*. Retrieved from http://www.bizible.com/blog/marketing-attribution-models-complete-list

Miller, S. (2013, February 12). *Digital Marketing Attribution*. Retrieved from http://www.dmnews.com/dataanalytics/digital-marketing-attribution/article/279065/

Shao, X., & Li, L. (2011). Data-Driven Multi-Touch Attribution Models. *Proceedings of the 17th ACM SIGKDD international conference on Knowledge discovery and data mining* - *KDD* '*11*. doi:10.1145/2020408.2020453

Kaushik, A. (2013). *Multi-Channel Attribution Modeling: The Good, Bad and Ugly Models*. Retrieved April 2, 2017, from https://www.kaushik.net/avinash/multi-channel-attribution-modeling-good-bad-ugly-models/

Rentola, O. (2014). *Analyses of Online Advertising Performance Using Attribution Modeling* (Unpublished master's thesis). Aalto University. Retrieved from https://aaltodoc.aalto.fi/handle/123456789/13898.

Benway, J. (1998). Banner Blindness: The Irony of Attention Grabbing on the World Wide Web. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 42(5), pp.463-467.

Anderson, M. K. (2012, April 19). Understanding How Your Marketing Analytics Gives Credit for Conversions. Retrieved March 10, 2017, from https://blog.hubspot.com/blog/tabid/6307/bid/32435/Understanding-How-Your-Marketing-Analytics-Gives-Credit-for-Conversions.aspx#sm.0000k8hup9bo5esxple2m4mj0j49k.

Sheridan, A. (2016, April 07). *The Pros and Cons of the Top 5 Marketing Attribution Models*. Retrieved March 12, 2017, from https://www.dialogtech.com/blog/marketing-analytics/pros-cons-top-5-marketing-attribution-models.

Raab, D. M. (2011, July 01). *Marketing Attribution Beyond the Last Click*. Retrieved March 12, 2017, from https://www.information-management.com/news/marketing-attribution-beyond-the-last-click

Chatterjee, P., Hoffman, D. L., & Novak, T. P. (2003). Modeling the Clickstream: Implications for Web-Based Advertising Efforts. *Marketing Science*, 22(4), 520-541. doi:10.1287/mksc.22.4.520.24906

Rpssi, P. E., & Allenby, G. M. (2003). Bayesian Statistics and Marketing . *Marketing Science*, 22(3), 304-328.

Nottorf, F. (2014). Modeling the clickstream across multiple online advertising channels using a binary logit with Bayesian mixture of normals. *Electronic Commerce Research and Applications*, *13*(1), 45-55. doi:10.1016/j.elerap.2013.07.004



Bishop, C. M. (2006). Pattern Recognition and Machine Learning. *New York: Springer Science Business Media*.

Dalessandro, B., Perlich, C., Stitelman, O., & Provost, F. (2012). Causally motivated attribution for online advertising. *Proceedings of the Sixth International Workshop on Data Mining for Online Advertising and Internet Economy - ADKDD '12.* doi:10.1145/2351356.2351363

Abhishek, V., Fader, P. S., & Hosanagar, K. (2012). *Media exposure through the funnel: A model of multi-stage attribution*. Retrieved from http://ssrn.com/abstract=2158421

Xu, L., Duan, J. A., & Whinston, A. (2014). Path to Purchase: A Mutually Exciting Point Process Model for Online Advertising and Conversion. *Management Science*, *60*(6), 1392-1412. doi:10.1287/mnsc.2014.1952

Kireyev, P., Pauwels, K., & Gupta, S. (2016). Do display ads influence search? Attribution and dynamics in online advertising. *International Journal of Research in Marketing*, *33*(3), 475-490. doi:10.1016/j.ijresmar.2015.09.007

Kennedy, G. (2015). Challenges in Digital Attribution Modeling. Retrieved April 1, 2017, from https://blog.adroll.com/best-practices/digital-attribution-challenges

Yamaguchi, K. (2014). *3 Challenges Of Attribution Modeling: The Bad, The Bad And The Ugly*. Retrieved April 3, 2017, from http://marketingland.com/3-challenges-attribution-modeling-bad-bad-ugly-101257

Olson, C. (2016). *Rethinking Today's Attribution Problem in Digital Marketing*. Retrieved April 1, 2017, from http://searchengineland.com/rethinking-todays-attribution-problem-260767

Mettler, T. (2011). Maturity assessment models: a design science research approach. *International Journal of Society Systems Science*, *3*(1/2), 81. doi:10.1504/ijsss.2011.038934

Fowler, M. (2014, August 26). *Maturity Model*. Retrieved April 05, 2017, from https://martinfowler.com/bliki/MaturityModel.html

Hamel, S. (2009). *The Web analytics maturity model: A strategic approach based on business maturity and critical success factors*. Retrieved from http://www.cardinalpath.com/cpwp/wp-content/uploads/ WAMM_ShortPaper_091017.pdf

Lahrmann, G., Marx, F., Mettler, T., Winter, R., & Wortmann, F. (2011). Inductive Design of Maturity Models: Applying the Rasch Algorithm for Design Science Research. *Service-Oriented Perspectives in Design Science Research Lecture Notes in Computer Science*, 176-191. doi:10.1007/978-3-642-20633-7_13

Borstein, J. (2014, December 15). *What is Your Attribution Analytics Maturity Level?* Retrieved April 02, 2017, from http://currents.rosetta.com/2014/12/what-is-your-attribution-analytics-maturity-level/

Chertudi, M. (2012). *Marketing Optimization Analytics Maturity Curve*. Retrieved from http://online-behavior.com/emetrics/marketing-optimization-analytics-maturity

Con, J. (2017, January 19). *The 4 Stages of B2B Marketing Performance Management Maturity*. Retrieved from http://www.bizible.com/blog/marketing-performance-management-maturity-framework

Allocadia. (2017). *The Essential Framework For Optimizing Marketing Performance*. (Rep.). Retrieved https://www.allocadia.com/marketing-performance-maturity-model/

Cosic, R., Shanks, G., & Maynard, S. (2012). *Towards a Business Analytics Capability Maturity Model*.

Halper, F., & Stodder, D. (2014, October 28). *TDWI Analytics Maturity Model Guide | Transforming Data with Intelligence*. Retrieved from https://tdwi.org/whitepapers/2014/10/tdwi-analytics-maturity-model-guide.aspx

Mulpuru, S., & Gill, M. (2015, January 14). *Rank Yourself With The Digital Maturity Model*. Retrieved April 02, 2017, from https://www.forrester.com/report/Rank Yourself With The Digital Maturity Model/-/E-RES61070

Gill, M., & Van Boskirk, S. (2016). *The Digital Maturity Model 4.0*. (Rep.). Forrester. Retrieved from https://www.forrester.com/report/The Digital Maturity Model 40/-/E-RES130881.

Myers, D. G., & Twenge, J. M. (2015). *Exploring social psychology*. New York, NY: McGraw-Hill Education.


Appendix I Delphi Study First Iteration Results

Dimension Ratings								
Dimension	Α	B	С	D	Е	F	Avg.	Dev.
Organization	7	7	6	7	8	7	7.00	0.63
People	5	7	7	8	7	8	7.00	1.10
Data Management	9	9	8	6	9	9	8.33	1.21
Technology	8	7	6	5	4	6	6.00	1.41
Avg.	7.25	7.5	6.75	6.5	7	7.5		

Di	mension Comments
Or	ganization
Α	A good structure makes a good offer/service/product. However, a good structure is
	likely to be 'settled in', which makes it hard to adapt to a changing environment.
B	The organization determines whether the attribution model will be created or not.
С	Organizational features can encourage the organization to start with Attribution
	Modeling and make the company more efficient.
D	
Е	Attribution Modeling is a complex topic. It will only have influence when the
	organization is ready to understand and apply its full potential.
F	The organization needs to have a clear vision on Attribution Modeling and put it into
	scale with investments and attention.
Pe	ople
Α	People are becoming less important with AI-technology and marketing-automation
	taking over jobs. This is however leading to the demand of people who can focus
	more on their core-tasks. It is more important now to have a diverse set of people
	working together.
B	The people guard the quality of the analysis. This affects the usability and relevance of the model.
С	For making the model, it is important that people know what they are doing.
	Otherwise the results can be not true and you will make the wrong assumptions.
D	
Е	Understanding the principles, (evolving) approaches and methods needs proper skills
	and right people.
F	People who are experienced in data analysis and marketing intelligence are needed to
	keep track of the entire process.
Da	ta Management
Α	Data is becoming the key for success and the key for constructing the roadmap for
	your organization. It is becoming easier every single day to get intelligence out of
	your data. Getting the right data is the biggest challenge today.
В	With proper data management you are able to correct for any lack in the other
	dimensions.
C	Data needs to be stored in the right way, so you can work with the data and know

	Master Thesis
D	
Е	Without proper data, models are useless.
F	Only with detailed aggregated data, can the models be applied accordingly to the organization.
Tee	chnology
Α	Almost as important as the data itself. Without the right technologies it is impossible to properly use the data that is collected, but also to use the findings fast and effectively. With the use of marketing automation and AI technology making a difference, there are even more solutions. Every company has to keep up with this.
В	Technology is something that has to be adjusted to the dimensions above. For a specific combination of Organization/ People and Data Management an appropriate technology can be used.
С	Most important are the right tools to make a good attribution model, without this you cannot do anything.
D	
E	Technology is already available for the most common forms of Attribution Modeling.
F	Even if the organization itself does not have the ability to work on advanced models, they can outsource it to other professional organizations. Data and objectives are more important than this dimension.

Fe	eatures	
Or	ganization	
Α	Adaptability	Can an organization change its way of working if the market
		demands a different approach?
	Structure	How are people working together and how is the hierarchy in the organization?
	Challenges	Does the organization understand their challenges?
	Strategy	Is the strategy something that defines the organization as a whole? And is that strategy 'future-ready'?
	Shared belief/culture	Is it clear to everyone in the organization, also in case of multiple offices, how they should behave according to the organization's culture?
В	Urgency in the	The organization must feel the urgency of creating an
	organization	attribution model. This is a pre-condition of setting it up.
С	Openness	Is the organization committed to make a change?
	Budget	Money available
	Awareness	
	Culture	
D	Believe	The organization needs to believe in data and attribution as added value for the business
	Long-term Strategy	The organization needs some stability in strategy to be able to use an attribution model
Е	Business and IT	Is there a gap or strong cooperation between business and
	alignment	IT?
	Structure	Does the organization work with silos or in an integrated way?
	Data-driven strategy	Is there a data-driven strategy defined? Are there specific marketing items?

	Business Steering	How is the KPI defined, specifically, integrally or
	D 1 (separately?
	Budget	How does the organization allocate its marketing and/or IT budget?
	Change capability	Does the organization use waterfall or agile method in terms of changes?
F	Strategy	If there is a strategy plan for improving marketing
		performance using attribution modelling techniques.
	Culture	throughout the organization.
	Budget	Gaining sufficient data for analysis can be quite costly. The organization should distribute enough money for the process.
	Variety of measured	What channels does the organization measure? Only several
	channels	digital channels, or all digital channels or also offline
		channels?
	Process	Is the analysis process conducted daily, monthly, or
		quarterly?
Pe	ople	
Α	Diversity	Are teams diverse enough to understand what different
		customers really need? It is also an important factor to
		overcome a possible narrow-minded view of things.
	Knowledge	Are people capable to do what is asked?
	Flexibility	Some markets are changing very fast. The people who work
		in an organization should be feeling fine to change their way
		of working and adapt in a short term.
	Challenges	Do the people understand their challenges?
	Accountability/Owner ship	Do people have clear ownership of tasks and challenges?
B	Experience	The people in the organization need to have some sort of
	Ĩ	experience in working with data analysis.
	Open and available to	The people contributing to an attribution model need to have
	discuss	open discussions about the data they see, to analyze and
		make sure all aspects of the data (see below) are included.
	Willing to dig deep	As some weird results may come into surface, a deeper
		analysis of the numbers is necessary. This will most likely
		happen. The people must not be scared by these types of
		challenges and fully commit to finding answers to
~	Y Y 1.1	unforeseen results.
C	Knowledge	People need to have knowledge about the topic and are
	Mativatian	Willing to learn.
	Iviouvation Skills	reopie need to have motivation to do it.
	Behaviour	How do people react to the decision of working with data?
	Experience	now do people react to the decision of working with data?
n	Experience	People responsible for attribution modeling should be
ען	Блроннос	canable and experienced
	Right positions	People that work on the attribution models should be on the
	1.15m Positions	right positions to involve and influence management
Е	Data Science skills	Ouality and quantity

	Digital Marketing	
	Attribution Modelling	Specific knowledge and experience
	skills	
F	Expertise	People who work on attribution models need to be
		sufficiently trained or experienced for the analytics and
		reporting needs.
	Cooperation	Not only marketing team is included in this process, other
		departments should also cooperate when help is needed.
	Knowledge/Understan	How well is attribution modeling process understood?
	Awaranass	Are people aware of the importance of attribution modeling?
Da	ta Management	Are people aware of the importance of attribution modering:
Δ	Reliability	Is the data that is gathered reliable?
1	Robustness	Is the data-source 'future-ready' and will it stay reliable?
	Uniqueness	Is the data not common? Thus, is it possibly a source for
		unique findings?
B	Availability of data on	Data on all marketing channels that a company influences
	all marketing channels	(paid or not) should be available.
	Availability of data on	Preferably, data is needed to really determine all aspects that
	all different users	influenced a single new customer.
	Availability of data on	For example, the weather could influence sales. Awareness
	all outside influences	and availability of this data should exist.
С	Preparation	What is done in the company to encourage data management
		and to provide the tools which are needed to do it in the right
		way?
	Storage	The data should be stored carefully.
υ		
ע	Limited change in logarithms	Not too many changes so data can be compared.
р Е	Limited change in logarithms Data Sources	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety?
E E	Limited change in logarithms Data Sources Data Governance	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety? Defined? Scope? Effective?
E	Limited change in logarithms Data Sources Data Governance Data (integration)	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety? Defined? Scope? Effective? Data Warehouse? Data Lake?
E	Limited change in logarithms Data Sources Data Governance Data (integration) platform	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety? Defined? Scope? Effective? Data Warehouse? Data Lake?
E	Limited change in logarithms Data Sources Data Governance Data (integration) platform Data Quality	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety? Defined? Scope? Effective? Data Warehouse? Data Lake? Measured? Low or high?
E F	Limited change in logarithms Data Sources Data Governance Data (integration) platform Data Quality Data Variety	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety? Defined? Scope? Effective? Data Warehouse? Data Lake? Measured? Low or high? What data is collected? Does it cover all information about
E F	Limited change in logarithms Data Sources Data Governance Data (integration) platform Data Quality Data Variety	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety? Defined? Scope? Effective? Data Warehouse? Data Lake? Measured? Low or high? What data is collected? Does it cover all information about different marketing channels? (Does it also include offline
E F	Limited change in logarithms Data Sources Data Governance Data (integration) platform Data Quality Data Variety	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety? Defined? Scope? Effective? Data Warehouse? Data Lake? Measured? Low or high? What data is collected? Does it cover all information about different marketing channels? (Does it also include offline data?)
E F	Limited change in logarithms Data Sources Data Governance Data (integration) platform Data Quality Data Variety Data Quality	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety? Defined? Scope? Effective? Data Warehouse? Data Lake? Measured? Low or high? What data is collected? Does it cover all information about different marketing channels? (Does it also include offline data?) Is the data about different channels collected in silos or integrated?
E F	Limited change in logarithms Data Sources Data Governance Data (integration) platform Data Quality Data Variety Data Quality	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety? Defined? Scope? Effective? Data Warehouse? Data Lake? Measured? Low or high? What data is collected? Does it cover all information about different marketing channels? (Does it also include offline data?) Is the data about different channels collected in silos or integrated? Haw is the data aggregated? Is it collected based on
E F	Limited change in logarithms Data Sources Data Governance Data (integration) platform Data Quality Data Variety Data Quality Customer Centricity	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety? Defined? Scope? Effective? Data Warehouse? Data Lake? Measured? Low or high? What data is collected? Does it cover all information about different marketing channels? (Does it also include offline data?) Is the data about different channels collected in silos or integrated? How is the data aggregated? Is it collected based on guarantee behaviors? Does the data collected include all
E F	Limited change in logarithms Data Sources Data Governance Data (integration) platform Data Quality Data Variety Data Quality Customer Centricity	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety? Defined? Scope? Effective? Data Warehouse? Data Lake? Measured? Low or high? What data is collected? Does it cover all information about different marketing channels? (Does it also include offline data?) Is the data about different channels collected in silos or integrated? How is the data aggregated? Is it collected based on customer behaviors? Does the data collected include all touch points throughout the customer journey?
F	Limited change in logarithms Data Sources Data Governance Data (integration) platform Data Quality Data Variety Data Quality Customer Centricity	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety? Defined? Scope? Effective? Data Warehouse? Data Lake? Measured? Low or high? What data is collected? Does it cover all information about different marketing channels? (Does it also include offline data?) Is the data about different channels collected in silos or integrated? How is the data aggregated? Is it collected based on customer behaviors? Does the data collected include all touch points throughout the customer journey?
F	Limited change in logarithms Data Sources Data Governance Data (integration) platform Data Quality Data Variety Data Quality Customer Centricity Accuracy	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety? Defined? Scope? Effective? Data Warehouse? Data Lake? Measured? Low or high? What data is collected? Does it cover all information about different marketing channels? (Does it also include offline data?) Is the data about different channels collected in silos or integrated? How is the data aggregated? Is it collected based on customer behaviors? Does the data collected include all touch points throughout the customer journey?
E F Teo	Limited change in logarithms Data Sources Data Governance Data (integration) platform Data Quality Data Variety Data Variety Data Quality Customer Centricity Accuracy chnology Flexible	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety? Defined? Scope? Effective? Data Warehouse? Data Lake? Measured? Low or high? What data is collected? Does it cover all information about different marketing channels? (Does it also include offline data?) Is the data about different channels collected in silos or integrated? How is the data aggregated? Is it collected based on customer behaviors? Does the data collected include all touch points throughout the customer journey? Is the technology capable to change processes?
E F Teo A	Limited change in logarithms Data Sources Data Governance Data (integration) platform Data Quality Data Variety Data Variety Data Quality Customer Centricity Accuracy chnology Flexible Reliable	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety? Defined? Scope? Effective? Data Warehouse? Data Lake? Measured? Low or high? What data is collected? Does it cover all information about different marketing channels? (Does it also include offline data?) Is the data about different channels collected in silos or integrated? How is the data aggregated? Is it collected based on customer behaviors? Does the data collected include all touch points throughout the customer journey? Is the technology capable to change processes? Does it work anytime you need it?
E F Teo A	Limited change in logarithms Data Sources Data Governance Data (integration) platform Data Quality Data Variety Data Variety Data Quality Customer Centricity Accuracy chnology Flexible Reliable Roadmap	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety? Defined? Scope? Effective? Data Warehouse? Data Lake? Measured? Low or high? What data is collected? Does it cover all information about different marketing channels? (Does it also include offline data?) Is the data about different channels collected in silos or integrated? How is the data aggregated? Is it collected based on customer behaviors? Does the data collected include all touch points throughout the customer journey? Is the technology capable to change processes? Does it work anytime you need it? Is there a vision of what is needed in the future? And if so
E F Teo A	Limited change in logarithms Data Sources Data Governance Data (integration) platform Data Quality Data Variety Data Variety Data Quality Customer Centricity Accuracy chnology Flexible Reliable Roadmap	Not too many changes so data can be compared. Availability? Accessibility? Missing data? Variety? Defined? Scope? Effective? Data Warehouse? Data Lake? Measured? Low or high? What data is collected? Does it cover all information about different marketing channels? (Does it also include offline data?) Is the data about different channels collected in silos or integrated? How is the data aggregated? Is it collected based on customer behaviors? Does the data collected include all touch points throughout the customer journey? Is the technology capable to change processes? Does it work anytime you need it? Is there a vision of what is needed in the future? And if so, are the changes being planned?

		some repetitive tasks needed?
B	Whether a statistical	Statistical significance indications are required for
	significance is	determining its value.
	provided	
С	Accountability	Who is responsible for the technologies?
	Integration	What systems are integrated?
D		
Е	Marketing	Scope? Platform?
	Technology	
	Tools	Low or high-end? Specific?
	Attribution Modeling	Are there already attribution models used? If yes, what
	Technology	level? Rule-based, or algorithmic models?
F	Advancement of	Does the organization use only Google Analytics, or tools
	Analytics Tools	that track detailed purchase path information like eBay
		Attribution, or is it outsourced to some attribution modeling
		consultancy firm to work on the data?
	Statistical Modeling	
	Techniques	
	Data Mining Tools	Efficiency in working with large volumes of data

Appendix II Delphi Study Second Iteration Results

Organization								
Feature	Α	В	С	D	Ε	F	Avg.	Dev.
Adaptability	3	3	3	3	3	3	3.00	0.00
Change Capability	3	2	3	3	4	3	3.00	0.63
Vision	4	5	3	5	5	5	4.50	0.84
Marketing Accountability	3	4	3	5	5	3	3.83	0.98
Awareness	2	4	3	4	4	4	3.50	0.84
Urgency	3	4	3	3	5	4	3.67	0.82
Strategy	3	3	4	3	4	4	3.50	0.55
Culture	2	4	3	2	4	3	3.00	0.89
Process	3	4	1	4	2	2	2.67	1.21
Hierarchy	4	2	2	1	2	1	2.00	1.10
Structure	3	4	3	2	2	4	3.00	0.89
Diversity	3	3	2	3	1	2	2.33	0.82
KPI Quality	2	2	3	4	4	4	3.17	0.98
Variety of measured channels	4	5	4	4	5	5	4.50	0.55
Business and IT alignment	5	4	2	3	3	3	3.33	1.03
Statistical Significance	3	3	3	4	4	2	3.17	0.75
Resource	2	3	2	3	4	5	3.17	1.17
Average	3.06	3.47	2.76	3.29	3.59	3.35		

People								
Feature	Α	B	С	D	Ε	F	Avg.	Dev.
Flexibility	4	4	3	3	3	2	3.17	0.75
Vision	5	5	2	3	4	4	3.83	1.17
Awareness	3	4	2	4	3	4	3.33	0.82
Understanding	3	5	3	4	5	5	4.17	0.98
Accountability	3	3	2	4	4	2	3.00	0.89
Openness	4	4	1	4	5	2	3.33	1.51
Dedication	4	5	3	4	4	3	3.83	0.75
Positioning	3	3	3	5	4	2	3.33	1.03
Cooperation	2	5	3	4	4	5	3.83	1.17
Experience	4	5	4	4	5	5	4.50	0.55
Data Science Knowledge	4	4	4	2	5	5	4.00	1.10
Digital Marketing Skills	3	4	2	2	5	4	3.33	1.21
Average	3.50	4.25	2.67	3.58	4.25	3.58		

Data Management								
Feature	Α	В	С	D	Ε	F	Avg.	Dev.
Reliability	5	5	5	5	5	4	4.83	0.41
Robustness	4	1	3	4	1	3	2.67	1.37
Uniqueness	4	4	3	3	4	2	3.33	0.82
Availability	4	5	4	3	5	4	4.17	0.75
Preparation	2	3	3	3	3	2	2.67	0.52
Accuracy	4	3	4	5	5	4	4.17	0.75
Variety	3	1	2	3	5	5	3.17	1.60
Customer-Centricity	3	4	2	1	5	5	3.33	1.63
External Factors	2	5	3	3	1	3	2.83	1.33
Data Integration Platform	1	2	3	3	5	4	3.00	1.41
Data Governance	3	2	2	3	3	3	2.67	0.52
Data Quality Management	2	3	4	4	4	4	3.50	0.84
Data Aggregation	2	2	3	3	4	2	2.67	0.82
Data Silos	3	2	3	3	5	4	3.33	1.03
Average	3.00	3.00	3.14	3.29	3.93	3.50		

Technology								
Feature	Α	B	С	D	Е	F	Avg.	Dev.
Flexibility	3	3	2	2	5	2	2.83	1.17
Robustness	4	3	2	4	4	3	3.33	0.82
Roadmap	4	1	4	3	4	4	3.33	1.21
Knowledge Base	4	1	4	3	5	4	3.50	1.38
Accountability	3	4	3	3	5	4	3.67	0.82
Completeness	4	2	2	3	5	3	3.17	1.17
Advancement of Analytics Tools	4	2	4	3	5	5	3.83	1.17
Statistical Modeling Techniques	3	4	3	4	5	5	4.00	0.89
Data Mining Tools	3	4	4	3	5	4	3.83	0.75
Attribution Modeling Technology	3	4	3	3	5	5	3.83	0.98
Average	3.64	3.00	3.09	3.00	4.82	3.73		



D '	•	a
Dimei	nsion	Comments
		Comments

Organizatio	n n
A	Marketing Accountability is relatively unimportant for the maturity of the attribution model. It is important for the effectiveness of the marketing-team
	If the organization is highly hierarchical, it may be difficult for it to cope with changes for an attribution model. But the relationship is not that strong.
	The Diversity of teams is especially important for organizations that focus on a bigger audience
	Data is key in establishing a strong attribution model. IT is key in storing data and helping organization in defining the model
В	The Strategy influences the consequences of an attribution model, but not how mature the model is.
	The frequency of the Process can be different across organizations, depending on availability of data, but it may not determine how mature the attribution model is.
	The Diversity of teams is less important if there are people who have knowledge in Attribution Modeling, but it is still important in order to have different views in this topic.
	A big company can still work our a good attribution model without extra investments in it, which makes Resource less important.
С	Marketing Accountability depends on the scale of the organization, it may not be necessary to do it company-wide. But I do agree that it is important.
	The frequency of the Process can be important for fast changing industries, but not so important for stable environments
	Money is not that necessary for Attribution Modeling, but we do need resources to gain a higher level of maturity.
D	It is important to do the attribution modeling process regularly since the landscape is constantly changing.
E	Statistical significance is strongly related to if the organization is data-driven. And in order to develop a good attribution model, the organization must be data-driven. So I think it is a very important indicator.
F	Attribution Modeling is the combination between business and IT. Therefore, it is fairly important to align business and IT.
	Resources are important. Money is a moderator of it, but does not make the model a success.
People	
Α	Vision makes people understand what the attribution model means for them personally, it is very important.
	Discussing models and data is important, understanding and accepting findings is key. Therefore, Openness is very important.
	Not important for every product/service, but key for example webshops.

	Master Thesis Z.
B	You really need to work towards a model that everyone in the organization agrees with, which makes the Vision is very important to define if the model is mature since it decides if everyone has the same goal for the model.
	As long as the job is done, it doesn't matter if there is a clear ownership of the tasks for everyone. It will only take a little longer to result in a mature model.
	Without Openness there will be fewer insights that you can get, which makes the model less good.
	Even if the project is outsourced, there should always be someone in the company who can understand. You can't rely fully on people outside the company.
C	Sometimes you need management to get resources, but sometimes you can still deliver a good model without the guide of the management. It is not decisive.
D	It should be really clear who is responsible with which certain task so that everyone can be devoted to their own work and find the right person for help.
	The people who work on the attribution model should have the right position to report to the management to ask for support and address importance as well as awareness.
	I agree that there has to be someone who can explain everything to the organization, no matter from internal or external sources.
	I have the same opinion for Digital Marketing Skills, and I would like to give it a higher score of 4.
E	For a more mature organization, the people who work on attribution modeling must not only have voluntary work, but also have clear ownership of what they are doing. Accountability is a strong indicator.
	Openness for me is a quite general feature, it is important generally for all models, but not specified to attribution modeling. It's not the determinative feature. Attribution Modeling does not necessarily need this feature. I would adjust it to 3.
F	Ownership is needed, but does not have to be extremely focussed
	When the help is NEEDED, the model will be stuck if there is no cooperation.
	No matter if the process is outsourced or done internally, there must be someone who understands the process and can explain to the rest of the people within the organization.
Data Ma	anagement
A	The Platform for data is not important at all as long as the data is accessible
	If the organization is aware that data changes fast and make the data source future-ready regarding the changing market, then it reduces the chance that there is false data in a false model.
	Formats can be converted if needed, that already showed that it is important to aggregate data.
В	The attribution model has to be consistent to be able to move to some other directions and to be used in a later stage. The Robustness feature can be adjusted with a higher rate.
	You may only need one angle that suits everything, like the behaviors of a single customer. However, I agree that the more angles you get, the more insights you may get from the attribution model.
	There are always external factors like seasonality that you should take into

	account in an attribution model.
	If a Data Integration Platform is needed depends on how big your company is.
	It may not influence the attribution model.
С	I agree that how customer-centric the company is will influence the maturity of
	the attribution model, since the advanced models are all based on aggregated
D	Individual customer data. We should use data from all angles. I would adjust the rating to a 5
D	we should use data from all angles, I would adjust the fating to a 5.
	For me, I thought the data doesn't have to be individually, I'm not interested in
	you need that kind of data
E	I can still make a immature model with reliable data. There is a weak
2	relationship between them.
	If the data is consistent with your distribution tactics is very important for an
	organization to develop a good attribution model. You need the data to work on
	the strategy. It is a strong indicator. I would keep it with a 4.
	External factors like seasonality is already included in the data. It only matters
	if you look into the data or if you take the factor into account. It is very specific
T	to attribution modeling. I would adjust it to a 4.
F	Clicks and impressions can lead to different results in an attribution model,
	attribution modeling technologies
Technology	
A	If the attribution modeling technology is not used properly, the data collected is
	useless. Therefore, the technology should be highly compatible with the vision
	of the organization.
	Making a difference now is cool, but making it in the future is just as important
	Having the right technologies but not using them right is painful, the
	Knowledge Base aims to make the technology right when needed.
	If there are still tasks to be done by people chances of errors grow fast and the findings can become false
В	If you have the right technology now then you have a mature model If you
	need new technologies, then you do it in the future. So the Roadmap is not
	necessary.
	If there are movement of people who are responsible for Attribution Modeling,
	then there has to be someone who are trained with the technology so that there
	are always someone who is handy of it.
	Completeness of the model is not that decisive
C	There is no perfect data, and it should be combined with the right technology to
C	be really valuable.
	It is very important to have someone or a system in the organization to make the
	technology available to be understood and used.
	The Advancement of Analytics Tools is quite important to show the maturity
	level of an organization because different tools are supposed to be used for
	different levels of attribution models.
D	The technology, no matter if it is internally implemented or outsourced, should
	iit the challenges of the organization.

	Master Thesis 2
Ε	The flexibility of attribution modeling technology regarding the changing
	deal with changing market, which is very crucial to define if a model is mature. So I would give it a 5.
	For Robustness, I focus on the functionality perspective. If the technology you use will still be valuable 5 years later can determine the maturity level of an attribution model. I leave it with a 4 as a strong indicator.
F	The marketing is changing constantly. The technology we use now may not be suitable for what we need in the near future. We need to have a clear Roadmap of the technologies we may need in the future to make the attribution model highly valuable.

Adjusted Ratings										
Organization	Ratin	g (1-5)								
Name	Α	B	C	D	Ε	F	Avg.	Dev.		
Adaptability	3	3	3	3	3	3	3.00	0.00		
Change Capability	3	2	3	3	4	3	3.00	0.63		
Vision	4	5	3	5	5	5	4.50	0.84		
Marketing Accountability	3	4	3	5	5	3	3.83	0.98		
Awareness	4 ²	4	3	4	4	4	3.83	0.41		
Urgency	3	4	3	3	5	4	3.67	0.82		
Strategy	3	3	4	3	4	4	3.50	0.55		
Culture	2	4	3	2	4	3	3.00	0.89		
Process	3	2	2	4	2	2	2.50	0.84		
Hierarchy	3	2	2	1	2	1	1.83	0.75		
Structure	3	4	3	2	2	4	3.00	0.89		
Diversity	3	3	2	3	1	2	2.33	0.82		
KPI Quality	2	2	3	4	4	4	3.17	0.98		
Variety of measured channels	4	5	4	4	5	5	4.50	0.55		
Business and IT alignment	5	4	2	3	3	3	3.33	1.03		
Statistical Significance	3	3	3	4	4	2	3.17	0.75		
Resource	2	3	3	3	4	4	3.17	0.75		
Average	3.12	3.35	2.88	3.29	3.59	3.29				
		•		•		•				
People	Rati	ng (1-5)							
Name	Α	B	С	D	Ε	F	Avg	Dev.		
Flexibility	4	4	3	3	3	2	3.17	0.75		
Vision	5	5	3	3	4	4	4.00	0.89		
Awareness	3	4	2	4	3	4	3.33	0.82		

 $^{^{\}rm 2}$ Red texts in the table represent the adjusted ratings

		1		1	1	1	1	
Understanding	3	5	3	4	5	5	4.17	0.98
Accountability	3	3	2	4	4	3	3.17	0.75
Openness	4	4	3	4	3	4	3.67	0.52
Dedication	4	5	3	4	4	3	3.83	0.75
Positioning	3	3	3	5	4	3	3.50	0.84
Cooperation	3	5	3	4	4	5	4.00	0.89
Experience	4	5	4	4	5	5	4.50	0.55
Data Science Knowledge	4	4	4	4	5	5	4.33	0.52
Digital Marketing Skills	3	4	3	4	5	4	3.83	0.75
Average	3.58	4.25	3.00	3.92	4.08	3.92		
Data Management	Ratin	g (1-5)						
Name	A	В	C	D	E	F	Avg	Dev.
Reliability	5	5	5	5	5	4	4.83	0.41
Robustness	4	3	3	4	1	3	3.00	1.10
Uniqueness	4	4	3	3	4	2	3.33	0.82
Availability	4	5	4	3	5	4	4.17	0.75
Preparation	2	3	3	3	3	2	2.67	0.52
Accuracy	4	3	4	5	5	4	4.17	0.75
Variety	3	3	3	5	5	5	4.00	1.10
Customer-Centricity	3	4	4	3	5	5	4.00	0.89
External Factors	2	5	3	3	4	3	3.33	1.03
Data Integration Platform	3	2	3	3	5	4	3.33	1.03
Data Governance	3	2	2	3	3	3	2.67	0.52
Data Quality Management	2	3	4	4	4	4	3.50	0.84
Data Aggregation	2	2	3	3	4	2	2.67	0.82
Data Silos	3	3	3	3	5	4	3.50	0.84
Average	3.14	3.36	3.36	3.57	4.14	3.50		
Technology	Ratin	ig (1-5)						
Name	Α	B	С	D	E	F	Avg.	Dev.
Flexibility	3	3	2	2	4	2	2.67	0.82
Robustness	4	3	2	4	4	3	3.33	0.82
Roadmap	4	1	4	3	4	4	3.33	1.21
Knowledge Base	4	4	4	3	5	4	4.00	0.63
Accountability	3	4	3	3	5	4	3.67	0.82
Completeness	4	2	2	3	5	3	3.17	1.17
Advancement of Analytics Tools	4	3	4	3	5	5	4.00	0.89

Statistical Modeling Techniques	3	4	3	4	5	5	4.00	0.89
Data Mining Tools	3	4	4	3	5	4	3.83	0.75
Attribution Modeling Technology	3	4	3	3	5	5	3.83	0.98
Average	3.64	3.36	3.09	3.09	4.73	3.82		

Appendix IV Application Survey and Results

(1) Attribution Modeling Maturity Assessment Survey

1. Please state to what extent you agree with the following statements based on your general view of your company. (1: Completely Disagree; 2: Slightly Disagree; 3: Do not Agree/ nor Disagree; 4. Slightly Agree; 5. Completely Agree)

Statement	1	2	3	4	5
1. We understand our challenges in marketing performance					
measurement.					
2. We are aware of the importance of Attribution Modeling					
and pay intense attention to Attribution Modeling and					
marketing performance measurement.					
3. It is very urgent for us to develop an attribution model.					
4. We have a strategic plan that includes attribution modeling					
technologies to analyze our marketing efforts and allows us to					
make data-driven decisions.					

2. Which of the following interactions with customers are you proficient to measure?

Direct Website Interaction
Display Advertising
Email Marketing
Social Media Marketing
Affiliated Marketing
Paid Search/ Search Engine Marketing
Offline Channels Influence
Cross-Device Interactions
None of them

Other (please specify)

3. Please state to what extent you agree with the following statements based on your knowledge about yourself and your colleagues. (1: Completely Disagree; 2: Slightly Disagree;3: Do not Agree/ nor Disagree; 4. Slightly Agree; 5. Completely Agree)

Statement	1	2	3	4	5
1. We have experienced attribution modeling specialists to					
guide our Marketing Analytics team throughout the attribution					
modeling processes.					
2. Our analytics staff is proficient in statistical modeling or					
data mining techniques.					
3. Our Marketing Analytics team members have clear					
understanding of attribution modeling processes.					
4. Our Marketing Analytics team members understand the					
challenges we have in marketing performance measurement.					
5. Our attribution modeling process receives executive					
sponsorship and support from individuals within the					
marketing team and other departments as needed.					
6. Our analytics staff is willing to dig deep into data and have					
open discussions about unexpected findings throughout the					
attribution modeling process.					
7. We have at least one person from the attribution modeling					
group who is on the right position to involve and influence the					
management decision-making.					

4. Which of the following specialists are there in your attribution modeling group?

5. Please state to what extent you agree with the following statements based on your experience with Data Management procedures in your company. (1: Completely Disagree; 2: Slightly Disagree; 3: Do not Agree/ nor Disagree; 4. Slightly Agree; 5. Completely Agree)

Statement	1	2	3	4	5
1. We have data collection and analysis methods documented					
to ensure that the same Attribution Modeling processes are					
followed each time.					
2. The data we use for Attribution Modeling is available,					
easily and quickly retrievable throughout the company.					
3. We have reasonable assurance that the data collection					
methods being used do not produce systematically biased					

	Master Th	nesis Z.Li
data.		
4. We integrate all data sources (clicks and impressions of each ad, conversions, online and offline data) to analyze all touch points throughout the customer journey and provide a single view of the customers.		
5. We have systems and processes in place to measure data quality, regarding Validity, Reliability, Timeliness, Precision and Integrity.		
6. We use an integration platform like a data warehouse or a data lake to integrate a large amount of data from different sources and ensure that the data is kept consistent.		
7. The data we use for Attribution Modeling is customized (consistent with our marketing strategies) and possible to facilitate unique findings.		
8. We take into account external factors (such as seasonality) embedded in the data during the attribution modeling processes.		
9. The data collection and analysis methods we use can be still used in a long term regarding the changing market.		

6. Please state to what extent you agree with the following statements based on the usage of Attribution Modeling Technologies in your company. (1: Completely Disagree; 2: Slightly Disagree; 3: Do not Agree/ nor Disagree; 4. Slightly Agree; 5. Completely Agree)

Statement	1	2	3	4	5
1. We have a knowledge base system to train our analytics					
staff sufficiently to use the attribution modeling technologies.					
2. Our analytics program uses statistical modeling to identify					
trends and customer behaviors.					

7. What analytics tools do you use to analyze the marketing performance of each channel? (Please only choose the highest level one that you use)

□None

□Excel/SPSS

□ Google Analytics

Other online tools that are specified in Attribution Modeling

□Outsourced

(2) Correlation between Feature and Survey Item

Dimension	Feature	Survey Items	Question Type
Organization	Vision	1.1	Statement
	Marketing Accountability	1.2	Statement
	Urgency	1.3	Statement
	Strategy	1.4	Statement

	Variety of measured channels	2	Multiple Choice
People	Experience	3.1	Statement
	Data Science Knowledge	3.2	Statement
	Understanding	3.3	Statement
	Vision	3.4	Statement
	Cooperation	3.5	Statement
	Dedication	3.6	Statement
	Positioning	3.7	Statement
	Digital Marketing Skills	4	Multiple Choice
Data	Reliability	5.1	Statement
Management	Availability	5.2	Statement
	Accuracy	5.3	Statement
	Customer-Centricity	5.4	Statement
	Data Quality Management	5.5	Statement
	Data Integration Platform	5.6	Statement
	Uniqueness	5.7	Statement
	External Factors	5.8	Statement
	Robustness	5.9	Statement
Technology	Knowledge Base	6.1	Statement
	Statistical Modeling Techniques	6.2	Statement
	Advancement of Analytics Tools	7	Single Choice