A Decision Support System for Balancing Critical Design Issues in New Service Development for the TomTom Mapshop Service Platform

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PREFACE

This thesis was submitted for final fulfillment of the Management of Technology Master of Science at the Delft University of Technology. A decision support system was developed for use within TomTom in order to attain higher business model viability for their mapshop service platform. I worked at TomTom from the 1st of November till the 30th of July 2012 in the form of an internship, within this dynamic time period TomTom re-organized by changing the organizational structure in order to cope with changing forces in the market. The re-organization emphasized the significance of this research and the increased focus on creating new value for mapshop service platform consumers. I would like to thank TomTom for giving me the opportunity to do an internship into this particular and inspiring field in order to finish my studies.

Furthermore I would like to thank my graduation committee Yao-Hua Tan, Harry Bouwman and Roland Ortt from the faculty of Technology, Policy and Management and Ello van Gelderen from TomTom for their mentoring support, valuable feedback and interesting discussions. I also would like to thank the employees of TomTom for their time and key insights into the workings of the TomTom organization.

TomTom is an icon in the car navigation industry and hopefully the findings of this thesis will help them in increasing business model viability. Secondly I hope the scientific contribution will assist managers, policy makers or scientists in their work efforts.

Jan-Paul van Leeuwen
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EXECUTIVE SUMMARY

The car navigation company TomTom is increasing focus on generating revenue by using their service platforms. One of the main revenue sources of TomTom is the mapshop service platform, this mapshop is used by personal navigation device owners to buy and upgrade maps for their devices. An increase in mapshop customers will lead to a gain of revenue for TomTom and an increase in value delivery to TomTom customers. To increase the mapshop service platform value viable business cases are needed that are able to grasp the important aspects of network value delivery. In order for business cases to be viable they need to be matured to a certain level before entering the development phases, this maturation is done by balancing design issues, which are critical for business model viability. State of the art scientific literature was used to derive the main business case components and corresponding critical design issues.

The balancing of critical design issues is a challenging task, and it is believed that a decision support system could guide the decision making process of the actors involved. A selection of business model literature is made and a suitable business model framework is chosen which consists out of four main components: service, technological, organizational and financial aspects. To give scope to the thesis project only design issues that stem from the technology domain are selected for incorporation in the decision support system.

A case study is conducted in which the main actors within the mapshop business unit are interviewed; a stakeholder framework was used to make sure no actors are missed. The interviews are semi structured and lead to the association of actors within TomTom that are working on or with the mapshop service platform to the previously selected critical design issues from the technology domain. The interview results are a complete set of actors, corresponding objects, interactions between actors and dependencies, which lead to an overview of actor value activities, information flow and business processes. By incorporating the actor activities in the decision support system and matching these with the critical design issues, it becomes easier for the decision makers to make the business case more viable.

The decision support system was validated using a group interview session in which the results were promising. The end result is a decision support system that needs further validation before mass rollout can take place. The decision support system is in theory extendable to incorporate other business model components, thereby making it suitable as an integrated solution for the entire mapshop platform. By placing the decision support system in the roadmap process it is believed that business model viability will be increased as a more structured decision making process will be put in place.

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LIST OF ABBREVIATIONS

BC   Business Case

BM   Business Model

CDI   Critical Design Issue

CSF   Critical Success Factor

DSS   Decision Support System

IA   Information Analyst

MUS   Map Update Subscription

PM   Project Manager

PND   Personal Navigation Device

PO   Product Owner

PU   Product Unit

REQ   Requirement

RM   Resource Manager

RQ   Research Question

SA   Support Application

SCF   Service Creation Framework, The main checklist used by project managers within TomTom when working on new services.

SPM   Software Product Manager

UI   User Interface

VIP   Value, Information and Business Processes, used in reference to a stakeholder framework.

QoS   Quality of Service

1. INTRODUCTION

The high-tech company TomTom has grown significantly over the past number of years, with over 3500 employees worldwide and 800 there-of situated in its HQ in Amsterdam, it has become an icon in the car navigation industry. With over € 1.5 billion in turnover and € 100 million in revenue in 2011 TomTom operates in over forty countries as one of the leading brands in car navigation products and services. Since the start of TomTom in 2001 and the first navigation product launch in 2003 it has grown very fast, going for an initial public offering in March 2006 at the Amsterdam Exchange, it is addressing a market that is still growing significantly today (TomTom 2010; TomTom 2011).

Only just over 30% of the cars in core markets Europe and North America have some form of navigation device installed. Most users of navigation devices are still first time buyers; however a shift in the market can be detected towards customers who are buying a newer version of their device to reap the benefits of the increase in technological capabilities and thus possibilities. (TomTom 2010). Car sales in the developing markets (Eastern Europe, Asia, South America and Africa) are picking up as the local economies continue to develop, this is a trend that TomTom is actively monitoring and intends to be at the forefront of exploiting.

By working in over forty countries TomTom operates in a dynamic landscape with ever changing competition. To stay ahead in its business and enable the workforce to make quick decisions regarding innovation, TomTom must have a clear vision, mission and strategy. TomTom sees the future as a: "*Globally connected and rapidly growing community, which uses navigation applications and services running on a variety of connected navigation devices, including personal navigation devices (PND's), in-dash infotainment systems and smartphones*". Thereby giving TomTom its mission to provide all drivers with the world's best navigation experience, the way forward to accomplish this is to have a strategy that clearly defines the road to take to attain such goals. TomTom's strategy is to provide the best location and navigation solutions across multiple platforms; from portable navigation devices, to in-built systems to mobile phones and the internet. (TomTom 2011).

Although there is still a lot of potential in the changing market landscape, TomTom is currently suffering from declining sales on the 'Personal Navigation Device' (PND) market. A PND in the most common form is a device that can be attached to the car front window to aid the driver in navigating. The decline in sales is a trend that has been going on for a couple of years due to increased competition, market saturation, people already owning a personal navigation device and the integration of navigation in the car dashboard. This declining trend is now reinforced because of the recession which makes people spend less.

Also competition is not standing still, a current trend is the increased focus on services and service innovation within companies, as it is perceived as a key growth factor (Hertog, Aa et al. 2010). Google offering free navigation, Nokia offering free maps for their phones or Garmin offering free map updates for the lifetime of the PND are examples of competitive challenges which TomTom is facing. Although TomTom is still in the forefront in many respects customers might be unaware of the competitive differences, thereby potentially losing revenue.

Song, Benedetto et al. (2009) see service innovation as the next big 'thing', along with scientific literature regarding service innovation gaining increased attention (Alam 2002). Traditionally, scientific literature focused mainly on product innovation and tangible product industries, service innovation however is different from product innovation. Although product innovation and service innovation share a number of distinct attributes, product innovation doesn't capture the finesses of service innovation. Services are characterized as intangible, heterogeneous, inseparable and perishable (Vargo and Lusch 2004). Services being different from products lead to a number of operational consequences; service updates are easier and quicker as they are easier to modify and services are easier to copy by competitors as they are not patentable (Vargo and Lusch 2004).

Another consequence of the service innovation trend is the shift from a single supply chain to a more complex value network. Where a supply chain is typically product based, a service may be used by multiple actors in a value network at the same time. Research looking into business models is paying increased attention towards the aspect of service value networks (Kijl, Bouwman et al. 2006). Service innovation typically involves a dynamically changing environment of actors (Reuver, Bouwman et al. 2011) and the dynamic ecosystem of stakeholders imposes challenges on the design of the service platform.

TomTom is shifting towards a higher focus on the services aspect, wanting to generate more revenue out of its mapshop platform. The mapshop platform is a service that offers new maps, map updates and map subscriptions which can be bought and downloaded on your Personal Navigation Device. Because of the drop in PND sales the services aspects becomes increasingly important as services can generate revenue continuously and not one time as opposed to tangible products. Furthermore services can potentially serve an entire network of stakeholders simultaneously, thereby acquiring more sources of revenue.

The amount of mapshop customers is currently low; from the total TomTom PND customers less than 10% is making use of the mapshop platform; therefore it is seen as a high growth opportunity. The benefits of even a slightly increased 'attachment rate' to the mapshop platform are significant in terms of revenue. Additionally the 2nd order effects of branding and an extra interaction channel with customers will lead to many potential growth opportunities. There is also an increased potential of customer lock in effects, making sure that it is less likely that customer will switch brands after making use of the mapshop platform services.

To increase the amount of customers and thus revenue, innovative new services with viable business models are needed that cover all the aspects and intricacies of the dynamic industry TomTom is operating in. Business models are seen as a key driver in delivering a new and valuable customer experience (Kijl, Bouwman et al. 2006). Currently new services and their related business models within TomTom are designed on top of the existing service platform. The use of service platforms give companies a significant competitive advantage (Reuver, Bouwman et al. 2011). Service platforms can be used to quickly attach new customers and thereby create the possibility to quickly acquire more sources of revenue when new opportunities are found. Since TomTom is already using a service platform, the business models should specifically apply to this service platform. Although there is no consensus on the definition of what a 'business model' actually is (Haaker, Faber et al. 2004), within this research it is seen as a blueprint of how a network of stakeholders cooperate in creating value from new services.

It is challenging to design business models around the mapshop platform due to its complexity, legacy issues and the many internal and external stakeholders involved. There is no clear overview of stakeholders that should be involved for every new service, thereby creating risk of overlooking potential insights or opportunities which leads to unneeded iterations within the technical development processes that ultimately decrease the time-to-market.

Furthermore it is challenging to cope with all the critical design issues and its implications for the service platform. Critical design issues are defined as decisions regarding the characteristics of a service that has a significant impact on the viability of the business model (Faber, Haaker et al. 2004). A critical design decision is based on which trade-offs to implement in the new service, for example the critical design issue 'security' is deciding on a trade-off between usability and privacy concerns. Each new business model offering has to go through a decision making process discussing these trade-offs.

A **decision support system (DSS) for balancing critical design issues in business models** should assist in the creation of viable business models that can generate value for customers, TomTom and other stakeholders involved. It makes sure that each new service has covered essential design issues and has gone through a decision making process that involves key stakeholders. As the mapshop platform has grown significantly in the past number of years the impact of new services and their related business models have a number of effects on the service platform that are difficult to detect in early stages, slowing down capitalization as a result. The mapshop platform has existing development processes in place and it is an initial requirement that the business model decision support system should fit within the existing processes.

The definition of DSS is not straightforward in literature, previously a DSS is defined as any system that makes some contribution to decision making (Sprague 1980). Sprague (1980) tried to create a definition using a number of examples to characterize a DSS. Sprague stated that decision support systems tend to be aimed to less well structured, underspecified problems that upper level managers face. The DSS that will be designed and validated within this research is different in the regard of the intended user, as the DSS will focus on the entire process chain from business case to development. Sprague (1980) additionally states that a DSS is characterized by an emphasis on flexibility, adaptability and quick response; it is user initiated and has support for the individual decision making style. Within the literature research a clear definition will be given to all relevant aspects of the DSS.

The final deliverable of this thesis is a validated decision support system which serves to bring TomTom to a higher level of viability for their service offerings. By focusing on a decision support system, an integrated approach will be generated that can assist in covering the critical design issues that lead to a more viable business model. Furthermore it creates a starting point for discussion on processes, critical design issues and the general roadmap of the service platform.

1.1. Problem statement

Following the line of argumentation from the introduction the **problem statement** is:

> TomTom currently doesn't have a *fitting* decision support system which assists in balancing *critical design issues* for new *service* development business models that takes *key* stakeholders into account.

The problem statement has a number of key aspects that need clarification:

Fitting, the business model decision support system should fit within the existing development processes already in place for the mapshop platform; therefore the DSS is directly useable after its specification and validation.

Critical design decisions, during development there are critical design issues that are potentially conflicting between stakeholders; to point these conflicts out in an early stage might make the decision making process go faster. Design choices in one part of the business model design might lead to unexpected implications on other part of the business model design (Reuver, Bouwman et al. 2006). Each business model design has to balance critical design issues; design issues are tradeoffs that need to be chosen carefully in order for the business model to be viable.

Innovative Services, successful new service development is key to survival for companies. Each new service has to balance critical design issues in order to become viable and alluring to customers.

Including stakeholders, the decision support system should make sure the key stakeholders are included in the new service design process. There are two types of stakeholders for new service design, internal stakeholders within the TomTom Corporation and the external stakeholders which are customers or partnering companies. There are a number of stakeholders that have a high visibility during decision making while developing new services, but possibly also stakeholders that have a lower visibility that dynamically change for the type of project. Examples of stakeholders are the designers, user experience researchers, project managers, developers, helpdesk, legal department, quality assurance managers, support group, security experts, release managers etc.

The project is limited to the design and validation of a decision support system specifically aimed at technology related critical design issues. Although business models have a number of other different important aspects (service, organizational and financial domain), it is chosen to specifically focus on the technology component of new service development. This limits the research in broadness but at the same time deepens the understanding of critical design issues and development processes within the technology domain. There are many stakeholders involved in the domain of the mapshop platform; the decision support system will only focus on the internal stakeholders of TomTom; although certain internal stakeholders represent external stakeholders. Furthermore it will only focus on the mapshop service platform, but it is a goal to make a start to generally valid DSS framework that can be used throughout TomTom or companies facing similar challenges.

1.2. Research Questions

This paragraph specifies the research questions and the explanation as *why* these research questions are relevant with regard to the problem statement and main research question. Goal of the research questions are first to acquire enough knowledge about the important concepts, and secondly to develop a validated DSS that matches with the requirements. To specify the DSS and to acquire the critical knowledge needed to solve the issues raised in the problem statement the following **main research question** needs to be answered.

How to specify a fitting business model decision support system to assist TomTom in balancing critical design decisions during new service development?

The main research question leads to a number of sub questions that need to be answered in order to come up with a validated business model decision support system. The first sub question focuses on the gathering of knowledge on the different concepts, this is important as literature provide valuable insights.

RQ1. What is the current state of the art knowledge regarding critical design issues and decision support systems in the context of new service development?

The entire research will borrow insights out of this literature study on business model design and decision support systems. The literature study will additionally provide definitions on the relevant concepts so there is no chance of ambiguity, which is necessary in later stages when evaluating the DSS. Furthermore an analysis of recent relevant publications will help forming an up to date decision support system. The critical designs issues that are gathered in this phase will later serve in the design of the DSS.

The next research phase is to clarify the 'design space', a design space is defined as the superset of design variables and components (Bouwman and Daas 2012). The design space will be specified in questions 2 and 3.

RQ2. What are the requirements that the intended DSS users within TomTom impose on the DSS?

The gathering of requirements and intended users is relevant as it gives a clear boundary on the DSS design. Without requirements the DSS can't be developed and it less likely to be supported by the organization. When the intended users with their associated requirements are known the DSS can be tailored to their specific needs. Furthermore the DSS will have a number of requirements imposed on it based on previous research captured in scientific literature.

The design and implementation of new services for service platforms is complex as multiple stakeholders are involved during the development stages. Multiple design criteria need to be balanced in order to let the business model become viable and deliver the intended value to the customer or network of customers (Faber, Haaker et al. 2004). The mapping of these design issues for the mapshop platform is seen as key for future development efforts, as TomTom is a large company with many actors operating in a dynamic environment it is also important to map the current stakeholders involved in balancing these critical design issues. This leads to research question three, which is relevant as it gives an answer to two components given in the problem

statement; namely the *processes* and the *critical design issues*. These two components will be linked and will form the contents of the decision support system.

RQ3. Which stakeholders are currently involved or should be involved when balancing critical design issues from the technology domain?

Once the design space is specified a start can be made to develop the DSS, this phase is the DSS Development phase. In the development phase a conceptual DSS will be specified, and implementation guidelines are created about the use of the DSS.

RQ4. What is the business model DSS specification for use within the mapshop service platform roadmap process?

After the conceptual DSS development it needs to be validated on the level of fit. This will be done in fifth phase, which is the validation phase, handled in research question five. By initially validating the conceptual DSS, it is made sure that the internal validity of the model is correct, but also that a proper solution has been given with regard to the problem statement.

RQ5. What is the validity of the designed DSS for use within TomTom?

The final result of research question five is a validated DSS which will serve as an answer for the main research question and thus a solution to the challenges stated in the problem statement. The conceptual DSS is presented into a final recommendation towards TomTom management, in the form of a presentation and report. The research questions will fit in the research framework depicted in figure 1-1, which also delineates the different phases of the research.
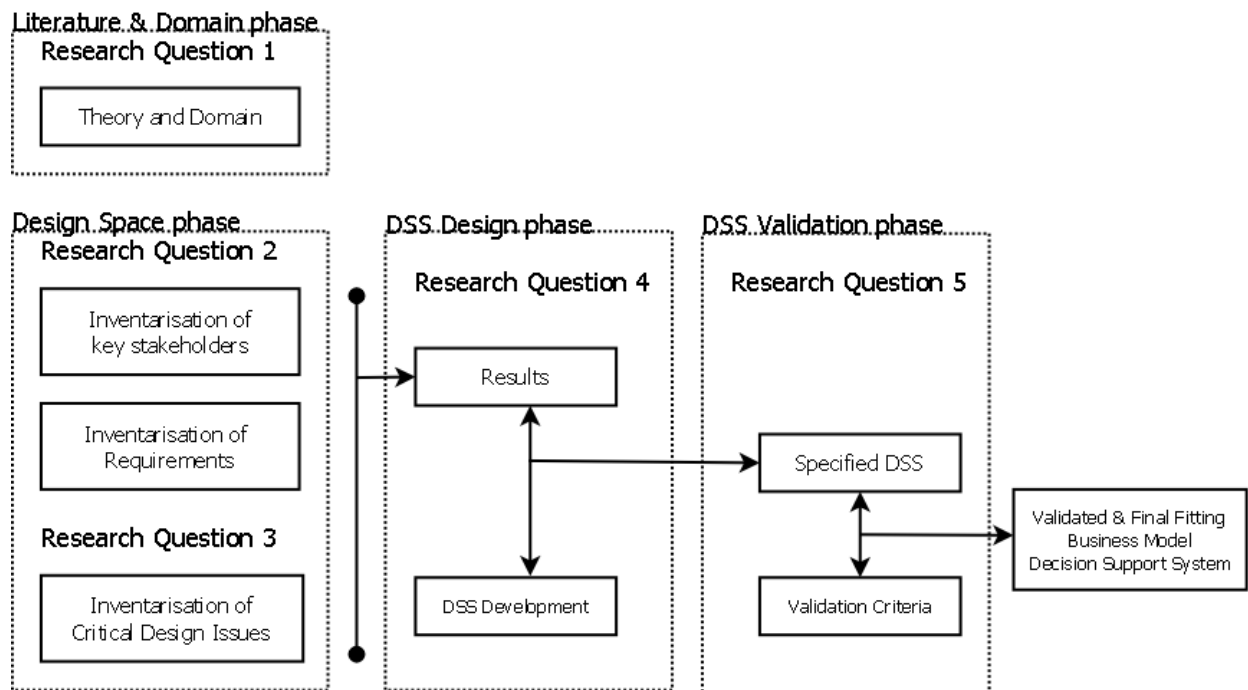
Figure 1-1 The research framework, based on Verschuren and Doorewaard (2007)

1.3. Methodology

The research is divided into six consequential phases; each research phase will be explained in general on *how* the research questions will be answered. In Table 1-1 the research phases are shown together with research strategy and type of data collection. Two phases are of general nature as they are about the outline of the research itself, which are phase one and six. The research phase two till five apply to the practical side of the research, each of those steps will be explained with regard to the original main research question, in terms of what will be researched, how this will be done and what deliverables will be generated.

Table 1-1 Research phases

#	Phase	Research Strategy	Data collection	Question
1	Definition phase	Preliminary interviews and literature study	Desk research and interviews.	
2	Literature research	Scientific Literature study	Desk research finding state of the art scientific literature	1
3	Field research	Qualitative research - Case study	Interviews	2,3
4	Design phase	Fitting of previous collected data	-	4
5	Validation phase	Testing conceptual DSS	Desk research and interviews	5
6	Deliverable phase	-	-	

Phase 1. Definition phase - Designing the Research and sketching the environment

The first phase is of a general nature as it is the step to design and define the research project itself. The specification of the problem, the research questions, the approach and impact the research will have on management and the scientific community. A preliminary literature study is conducted to define the main concepts in order to specify the definitions in the problem statement and research questions. Also the problem statement is specified and the type of research is chosen together with the methodology of research.

Furthermore the environmental background, the domain, will be sketched in order to increase understanding of the implications of this research. The competitors of TomTom and the value these competitors offer to their customers will be explained. After the explanation of the dynamic competitive landscape there will be a detailed explanation of the mapshop platform and the position of this platform within the dynamic landscape of actors. The domain analysis will provide background information on the competitive challenges TomTom is facing.

Phase 2. Desk phase - Literature study

The second phase is to gather scientific literature to get a better insight on the key concepts in this research. This desk phase only consists out of research question 1;

RQ1. What is the current state of the art knowledge regarding critical design issues and decision support systems in the context of new service development?

An extensive overview on scientific literature will be given, explaining the current state of the respective research domain. Different insights within scientific literature will be elaborated upon and compared with each other. The breaking down of scientific models into comparable components will lead to insights on current progress and gaps in knowledge, also the terms 'business model', 'critical design issue' and 'decision support system' will be defined more specifically. The purpose of the first research question is to categorize different types of business models from literature and distinguish between types of decision support systems, to derive important aspects and building blocks of business models and DSS that can later to be used in the DSS design phase.

Phase 3. Field Research – Defining the design space

The third phase contains the field research in order to specify the design space.

RQ2. What are the requirements that the intended users within TomTom impose on the DSS?

The second research question will be answered by holding interviews and by applying a stakeholder framework, management will be asked on what the processes and roles are within the business model design processes. The stakeholder framework will be used to create an overview of key stakeholders, their value information and the processes in use.

Two types of requirements need to be gathered in order to design the DSS, first the requirements that stem from the literature. And secondly the requirements that stem from the stakeholders. The requirements from literature will be sought by processing the insights gained while answering the first research question. The user requirements are what the intended users want from the to be designed DSS, these requirements will be gathered using semi-structured interviews; a selection of the stakeholders found will be interviewed.

The second step in determining the design space is to specify the critical design issues, these issues form the key element of the DSS, once the critical design issues are defined they can later be used in DSS design.

RQ3. Which stakeholders are currently involved or should be involved when balancing critical design issues from the technology domain?

The third research question will be answered using semi structured interviews of the stakeholders. One interview per stakeholder will be conducted which addresses both the requirements and the critical design issues. The stakeholders will be asked regarding the critical design issues that have been derived from literature and how they cope with these CDI's. The decision making process regarding the CDI's is mapped, which will later serve as input for the DSS design. A stakeholder framework will be applied in order to map the key stakeholders associated with the critical design issues. Once it is understood how certain critical design issues

are balanced and how this process of balancing takes place a DSS can be created that will incorporate these balancing aspects. During the interview they will be asked to identify stakeholders that are needed to balance the requirements and thus make the critical design choices. Overall a valuable insight will be created to serve as a basis for the DSS.

Phase 4. Design Research – Development of the DSS

Within phase four the actual DSS will be developed, resulting in a conceptual DSS that has to be evaluated. The DSS will be designed using the acquired results from the previously found answers. The conceptual DSS should be integrated in the existing processes, thereby making it meet the requirement of *fit*.

> *RQ4. What is the business model DSS specification for use within the mapshop service platform roadmap process?*

The fourth research question will be answered using a design approach, based on linear analytical research (Verschuren and Hartog 2005), all the findings of previous research questions are molded together to specify the DSS. Together with the requirements and the results of the research questions a practical guide will be developed on how to use and integrate the DSS into existing processes.

Phase 5. Validation phase – Evaluating the conceptual DSS

In this phase the conceptual DSS will be evaluated on the given goals and by validating the DSS credibility will be increased.

> *RQ5. What is the validity of the designed DSS for use within TomTom?*

The fifth research question will be answered by a group interview session to identify potential shortcomings or missed actors. After this phase the end result will be an evaluated DSS which can be used within TomTom, the result thus answers the main research question.

Phase 6. Deliverable phase – Presenting final DSS proposal

This is a phase of general nature as this is the final phase in which it is needed to generate all the necessary deliverables. The report, DSS and presentation will be finalized.

1.4. Scientific Relevance

The scientific relevance of this thesis is based on the expansion of knowledge in a number of theoretical domains. As the final deliverable of this thesis is a fitting decision support system to assist in creating viable new services; associated scientific fields will be touched upon. A new light will be shed on coupling the high level definition of business model design into practically usable process improvements. Especially a contribution will be made to the scientific fields of business models, stakeholders gathering and critical design issues; this paragraph will discuss the contributions of this thesis for each scientific field on why and how it will contribute.

There are different types of business model frameworks to be found in scientific literature, the STOF-model is one of these and is used by a number of companies operating in the service domain. The STOF-model has four different components that together comprise a business model; service, technology, organization and a financial component. This thesis will also make use of the STOF-model and will specifically look into the critical design issues that stem from the technological domain component; therefore this aspect will be validated and verified even further. The user base of the STOF model will be increased thereby possibly leading to new insights or shortcomings. Contributions to this model and the validation of this model will benefit the scientific field of business models, and also benefit companies who are using this model.

An integral part of the decision support system will be the integration of a stakeholder overview. For the gathering and creation of an overview of the key stakeholders the VIP framework by Solaimani and Bouwman (2011) will be used. This VIP framework is created for mapping value exchange, information exchange and business processes for external stakeholders. Within this thesis it will be extended for the use of internal stakeholders within TomTom. Furthermore the VIP framework is lacking in a number of areas as stated in the original article; it needs (1) further analysis of operationalization, (2) empirical evaluation of the framework in different environment, (3) visualization of the conclusions of the VIP analysis. This thesis will address all three of these issues thereby contributing significantly to this framework and its use.

A major component of the DSS will be the critical design issues combined with the VIP framework. The coupling of critical design issues with the VIP framework has never been done before and this is seen as an opportunity to extend the field of critical design issues.

1.5. Managerial Relevance

The results of this thesis have a number of managerial and organizational implications. The first is a faster decision making process, the use of the finally proposed DSS will speed up decision making processes as less time is needed per new feature on the critical design issues, since less iterations are required during the development processes.

With the implementation of the DSS the quality of the final value delivered to the customer will be higher, as critical design considerations are included early in the process. The long term effects of the DSS are a more stable service platform as the critical decisions are considered thoroughly before implementation. Furthermore there is less chance of overlooking potential insights from stakeholders as these are part of the decision making process.

High tech software companies and companies operating in the mobile services domain will benefit as they will have another insight in speeding up development processes and achieve faster innovation cycles thus shortening time to market. The industrial domain of TomTom will be researched, thereby creating an insight in current technological trends, which are important to understand when focusing on new markets and thus also new research areas.

Potentially the DSS can be expanded to contain more critical design issues related to other domains from the STOF model. Furthermore the DSS can also be extended to include external stakeholders too through the use of the VIP framework.

The mapshop development teams will gain insight in the decision making and flow of deliverables. Which is generally a weak point within the Agile SCRUM project management method, by incorporating a DSS in the beginning stages leading towards the Agile approach the decision making process is traceable and thus people can be held accountable as well.

1.6. Document outline

The outline of this document is structured in such a way that it corresponds with the order of research questions and deliverables. Earlier chapters form deliverables that will be used in later chapters, thereby creating a linear flow of information. This section provides an overview on each chapter and its context.

Chapter 1 is the introduction to the problem statement, research questions, methods and relevance. *Chapter 2* will clarify the domain and the technical concepts of the Mapshop service platform. *Chapter 3* will answer sub research question one, and will give an overview of literature on business models, critical design issues and decision support systems. *Chapter 4* will present the methodology on how to answer the remaining research questions. *Chapter 5* will present the results of the interviews, resulting in a list of stakeholders, requirements and critical design issues couple to stakeholders. In *Chapter 6* the results will be processed and fitted into all the DSS components. *Chapter 7* will evaluate the DSS, based on the given requirements, thereby validating and eventually presenting the final DSS. *Chapter 8* will be the conclusion of this research, together with lessons learned, recommendations and future research possibilities.

Table 1-2 Document outline

Chapter	Title	Research Questions
1	Introduction	
2	The Mapshop Platform Domain	
3	Literature Study	Q1
4	Methodology	
5	Field Research Results	Q2, Q3
6	Design of the DSS	Q4
7	Validation of the DSS	Q5
8	Conclusion	

2. THE MAPSHOP PLATFORM DOMAIN

The surroundings and background information of the research topic should be known in order to have a reliable and valid case-study, furthermore the industrial domain should be known when contributing to the scientific field; this chapter gives an overview on the competitive domain that surrounds the mapshop platform and the technological aspects of the mapshop platform itself. First an introduction will be given on the PND and map market, continuing with an actor analysis in which the actors will be classified in terms of critical assets, critical control points and strategy. Secondly a high level viewpoint will be taken to look onto current industrial trends based on publically available data on the competitors of TomTom and an interview with a TomTom map industry expert. The next step is to zoom in on TomTom and its organizational structure, describing the business units. Concluding with a section on the mapshop platform and the corresponding technical intricacies which will shine a light on the capabilities and challenges the mapshop platform is facing.

2.1. Introducing the Market

Every region where there are cars or motorcycles there is a market for personal navigation devices, figure 2-1 displays the total amount of cars as indicated by a research in 2011 (TomTom 2011). But the navigation market is not only corresponding with cars and motorcycles it is expanding into other fields too; pedestrians, sports, aviation and cyclists are now reaping the benefits of technological innovation. Each segment can be addressed with similar technology but adjusted for the particular application.
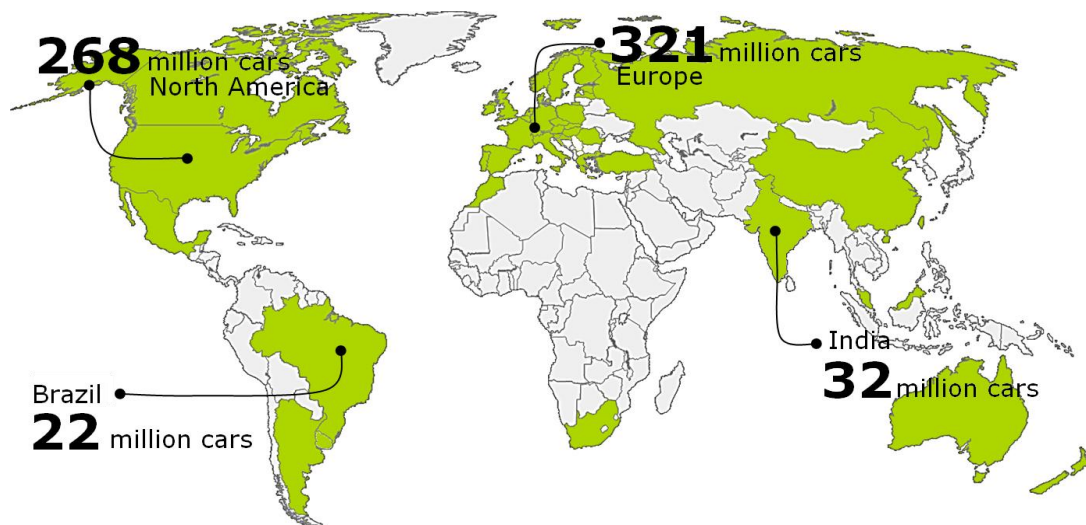
Figure 2-1 Marked countries are where TomTom PND's are sold (TomTom 2011).

The PND market is a base for the map product that will be the main focus in the domain analysis. Maps are a key value driver of PND's, as navigation is impossible without a map. The coverage and accuracy of the map are important because it significantly impacts the value experience of consumers.

2.2. Actors in the Map Segment

The competitive arena in which TomTom is operating can be seen as an eco-system of companies. Each company has its capabilities, critical assets, critical control points and strategy to deliver value to customers. First a selection will be made on who the relevant actors in the eco-system are. Secondly the capabilities of these actors will be mapped in terms of critical control points and critical assets in order to understand the collaboration schemes that are needed between the major actors. And thirdly the strategy of each major actor is discussed on how it intends to deliver value to its customers.

Based on a discussion with a TomTom marketing expert on map propositioning the following competitors are seen as threats for TomTom; Garmin with its daughter company Navigon, Google, and Nokia with Navteq. Garmin is a direct competitor of TomTom as it offers similar products, services and addresses the same market segments. The threats of Google and Nokia originate from the map capabilities; one third of TomTom is dedicated to the creation of maps, with Nokia owning Navteq; and Google collecting its own map data, it has two strong competitors that have the ability to create map data. TomTom won the bidding competition regarding TeleAtlas from Garmin in 2008, leaving Garmin without the capabilities to create map data. Garmin get its map data from Navteq which is owned by Nokia. The result is that there are three companies who can offer map information to the market today; TomTom, Navteq and Google, leading to the landscape in figure 2-2, arrows indicate the value delivery.
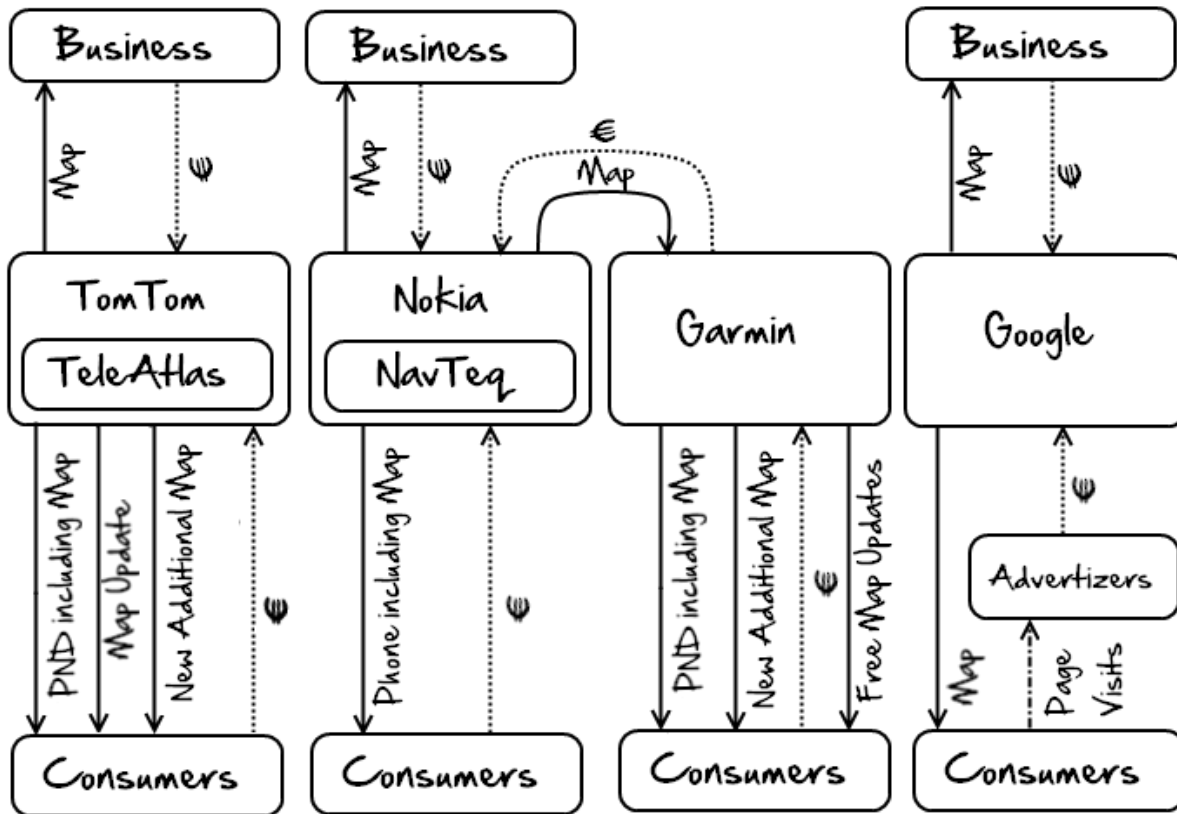
Figure 2-2 Landscape of navigation devices and Maps

A number of companies are left out of scope within the competitor analysis, as they are deemed a too small player in the eco-system or not seen a big threat to TomTom. The companies that are left out of scope are: MiTac (with Mio, Magellan, Navman), Bluetech, Mappy and Takara (France); Falk, Medion and Becker (Germany) and Binatone (UK). These actors are most of the time pure PND manufacturers, unable to create maps themselves and only addressing customers within a certain geographical region or niche market.

Table 2-1 Major actors from the viewpoint of TomTom

Company	Products\Services	Map creation?	Free maps?
Garmin (with daughter Navigon)	PND	No	Yes
TomTom (merged with TeleAtlas)	PND + maps	Yes	No
Google	Maps + advertising	Yes	Yes
Nokia (with daughter Navteq)	Phones + Maps	Yes	Yes

Garmin is the biggest player in the PND market and a direct competitor of TomTom, as it offers a similar value proposition to customers. The *critical assets* of Garmin are the ownership of a range of navigation devices and a solid marketing effort. Garmin however does not have the capability to create maps themselves. The *critical control points* are the possibility to bill end consumer or resellers directly by offering products and services for the PND's, Garmin also has a solid foothold in the 'outdoor' PND market. One of the shortcomings of Garmin is the service offering, this lags behind the promises that are made by marketing, for example to update a map on a device a customer needs to do at least 60 steps that needed to get the right map on a PND. Furthermore the services are not intuitive for users to work with; it is a field in which Garmin is struggling to keep up with their competitors.

Garmin also offers free lifetime map updates for some of their PND's, which is a direct *strategic* attack on the TomTom business of selling maps. Although marketing states that some devices get a lifetime free update service the actual service arrangements are still lagging behind, but this is mostly detected later by customers who are by then already 'locked-in'. Garmin does not have the capabilities to create maps themselves, so they have a licensing agreement with one of the daughter companies of Nokia, Navteq, to use their map data. By offering a lifetime of free map updates for some PND's Garmin is actually losing money somewhere in the value chain. But by effective marketing the amount of PND's sold make up for the loss of including pricy maps for free on the devices as PND's have a higher profit margin as maps.

Another key actor is Nokia which core business is the development of mobile phones and sell these all over the world, a second part of their product portfolio is the sales of maps. The critical asset of Nokia is that they are in control over their own map data; they can license this map information to other companies, for example, as stated before, Garmin licenses the map data created by Nokia's daughter Navteq. The strategy of Nokia is to provide free maps for their mobile phones, with the goal to boost mobile phone sales. Nokia acquired the map company Navteq in 2007, leaving only the main map competitor TeleAtlas available for a takeover, TeleAtlas was eventually taken over by TomTom in 2008.

The mapping technology of Navteq is different from the technology used by TomTom, thereby impacting the service offering of companies making use of one of these map technologies as a

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whole. The mapping technology of Navteq is modular based, thereby enabling incremental map updates for certain countries. The map technology of TomTom is not modular based but package based, therefore a small update in a Europe map will lead to an entirely new Europe package, whereas in Navteq only the affected region will be updated. Since Garmin is also making use of Navteq maps their PND's can also make use of this modular updates.

Table 2-2 Overview on critical control points, critical assets and strategy from a 'map' perspective.

Company	Critical Control Points	Critical Assets	Strategy within eco system
Garmin	'outdoor' market Able to directly bill customers	PND Marketing No maps and services	Offer maps for free, which only 'hurts' TomTom'
Google	Marketing leader, able to bill companies directly.	Map making No dedicated PND, only works when online	Free maps, in order to advertise with 'points of interest'
Nokia	Mobile phone industry Able to bill customers directly. Selling of map data	NavTeq Modular Map making Mobile phones No dedicated PND	Free maps, in order to boost sales on own mobile phone products
TomTom	Able to bill customers directly Selling of map data	TeleAtlas Non-modular map making	Sell maps as it is a major source of revenue.

Google is also identified as a key actor in the field of navigation and map technologies. They used to get their map data from TomTom directly but since 2008 started acquiring and building its own map database, becoming another player in the domain of map technologies. The critical asset of Google is combining advertising with different other technologies and is now expanding in the field of points of interests in maps. However the downside of Google is the view consumers have on its advertisement practices; consumers are already complaining on the possible privacy infringements and amount of advertisement in the maps, thereby leading to a lower value experience. Another aspect to point out is the map technology of Google only works when the navigation device is connected to the internet.

2.3. Trends in Market and Map Segment

The following three trends have been identified as important for the industrial domain of navigation companies. The first two are related to map proposition and the third is on a more general note, each of the identified trends will be discussed separately.

1. Increasing consumer perception that maps are free of charge.
2. Increasing use of community in map generation.
3. Decline in PND sales.
   a. Increasing use of smartphones as PND.
   b. Increasing use of in-dash navigation in cars.

Increasing consumer perception that maps are free of charge

The increasing consumer perception that maps are free of charge is a trend which is just starting to emerge; in the field of smartphones it was already logically assumed by consumers that the maps are free to use, in return users would see advertisements or advertised locations when searching. In the field of navigation devices for use in motorized vehicles the trend is new, consumers understood the amount of effort that is put in the creation and ensuring the quality of the maps and are willing to pay for updated versions. The strategic move of Garmin by making map updates free of charge for some of their PND's is changing the perception of consumers over time, consumers now tend to question on why PND maps should cost money.

Increasing use of community in map generation

TomTom is actively using consumer contributions to increase quality of the maps; these contributions are made through the mapshop service platform using a community of TomTom users. The community makes sure that roadwork or changes in traffic flow due to new legislations or traffic signs are quickly updated and applied to all devices who are set up to use this service.

A step further is the Openstreetmap project, which is an open project and solely based on user input to generate maps. Currently the quality of the Openstreetmap database is low compared to Google, Navteq and TomTom, but it has a potential to grow significantly as more users will contribute to the project. This trend is just emerging but is deemed to quicken its pace as the recently introduced iPad (the new iPad, also known as iPad 3) in the beginning of 2012 makes use of the Openstreetmap database. Apple products used to make use of the Google maps database for all its navigation and map applications, but with the integration of Openstreetmap Apple seems to have taken another path which will impact the power balances of the map industry.

Decline in PND sales

As stated before in the introduction, the PND sales are declining, in the meantime the smartphone and in-dash navigation sales are increasing. The smart phones are becoming powerful enough to replace traditional navigation devices, and are often shipped with standard navigation software installed of for example Google or Nokia. TomTom recently made a deal with Samsung for a navigation application on Samsung smartphones. Currently the value of these navigation devices are considered low in comparison with dedicated PND's as the navigation software is not good enough and map quality is low, furthermore most current map software for smartphones can only be used when connected to the internet. Many car manufacturers are now integrating in dash navigation software from 3rd parties to increase value. The decline in PND sales forces companies to increase focus on services instead of products.

2.4. TomTom

TomTom as the 2nd biggest player in the navigation market needs a competitive organizational structure; figure 2-3 displays the organizational structure identifying the core business units. The mapshop platform used to be a separate business unit considered a 'shared activity' in 2011, but due to reorganizations called project Mercury the mapshop platform was merged with the 'PND' product unit in an effort to try and increase alignment between the consumers who bought the PND and the value experience of the mapshop platform service.
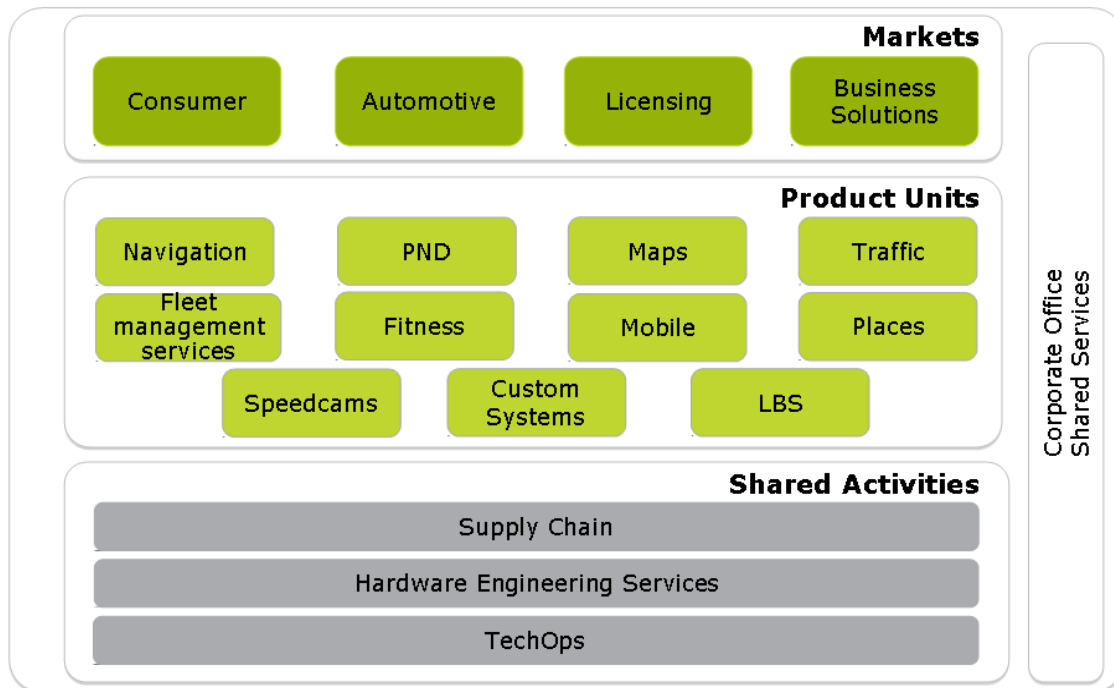
Figure 2-3 Organizational structure of TomTom in 2012.

TomTom has four pure marketing business units; consumer, automotive, licensing and business solutions, dedicated to specific market segment. Consumer products are the most recognizable product line as this is business to consumer sales, and generate the most revenue at the moment; an example is the TomTom Go navigation device. Automotive products are about in-dashboard navigation systems within cars; this business line strives for ongoing partnerships with car manufacturers; Renault, Fiat, Mazda, Ford, BMW, Mini are already using TomTom software or maps within their in-dashboard entertainment system for navigation.

Business Solutions offer tailored solutions for business customers that own a fleet of motorized vehicles. This business line enables companies to integrate GPS tracking, job tracking, vehicle tracking, and traffic avoidance for faster routing of their cars to their destinations. Apart from tailored approaches Business Solutions also offers out of the box solutions called WORKsmart and WEBFLEET, giving companies total fleet management control of their motorized vehicles. The Licensing business unit is selling license agreements of TomTom patents and technologies to a mix of different business groups, including portable navigation device companies, wireless companies, smartphone manufacturers, mobile application developers, governments and enterprises worldwide.

Below the marketing business units in figure 2-3 the product units can be found, each product unit is responsible for a family of products. For example 'Speedcams' is responsible for the inventarisation of speeding camera's and making this data available for sale, 'Places' is working on the collection and packaging of points of interests, 'Fitness' is a product unit dedicated to sports and has a contract with Nike and a GPS sport watch in its portfolio. The key factor in understanding the division of these product units is that each product unit has a competitor in the market from either Garmin or different other smaller competitors, thereby making it possible to easily benchmark product units in comparison with competitors.

The product unit PND is dedicated to the sales of navigation devices to consumers, the mapshop platform is specifically merged into this product unit to deliver added value for this consumer segment. The mapshop platform provides downloading of maps for new areas into a personal navigation device and the updating of previously installed maps to the latest version. The platform provides multiple types of connectors, enabling TomTom to quickly launch new navigation products making use of the existing platform thereby shortening time to market. The mapshop platform will be discussed in detail in the next subchapter.

The shared activities are the supply chain, and hardware engineering services which are both needed for most product units, as it has to do with the manufacturing and delivering products. The Techops department is dedicated to the daily operations of TomTom services and is a key stakeholder for the mapshop platform.

Competitive Advantage TomTom

Based on the previous paragraphs a conclusion can be drawn on the competitive advantage of TomTom. Firstly TomTom has the map technologies in-house and are therefore independent, as the mapping technology is scarce in the market, being an oligopoly with only three major players: Google, Nokia and TomTom. Secondly TomTom is a very strong brand; the name is considered an icon in the navigation industry. For example when consumers are going to buy a navigation device they are saying it as going to buy a TomTom. Consumers also rate TomTom devices among the highest quality in terms of user interface and map quality. Also the HD traffic technology is currently leading in real-time traffic information systems leaving Garmin behind. The Europe maps of TomTom are of the best quality in comparison with competitors.

While other companies give away map data for free, TomTom is able to sell these maps with a profit margin; the capability of selling these maps is a competitive advantage as it is making more revenue on this terrain than its competitors.

The use of a consumer community contributing to changes in maps is more advanced in comparison with its competitors, although the Openstreetmap project might be a threat to the community of TomTom. The community of TomTom is already in place for a couple of years and is actively being used.

2.5. The Mapshop Service Platform of TomTom

What is the mapshop service platform exactly? Consumers can make use of the mapshop service platform by connecting a TomTom PND to their PC; a support application will then connect to the service platform and initiate a communication session between the PND and the service platform. The consumer is presented with updates, latest map guarantee, the possibility to backup or install bought map and the management of the content that is available for the device. The mapshop platform doesn't only serve maps, but also data on speedcams, points of interests, voices and map subscriptions.

The mapshop service platform overlaps multiple product units that are depicted in figure 2-3; the development team is situated in the 'PND' product unit, but gets business case requests from multiple other departments. The actual map data is delivered by the 'Maps' product unit and the live production environment that is running the service platform is maintained by TechOps.

The mapshop is a significant revenue stream for TomTom and is an essential element in the value chain of delivering value to consumers, it is predicted that this is becoming even more so in the future. There are a number of technical trends in Internet Technology, for example the increased personalization possibilities of products and services; the mapshop will play a significant role in the future in fulfilling these other technical trends (Bouwman, Hooff et al. 2005). This mapshop can be seen as a service platform delivering value to an entire network of users. The origins and emergence of the mapshop service platform best describe the challenges TomTom is currently having with development efforts. TomTom's high growth rate in the beginning years led to many ad hoc building of new services, interfaces and systems, what currently leads to legacy issues while trying to maintain the service platform.

The Mapshop platform has a number of interfaces that allow applications or the TomTom website to interact with the system. TomTom makes use of two types of support applications (SA's), called myTomTom and TomTom Home. Both are applications that are installed on the customers' computer, to interface between the PND (connected with USB for example) and the mapshop service platform. The difference between Home 2 which uses the 'TomTom Home' support application and the newer Home 3 which uses the 'MyTomTom' support application is the usage of the internet browser. Both these applications are installed on the customers' pc, and interact with the Mapshop platform, but the MyTomTom application is innovative as it uses a website for presenting device data and possible offers.

The development teams that are working on the mapshop platform are using an agile project management approach, namely SCRUM. Agile project management is a reaction to traditional plan based software development methods, these traditional methods state that problems and requirements could be specified completely upfront (Dybå and Dingsøyr 2008). The SCRUM project method is specifically focused on situations where it is challenging to plan development upfront, feedback loops are the core element. The development is done by self-organizing teams in so called increments or sprints, starting with the sprint planning and ending with a review (Schwaber and Beedle 2001; Dybå and Dingsøyr 2008). New feature requests can be put forward by a number of stakeholders and are put on a product backlog. When the roadmap needs to be planned the product owner (called information analyst within TomTom) and software product manager use the product backlog to decide on which direction to take and what the priorities are

for each new feature. This prioritized list is put in the sprint backlog of the corresponding development team, which is then sized by the team for effort it takes to develop the feature. After two weeks of development a new incremental version of the software is delivered, a summary is given in figure 2-4.
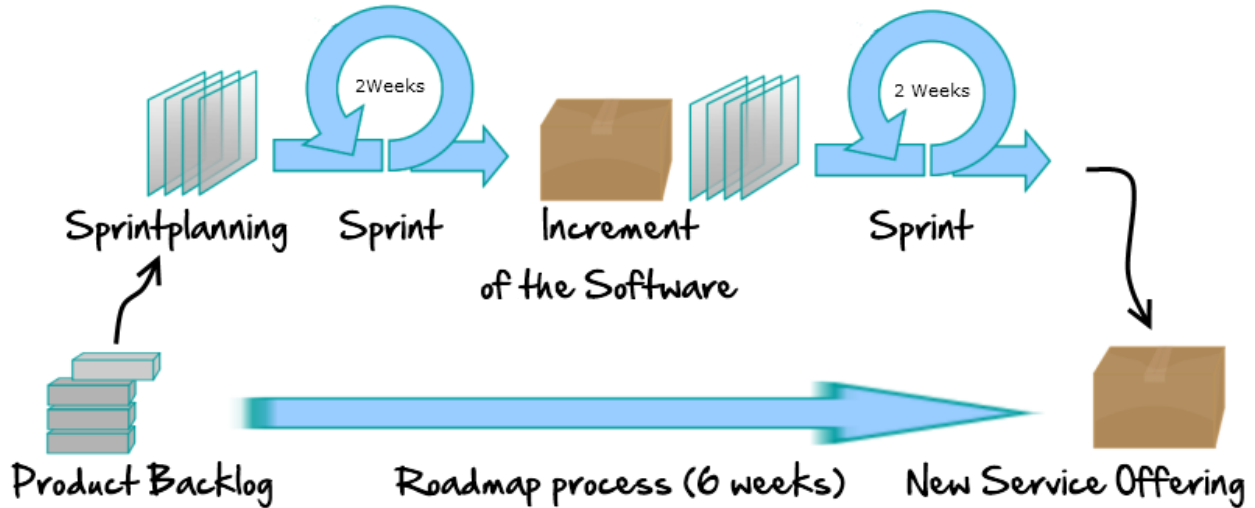
Figure 2-4 A generalized Agile project management approach.

To understand the implications that new business models have on the service platform and its users, a number of key aspects will be mentioned to better understand the scope and complexity of each new business model. Each new feature on the mapshop platform that is visible for the customer, which is mostly always the case, needs to be localized in 60 different languages. This localization means not only the translation of texts, but also images and the way the text is written for specific dialects. Also TomTom strives to keep prices in local currencies, thereby making it necessary to do currency calculations for at least 40 countries, thereby also keeping in mind certain discounts that apply for certain regions. Each region might have its own specific payment possibilities, offering the use of payment by a local bank, for example, a use of iDeal in the Netherlands.

The amount of consumers making use of the platform is significant; this leads to a high load of the servers. Although the servers can handle the number of requests at the moment, a wrongly implemented feature might slow down the system significantly, which logically leads to lost sales. Because of the large amount of users the platform is divided into multiple segments, for example a dedicated service exists for serving static content like images and text.

The size of one of the bigger maps offered is typically around 3 gigabyte, which is currently a significant download for many internet users. The data center doesn't offer the bandwidth capacity to allow multiple of these downloads to users. Furthermore the user experience will be low when downloading a 3 GB Map from a European server when the user is residing in the US, as the speed will be less than possible. Therefore all large downloads are geographically dispersed on secured download sites all over the world, offering fast download speeds everywhere. The downloading of maps therefore is not a major problem anymore but still is a

challenge when releasing new maps to make sure the new maps are distributed correctly across the network. In developing countries the internet speed is below average thereby still posing challenges to bring value to these upcoming markets.

The platform allows multiple connections from different kind of support applications, from the earlier launched software till the more recent MyTomTom application. The support of all these (legacy) support applications currently remains intact to serve consumers. Continuous changes in technological environment such as the introduction of internet explorer 9 or new operating systems require continuous improvements to cope with this changing technological environment.

A Map is sold and coupled to a specific user and device, a secure certificate makes sure of this coupling. Each sale will generate a specific certificate for that product. The final example is the amount of devices the mapshop service platform is currently supporting, this can lead to many side effects when innovation continues, leading to challenges. For example sometimes a map is too large to fit on a device so it is cut into pieces called map zones, which are made available for the device but originate from the Mapshop service platform.

Based on these statements it is logic to assume that a wrongly implemented business model will lead to lost revenue and a costly waste of time. Therefore it is key to mature the business model in an early stage as possible and to have a speedy process towards implementation.

2.6. Conclusion

The second research phase was to conduct a domain analysis to gain background information on the industry actors and power balances. This chapter has provided an overview on the market and key actors in the map segment. It identified a number of relevant trends for the industry that also will impact the mapshop platform in the future. Finally the case-study company TomTom is discussed in terms of organizational structure, technology, processes and technical intricacies of the mapshop platform. The background information for this case-study is not complete without a scientific literature overview which will be discussed in the next chapter.

3. LITERATURE STUDY

The third chapter is part of the second research phase and will answer the first research question regarding the literature study; initially an introduction will be given on the research question and the approach in answering. Secondly an overview will be given on scientific literature regarding decision support systems, business models, critical design issues and stakeholder analysis. The DSS consists of a number of components which will be elaborated upon using business model theory. The chapter will end with concluding remarks and lessons learned from the gathered scientific knowledge and a framework that can be used during information gathering. The business model focus of this literature study is on e-business literature and literature from the mobile services domain, as these are specifically applicable to the market environment of TomTom.

3.1. Introduction

From the problem statement it became clear that a decision support system would solve a number of important issues, and most importantly the increase of business model viability. To better understand the difficulties stated in the problem statement it is necessary to gather background knowledge on the introduced concepts. A scientific literature overview needs to be created and the following question is raised to address and clarify the state of the art knowledge.

> *RQ1. What is the current state of the art knowledge regarding critical design issues and decision support systems in the context of new service development?*

This question will be answered by first clarifying DSS by defining different components, secondly by addressing business model and critical design issue literature that will be fitted into the DSS components.

3.2. Decision Support Systems

Decision Support Systems are closely interlinked with business processes, as the goal of this research is to create an integrated business model decision support system it is necessary to get an overview of state of the art knowledge regarding the concept of decision support systems and business processes. Literature on decision support systems can be classified into different research areas; multiple articles regarding DSS give their own definition, classification, user roles, components and type of decision making towards decision support systems. Especially the definition of DSS is troublesome as Power (1997) noted, he implied that when a system is not an online transaction processing system someone will sooner or later call it a DSS. Furthermore DSS has a certain 'intuitive validity', as any system that supports a decision process is a DSS (Sprague 1980).

Definitions of DSS

The **definitions** of DSS are broad throughout literature and depend on the point of view of the author (Druzdzel and Flynn 2002). Definitions found in literature range from "*the use of computers to assist managers in their decision processes of semi structured tasks. Support rather*

than replace managerial judgment. Improve the effectiveness of decision making rather than its efficiency." (Eriksen 1984), to: "*An interactive, flexible, and adaptable computer-based information system especially developed for supporting the solution of a non-structured management problem for improved decision making. It utilizes data, provides an easy-to-use interface, and allows for the decision maker's own insights.*" (Turban 1995). There is also criticism on the precision of the definition on the DSS, as some authors claim it is impossible to give a precise definition of DSS including all its components (Schroff 1998). In this research the DSS definition of Finlay (1994) will be used: "*a computer-based system that aids the process of decision making*".

Sprague (1980) tried to define a DSS by its characteristics, which are: (1) the tendency to be aimed at the more unstructured and underspecified problems that higher managers face (2) attempt to combine analytical modeling techniques with data, (3) focus on average computer user and (4) emphasizing flexibility and adaptability to make adjustments possible when environment changes or the decision making style of the user. Alter (1980) identified three major characteristics:

1. DSS are needed to facilitate decision processes, and should specifically be designed for that purpose.
2. DSS should play a supporting role rather than automate the decision making process itself
3. DSS should be designed in such a way it is capable of responding quickly to the changing needs of decision makers.

Taxonomy of DSS

A DSS can be **classified** into a number of categories for example the amount of aid the DSS brings to the user of the system during the decision making process (Jelassi, Williams et al. 1987), or the source of the data (Power 2002) and the technical viewpoint (Power 1997). Jelassi, Williams et al. (1987) differentiate between active and passive decision support systems, where within a passive DSS managers have still have to search and find new opportunities, an active DSS has the capacity to look forward based on aggregated data. Power (1997); Power (2002) identified five different kinds of classifications possible for DSS systems. The Model-driven DSS which consists out of three components: data, a model to interpret the data, and the visualization of the advice based on the model. The knowledge-driven DSS, which supports in specialized decision making in situations where expert knowledge is required. A document-driven DSS, which enables the user to download documents or information an example, will be the use of Wikipedia. A data-driven DSS is one that gets its information from one or multiple sources or databases, mostly internal company data and sometimes also external company data. And finally the communication-driven DSS which supports multiple persons working on a shared task and are in the need of a coordinated approach of decision making. Power (1997) also differentiates in the technical viewpoint within a DSS, whether it is either an enterprise wide system or a smaller desktop DSS only used by one person at a given time.

Users of a DSS

Furthermore one can argue about the position of the DSS within the entire chain of decision making processes, and thus **the users** making use of the DSS. A number of authors automatically assume that higher management will make use of the DSS (Sprague 1980; Druzdzel and Flynn 2002; Power and Sharda 2007), however this doesn't need to be the case, for example these assumptions contradict the communication-driven DSS where each user might base decisions on the data presented by the DSS. Shim, Warkentin et al. (2002) use the term 'user' in their research on the past present and future of decision support technology, thereby acknowledging that not only management is or will make use of decision support systems, a DSS can also be used by a workgroup, team or virtual team, instead of an individual decision maker or individual manager. Furthermore Houdeshel and Watson (1987) state that staff specialists may use the DSS to supply information to management, thereby claiming that top and middle management seldom use DSS.

Components of DSS

Most authors agree that each DSS has three main components that are in place for any class of DSS (Sprague 1980; Druzdzel and Flynn 2002; Shim, Warkentin et al. 2002), these three components are (although named differently by each author) a user interface, a data component and a modeling component. Other authors see the user as a separate component (Matsatsinis and Siskos 1999; Druzdzel and Flynn 2002) and some described a separate knowledge component (Power and Sharda 2007), for this research the 'knowledge' component will be integrated in the data component. This leads to the following unified component framework of a DSS, as depicted in figure 3-1.
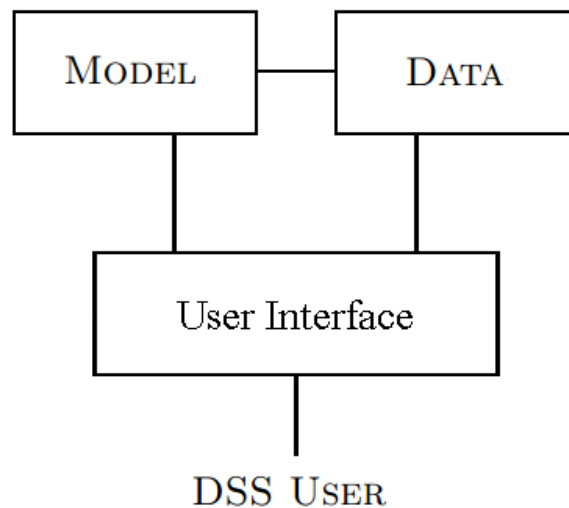

Figure 3-1 Unified framework of a DSS

The data part can be seen as raw collected data from for example databases, it is pure information in the sense that it is unprocessed. The data component can either be seen as a qualitative or quantitative component containing data. The Model-driven type of DSS is most

likely to use large amounts of aggregated data from a database, while the communication-driven DSS in which users collaborate might contain qualitative gathered data.

The knowledge component mentioned by Power and Sharda (2007) can be defined as codified information and can be used for the acquiring of background information relevant to pure data. Knowledge can't be processed by the model itself, but it can be presented to the user to guide it to make better decisions. Within this research it is chosen to incorporate the knowledge aspect into the 'data' component, this will become clear when trying to extend the model further, and will be elaborated upon in the chapter 'stakeholder framework'.

The model part consists out of three components, the decision options, the preferences a user has and an uncertainty factor (Druzdzel and Flynn 2002). The preference is the most important concept as these are used to tradeoff between different data elements, for example more of X is preferred to less of X. The second part within the model component is the available decision options, these options sometimes can be enumerated, like a list. Listing these variable decision options can be important to structure the model. The third part is the uncertainty factor, data or information can be wrong, biased or incomplete. The model must try to cope with the uncertainty factor, or at least make the user aware of uncertainties.

The user interface or also called 'dialog generation and management system' (DGMS) is the main interface between the system and interaction with the users. The user interface needs an intuitive easy-to-use interface, and should support the user in gaining insight in the underlying model and why the system presents certain data. The goal of the user interface is to maximize the ability of the user to benefit from the DSS (Druzdzel and Flynn 2002).

The DSS user is an important aspect of the total DSS, as this is the actual person making use of the DSS and being responsible for the correct interpretation of the presented information. As stated earlier most literature focuses on the user being part of management, Sprague (1980) argues that it can be used by any layer of management, but it also identified other user roles within the DSS. One might also argue that with the change of organizations today with the introduction of information analysts, project leaders, marketing analysts, and the communication-driven DSS that it is logic to assume it will be used by many other users other than management alone.

Type of Decision making within the DSS

The decision support system is only effective for certain types of decision making (Sprague 1980). An overview on proper decision making areas suited for a DSS can be found in figure 3-2 where the decision making is split into two dimensions, structure and frequency (Power and Sharda 2007). Shim, Warkentin et al. (2002) coupled the decision type with the user roles, thereby creating a link between management/user activities and the decision problems itself. By combining the decision problems and the management/user activities the terms 'structured' and 'unstructured' decision making got their meaning. Another aspect is the human judgment within decision making, human judgment is based on intuitive strategies instead of theoretically correct rules; this phenomenon is called *judgmental heuristics* (Druzdzel and Flynn 2002). This judgmental heuristics reduces the cognitive load on people, but thereby also impacting decision making; sometimes leading to non-optimal decisions.
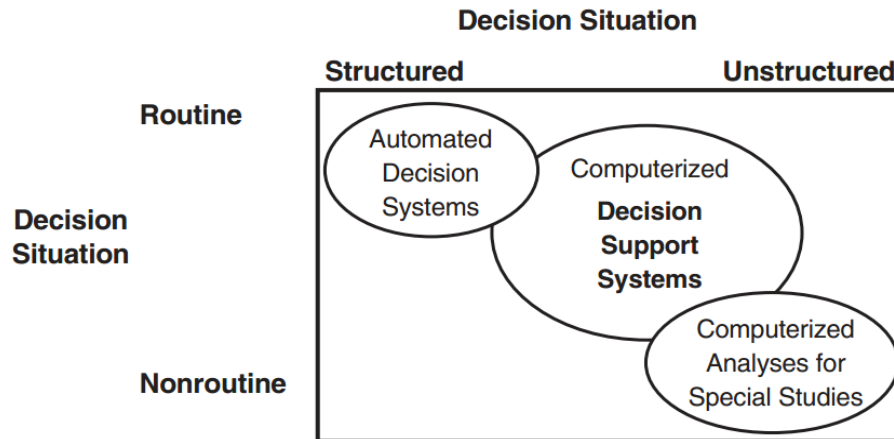
Figure 3-2 DSS fit for certain decision situations (Power and Sharda 2007)

Motivating users to use the DSS

As the goal of a DSS is to have an increase in company performance and productivity gains of the users, it must be accepted and used by the users involved (Venkatesh 1999). Ease of use and proper training will significantly contribute to the user experience.

Concluding remarks

The decision support system consists out of four components, model, data, the user interface and the user; furthermore the 'model' component has three subparts namely decision options, user preferences and the uncertainty factor. These components together form the DSS canvas which is the main part of the design space. All gathered data, whether from literature or interviews will be fitted into the DSS components.

3.3. The DSS 'Model' Component
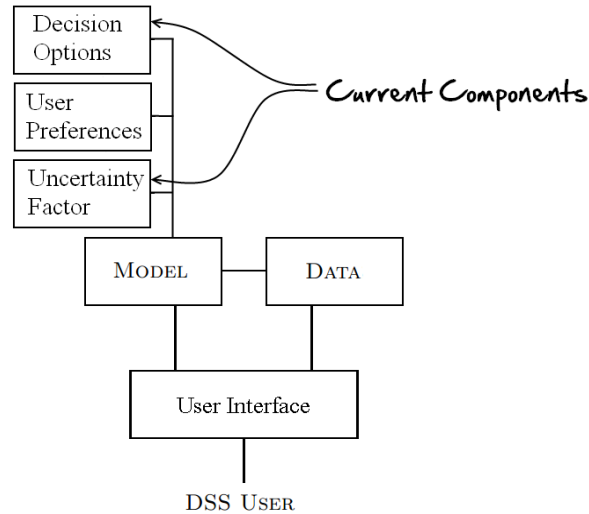
Figure 3-3 Decision Options and Uncertainty Factor expanded using literature

The model component consists out of three subcomponents, and two of which will be specified using scientific business model literature, thereby specifying it a level deeper. The two components that will be specified using literature are decision options and the uncertainty factor, as seen in figure 3-3. The goal is to have a finalized model from a literature perspective, in which remaining 'open' subcomponents can be addressed using interviews. The 'Decision Options' will be specified using business model literature as these clearly delineate the decision options available in business cases as based on previously published research. Before discussing business models for the DSS model component the nature of business models need to be understood. The origins of business models lie in innovation in which literature has a number of perspectives to describe this innovation process, (1) high level view on innovation, (2) innovation management in the light of business strategies, (3) new service development which pays attention to stages and prototyping and (4) a design science perspective which pays specific attention to stakeholders, but currently lacks into the depth regarding to commercialization. (Bouwman, Reuver et al. 2011). Narrowing it down even more is possible when (5) looking at the business model life cycle (Kijl, Bouwman et al. 2006; Reuver, Bouwman et al. 2006).

One pre-condition for innovation is the successful identification and implementation of ideas at the front end component of the innovation funnel. (He, Probert et al. 2008). Looking from a bird-eye view onto Innovation management, literature defines exploration towards exploitation as a process of 'chaos' to standardization and reutilization, which is based on a macro-economic and an industry viewpoint (Gilsing 2003; Bouwman, Reuver et al. 2011). It is dependent on the industry where the company is operating in if there is a larger focus on research and development or on the commercial exploitation of products, services or product/service combinations. (Bouwman, Reuver et al. 2011). A way to structure this is the 'cycle of knowledge' concept by Nooteboom (2000), presented in figure 3-4, which is based on the notion that evolutionary survival of companies is dependent on the tradeoff between exploration and exploitation; in this regard exploitation is seen as short term survival and exploration as long term survival (March 1991; Nooteboom 2000; Gilsing 2003).
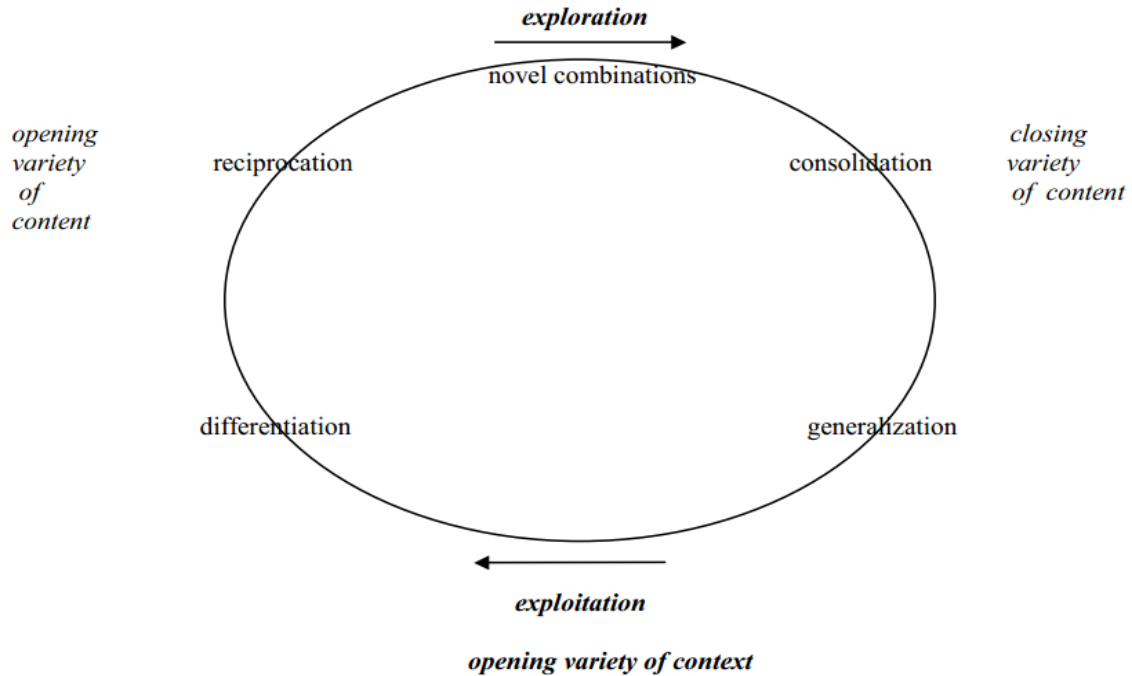
Figure 3-4 Nooteboom 2000, knowledge cycle of exploration and exploitation.

Kijl, Bouwman et al. (2006) made an overview on phases in innovation based on scientific literature in different research domains, they combined this overview in a timeline seen in figure 3-5. They identified that when comparing literature about innovation in the light of business models, three main phases can be identified: (1) technology/R&D, (2) implementation/roll-out, and (3) market. (Reuver, Bouwman et al. 2006). The scope of this thesis is on these phases, thereby focusing explicitly on the exploration till exploitation phases of the Nooteboom (2000) model. The first phase of the Kijl, Bouwman et al. (2006) timeline is the part where the concept is developed, also a lot of focus is placed on the technology aspect. The implementation and roll out phase is focused on fine tuning the intended service offering, more focus is given towards regulations and the service offering is beta tested. The final marketing phase is concerned with grabbing the attention of potential buyers. The phase's model has implications on the business model, as more information becomes available during the process, the business model can be adjusted to better serve the needs of consumer or the value network. A business model therefore can't be seen as a static given 'object', it is dynamic by nature and evolves during the maturation of the initial idea (Kijl, Bouwman et al. 2006).
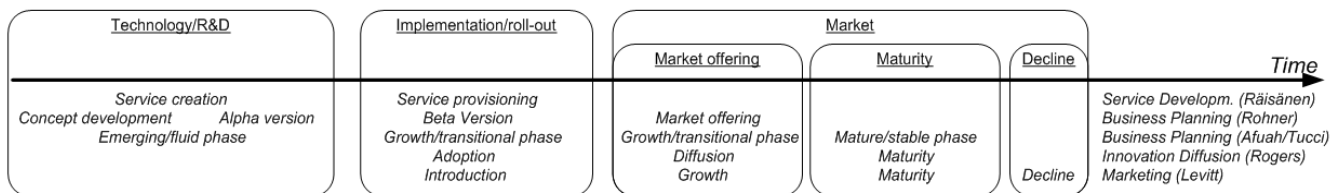
Figure 3-5 Phases from exploitation to exploration (Kijl, Bouwman et al. 2006)

Overview of business model literature

In order to categorize and make an overview from literature, a categorization framework will be used to classify different literature studies about business models. Pateli and Giaglis (2003) created an overview and classification schema on business model research which will be used to distinguish between the different research sub domains. The following six research sub domains were identified mentioned in figure 3-6. The classification of research domains becomes important when viewing them on two dimensions, namely integration and timeliness. Integration in the sense that some research domains are built on top of previous research and whether it is dependent on prior understanding of knowledge gained in other domains. Timeliness indicates the maturity of the research domain, the higher on this scale the newer the research domain is and further pursuit of research in this domain is necessary.
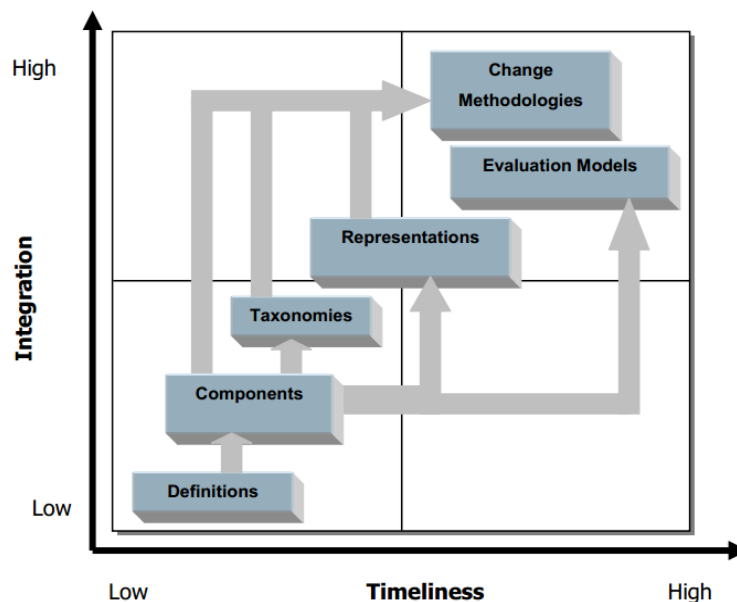
Figure 3-6 Different concepts discussed in BM Literature (Pateli and Giaglis 2003)

Although Pateli and Giaglis (2003) identified the definition of business models a much discussed topic, the definition of a 'business model' still differs throughout literature. Osterwalder, Pigneur et al. (2005) did research on clarifying the business model concept, in their paper the business model is defined as a blueprint of how a company does business. This definition is also used by Faber, Haaker et al. (2004) and Reuver, Bouwman et al. (2006) that a business model blueprint tries to capture value from service innovation or product innovation. Kijl, Bouwman et al. (2006) agree with Magretta (2002) on the viewpoint that in the core each business model design is a variation on of the generic value creation system that is applicable to any organization.

The e-business model ontology described by Osterwalder and Pigneur (2002) is composed out of four components; product innovation, infrastructure management, customer relationship and financial aspects. Their business model approach can be seen as a link between strategy and business processes. The model of Osterwalder and Pigneur (2002) is similar to the STOF model by Haaker, Faber et al. (2004) with regard to the components, as can be seen in figure 3-7.

3.3.1. The STOF Model

The focus on service innovation for the mapshop service platform is apparent, and therefore the focus will be put on a business model framework that is suited both for the domain and services aspect. The STOF model by Kijl, Bouwman et al. (2006) is promising in this regard as it is tested within the 'mobile service' domain thereby very applicable to the industrial environment TomTom is operating in. The STOF model distinguishes four components: (1) Service domain, (2) Technology domain, (3) Organization domain and (4) Finance domain (Reuver, Bouwman et al. 2006). The service domain is the added value the company will bring to its service offering, thus the value proposition within a certain market segment. The technology domain contains the required technical functionalities to enable the service offering; technological innovation is of major influence in this domain. The organization domain provides the stakeholder network both internally and externally and the position of the company within this value network. The finance domain is concerned with how the entire value network will generate revenue from the service offering.
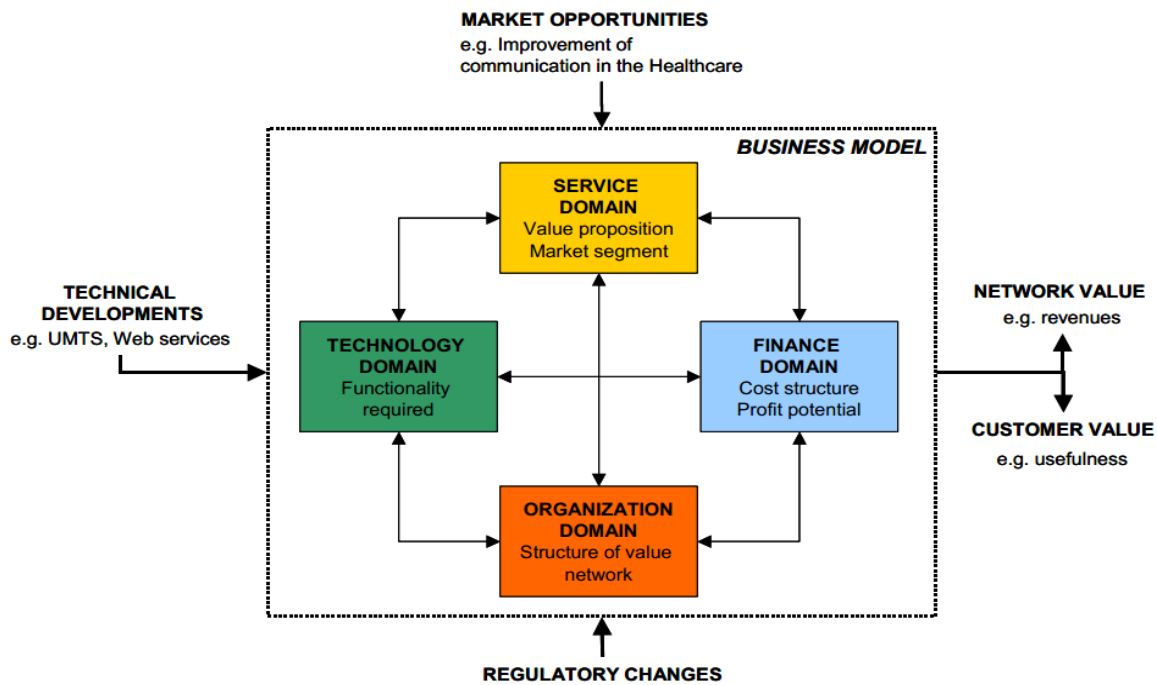
Figure 3-7 The STOF model as proposed in (Haaker, Faber et al. 2004).

The mapshop service platform is depending on the TomTom navigation devices, as customers without a TomTom navigation device can't make full use of the platform; only buying maps is possible but specialized offers or map installation isn't. The STOF model allows for the incorporation of the devices aspect, thereby allowing for a combined business model design with both intangible services and tangible devices.

A major difference between the STOF business model and the business model from Osterwalder and Pigneur (2002) is the aspect of network value; to make a business model more viable the value for other stakeholders involved should be incorporated in the business model design. However the four components are similar to the ones used by Osterwalder and Pigneur (2002b).

The order of components used by the E-business ontology and the STOF model is different, as the model by Osterwalder and Pigneur (2002) has as an end goal the 'Customer relationship' which is the starting point in the 'Service domain' of the STOF model.
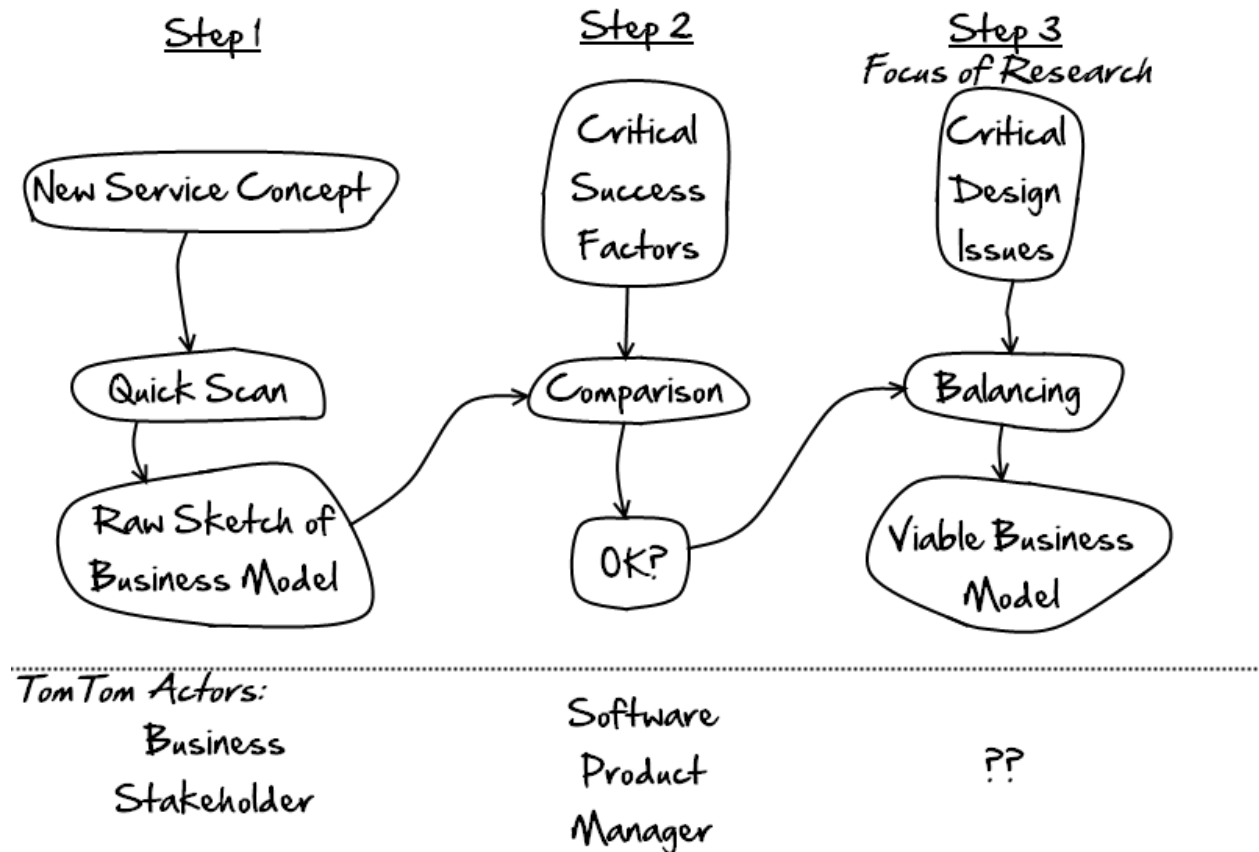
Figure 3-8 Business Model design steps and TomTom actors

Not only does the STOF model give an extensive overview on all the components within business model design. Continued research with this model has created guidelines on how to design a business model following certain design steps (Bouwman, Vos et al. 2008). These design steps specifically address critical design issues and critical success factors. The focus of this research is on critical design issues and needs further elaboration, the technology component and the critical design issues will be part of the 'decision options' component of the DSS. Haaker, Oerlemans et al. (2004) and Bouwman, Vos et al. (2008) created a combined manual for STOF model usage within organizations, thereby focusing on the process a business model has to go through by means of these design steps. When the TomTom processes and the proposed STOF process are compared an integrated solution becomes instantly visible, as depicted in figure 3-8. The level of fit is significant as adoption and implementation of the DSS will become less risky as existing processes need to be extended.

Within step one the new service concept is introduced and the *business stakeholder* will take care of the initial quick scan for viability and prioritization. The second step is the comparison with

critical success factors which stem from literature (Reuver, Bouwman et al. 2006), within TomTom the *Software Product Manager* manages the roadmap, and thus has to prioritize the incoming business models. The critical success factors within TomTom are decided upon by the software product manager himself by a decision making process involving the business stakeholders. The third step which requires the balancing of critical design issues is not implemented at the moment and is seen as a key improvement for the TomTom development processes.
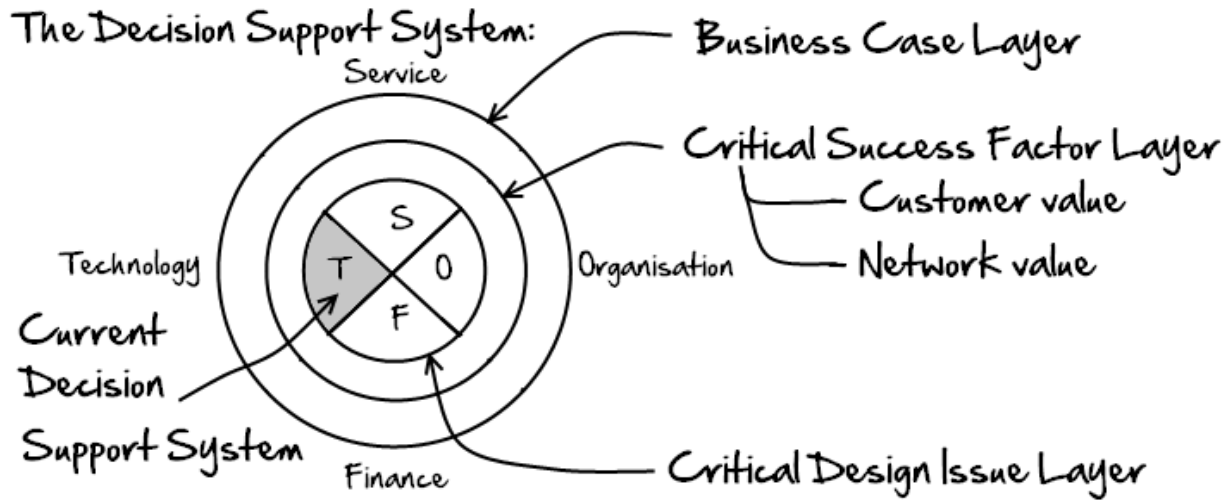
Figure 3-9 Positioning the Current Decision Support System

The scope of this research is on the critical design issues from the technology domain only, which is concerned with the technical aspects of the business model, thereby limiting this research for usage outside this domain. The focus on the technology domain however does give an in-depth analysis and pilot of how to incorporate a DSS without much risk. The decision to only focus on the design issues from the technology domain is due to time constraints. In figure 3-9 an overview is given of the DSS within this thesis and the end goal DSS covering all business model aspects.

The focus is on technology only as to give focus on the research and as the technology domain is deemed the most complex to balance the critical design issues in, in the case of TomTom. The technical domain architecture as given in figure 3-10 defines guidelines on how the system should be used and implemented, characteristics are for example: centralized vs. distributed. The backbone infrastructure and access network refers to the bandwidth needs and geographical location of servers. For example TomTom needs a high bandwidth capacity all over the world due to the service offering and this has implications on costs. Important characteristics of the service platform are for example security, legacy vs. new or open vs. closed. The term 'devices' in this framework refers to the end-user devices which provide access to the mapshop service platform, for TomTom this can be seen as the previously mentioned support application, TomTom Home or myTomTom which is installed on the computer of the consumer and acts as an intermediate between the device and the service platform. Another sub component is the data aspect which results from the use of the service, this data can be data-bursts vs. real-time or for example of a large size in terms of bandwidth. It is logical to assume this imposes requirements

on the service platform, backbone infrastructure and service platform. The total composition will lead to a technical functionality which will deliver the value to the consumer.
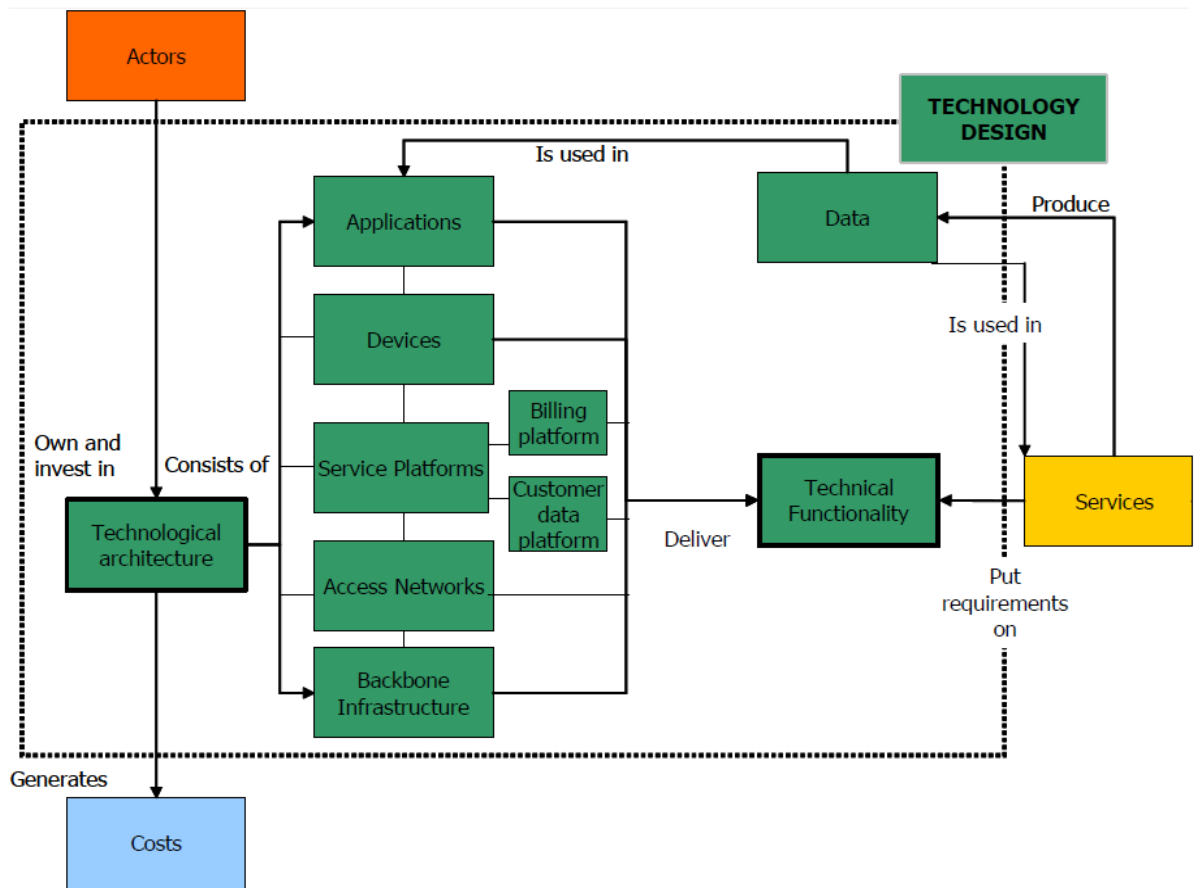
Figure 3-10 Subcomponents of the Technology domain (Faber, Ballon et al. 2003)

A number of critical design issues are derived from the technology domain; critical design issue literature which is used throughout this thesis is built on top of the STOF model.

3.3.2. Critical Design Issues

The balancing of customer and organizational requirements on business models describing innovative services is a delicate task (Reuver, Bouwman et al. 2006). Research by Reuver, Bouwman et al. (2006) identified critical design issues that correspond with the four domains (service, technology, organization and finance) from the STOF-model. Critical design issues can be defined as a *design variable of the business model*. Critical design issues that originate from the technology domain are enablers for the service domain as for example; the perceived service quality is dependent on the quality offered and the ease of access. The DSS 'decision options' component is specified using these critical design issues that were derived from scientific literature

The following critical design issues originating from the technology domain have been identified: security, quality of service, system integration, accessibility for customers and management of user profiles.

The critical design issue **Security** originates from the trade-offs between ease of use, privacy considerations and preventing abuse. For example when consumers are using the mapshop platform it is theoretically possible to automatically load the user account, based on the connected device, without the user having to log in. This could however lead to privacy considerations, so a user login is always required before being able to manage the device and its account.

The **Quality of Service** is a tradeoff between quality and cost, when the technical functionalities can't be delivered in a timely fashion to the customer, the perceived value is very low. For example when a consumer buys a new TomTom PND and is eligible for the latest map guarantee, it expects this feature to work and get the latest map in a timely fashion. The quality of service is a broad term that incorporates timeless and has implications on the expected system load, system throughput, response time, bandwidth capacity, scalability, error rate under load and degradation under load.

The level of **System Integration** for new services is important as it is a tradeoff decision between flexibility and costs. When building on legacy systems the development costs are likely lower as existing functionality is reused but also provide less flexibility on the long term. For each new feature a decision needs to be made on the level of integration with existing services already in place. For example when launching a new service, large parts of existing infrastructure might be reused but leading to lower flexibility later as the new service is made dependent on other services.

The choice whether the architecture of the service platform should be open or closed for customers is an important trade-off and impacts the viability of the new business model. The term **Accessibility** is in terms of the allowance of third parties to make use of the service platform; if it is a closed platform only the direct customers can make use of the service platform. In an open platform architecture other parties can also benefit from the capabilities of the service platform, for example the TomTom HD Traffic service is unique and unrivalled in the world, opening this service to other parties might pose as an potential revenue stream.

The **Management of User Profiles** is a critical design issue as it requires technical functionality and can be implemented in different ways. For example TomTom is theoretically able to add historical route data to its user accounts, making it visible for users after logging in, however it will not do this as it will lead to privacy concerns of their customers.

3.4. The DSS 'DATA' Component a Stakeholder Framework

The balancing of the different decision options is a tedious process and can't be automated due to its complexity; hence a decision support system is required. The decision support system can guide the balancing actions helping teams or individuals to improve the business model as a whole, as there is no 'system' within TomTom that knows the mapshop service platform better than the entire team behind it, it makes sense to incorporate their input into the balancing data.

For the acquirement of data a stakeholder framework is sought that will fit into the 'data' component of the decision support system. With the data gathering from different stakeholders the balancing of the available decision options should be more straightforward. The data that is required to make the balancing decision is the input from different stakeholders. Involving key stakeholders at the right moment in time during the innovation cycle will increase the potential for market commercialization (Reuver, Stein et al. 2010). The identification, management and mapping of stakeholders in innovation projects is becoming more complex due to the permanently changing environment of innovation and development in businesses (Bunn, Savage et al. 2002; Solaimani and Bouwman 2011). The changing environment poses a requirement on the DSS design as it needs to be adjusted occasionally as the environment changes. For this research the term stakeholder is defined as: "*any group or individual working within TomTom who is affected by new feature development in the Map Shop service platform*".

A fitting stakeholder framework needs to be found that is appropriate to fit into the 'data' component and make the balancing of critical design issues straightforward. Solaimani and Bouwman (2011) created a rich overview on stakeholder analysis done in the past, and extend the conceptual VIP framework to include operational interactions (Solaimani and Bouwman 2011). This extension on the VIP framework is important for this research as the extension is based on the service innovation domain and is therefore suited for use in the DSS at TomTom. The VIP framework breaks the stakeholder analysis down into three horizontal components (1) value exchange, (2) Information exchange and (3) business processes, as can be seen in figure 3-11. The VIP framework also provides methods of operationalization which will be used in the gathering of requirements and the mapping of stakeholders. However one can also state that it are actually four vertical components (1) Actors, (2) Objects (3) Interactions and (4) Dependencies, as there are different methods needed to visualize each of these pillars. From the viewpoint that the VIP Framework consists out of four pillars (actors, objects, interactions and dependencies) and three layers (value exchange, information exchange, business processes) table 3-1 can be derived which originate from the original model in figure 3-11.

Table 3-1 The four pillars of the VIP Framework

#	Pillar	Components
1	Actors	Actors, Information authorization and process unit boundaries
2	Objects	Value objects, data objects, information objects, knowledge objects, business process behaviors
3	Interactions	Value activities, value goals, information flow and business processes
4	Dependencies	Value dependencies and business process dependencies

Bunn, Savage et al. (2002) also created an extensive stakeholder analysis framework in which they identified five steps on how to map stakeholders; identification of the stakeholders, describe characteristics, classification according to attributes, investigate relationships and evaluate strategies. However this five step model is inadequate as its goal is to map external stakeholders that operate outside the company. The VIP framework with the four pillars however is able to map internal stakeholders using a four step method; identification of actors, describe objects, describe the interactions and investigate dependencies. The trust dependencies are out of scope

for the DSS design as it are currently only internal stakeholder which logically leads to the assumption that within a company the trust dependencies shouldn't be an issue, when extending the DSS design to incorporate external stakeholders the trust dependency item should be added. The process of mapping the stakeholders becomes more straightforward when making use of the VIP model, once the four steps are complete a switch can be made to the horizontal level of value exchange, information exchange and business processes.
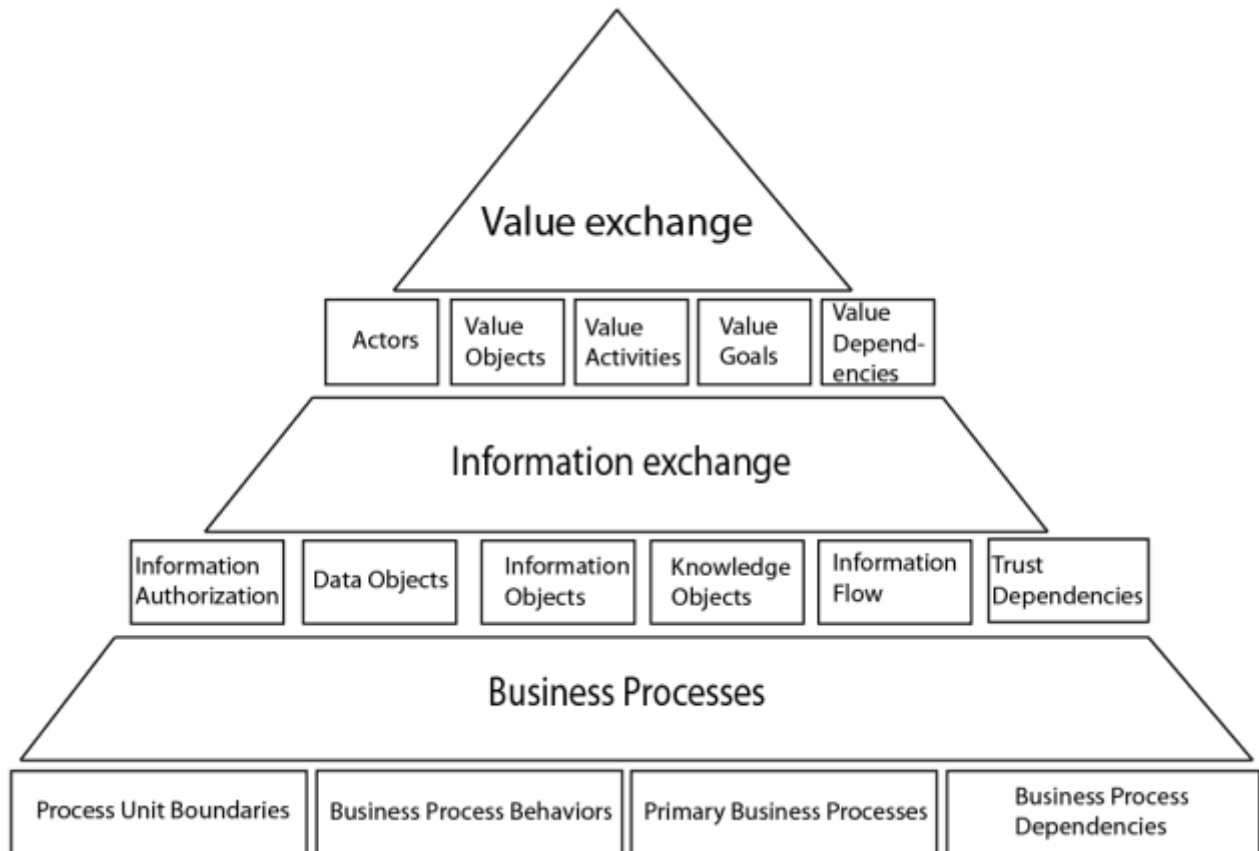
Figure 3-11 VIP Framework (Value exchange, Information exchange, business Processes)

The VIP stakeholder framework is designed to be used in an inter organizational context, it is arguable that it can also be applied intra organizational, thus within TomTom. By applying it within an organization the model will be used in such a way it potentially benefits future researchers as it gives a start to a validated stakeholder framework for intra organizational use too. The second benefit of making use of the VIP model is that the DSS will seamlessly support the incorporation of external stakeholders in later phases of DSS development. The current DSS will consist only of intra organizational stakeholders, however by using the VIP framework it is extendable to incorporate external stakeholders too to capture network value.

3.5. Conclusions

The second research phase was to conduct a literature study and to gain background information on the important concepts presented in the problem statement. The research question for this phase and chapter was as follows:

RQ1. What is the current state of the art knowledge regarding critical design issues and decision support systems in the context of new service development?

The chapter has defined the components of the decision support system, providing a canvas for fitting in the critical design issues that make a business model viable, thereby answering the first research question.

First literature on decision support systems was discussed; a classification scheme was created in which to categorize different scientific literature. Secondly a list of definitions was presented based on literature, and a scope for this research was chosen. Thirdly different classes of DSS were discussed; as DSS is a broad topic therefore it is important to have an overview of different DSS types. The different components were identified, creating a unified component framework which represents the important aspects of a DSS. This unified component framework can later be used in the design phase of this research. The effectiveness of DSS is discussed with regard to the types of decisions made in organizations. The theory on how to motivate DSS users is important as the DSS is an aid in decision making, and therefore should support the user with the goal to increase user acceptance when the DSS is finished.

The second part continued to fill in the 'model' component of the DSS, with the critical design issues that make business models viable. But initially an introduction was given of business models from a high level viewpoint from exploration towards exploitation, to clarify the origins of business model research. Secondly an introduction is given on how business models can be classified and what the important aspects are within business model research. The different phases of business model design and service innovation were identified leading to an overview of steps that an innovation has to go through. An overview on e-business models is given and on a promising business model in the mobile services domain, thereby paying attention to the two significant aspects of business models from the viewpoint of TomTom. Eventually from each business model type the components are identified which can later be used in the design space.

The third part was about the critical design issues and the relevance of these issues to the viability of business models. The mapping of critical design issues to according stakeholders is an important aspect in this research and a corresponding stakeholder framework was chosen that meets the research goals. The VIP framework will be extended to include internal stakeholders in the identification of stakeholders.

The DSS canvas to be used in the design space is given in table 3-2 and figure 3-12 both will be elaborated upon in chapter five and six, in gathering the necessary data for the components and the design itself. These frameworks will be used throughout the upcoming chapters as guidance through the empirical findings in chapter 5; it will be the backbone of the design in chapter 6.
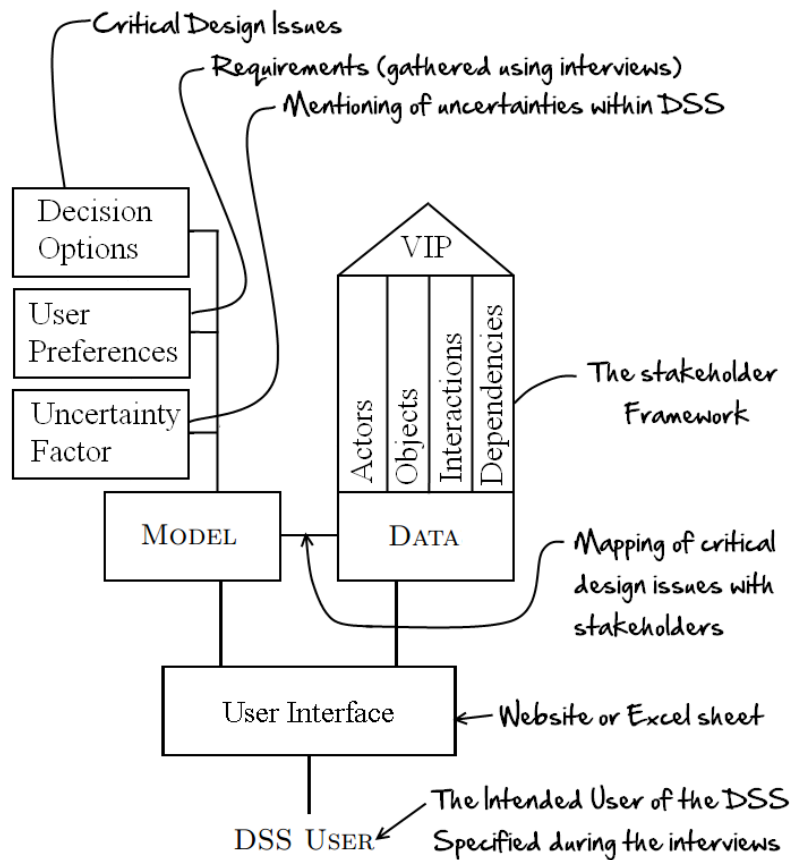
Figure 3-12 Combined DSS Framework, will be used as the basis for this research.

Table 3-2 DSS components overview

#	Component	Design Space
1	Model	The 'model' component was specified using literature of critical design issues within business models, and the stakeholder framework components.
1a	Decision Options	The balancing of critical design issues.
1b	User Preferences	This subcomponent is dependent on user role, and specific user needs.
1c	Uncertainty factor	Mentioning of uncertainties in the user interface.
2	Data	Gather data using interviews, so the model is fitted with the gathered data. The data consists out of the filled in stakeholder framework.
2a	Actors	Actors, Information authorization and process unit boundaries
2b	Objects	Value objects, data objects, information objects, knowledge objects, business process behaviors
2c	Interactions	Value activities, value goals, information flow and business processes
2d	Dependencies	Value dependencies and business process dependencies
3	GUI	An initial management requirement is to create a DSS that uses a website or excel sheets.
4	User	The intended user(s) is/are unknown and will be addressed during interviews.

4. METHODOLOGY

This chapter describes the research methodology of the remaining research questions two till five. First an overview will be given on the generic aspects of case study research. Secondly the methodology used to conduct the field research, design research and validation. This chapter extends the methodology chapter given in chapter one.

4.1. Introduction

This research project is in the category of applied and prescriptive research, with the goal to develop an intervention or application for an actual real world problem (Velde, Jansen et al. 2004), the development of a DSS within existing processes is an intervention. The units of analysis are the development teams of the mapshop service platform.

Research can be categorized in two dimensions (1) the degree to which the researcher intervenes and (2) the degree to which the researcher wants to make generally valid conclusions (Verschuren and Doorewaard 2007). A case study will describe a single case, so there is only one research unit, in this case that it's the mapshop development team of TomTom; therefore this research will fit in the former category of intervention. The general nature of a case study is that there are more variables than research units. One of the advantages of a case study is that it provides deeper insights into the way people or departments interact with each other. A disadvantage of a case study is that it is not statistically generalizable, due to a population of one, therefore the case study is only generalizable to a theoretical domain (Verschuren and Doorewaard 2007).

In case studies it is important to have a complete description of the case, which includes a description of the company and the relevant aspects of the case (Verschuren and Doorewaard 2007). Chapters one and two were specifically aimed on clarifying the case as they provide the necessary background information.

In order to structure the results of the case study and research questions to create a workable overview of the findings the 'linear-analytical' approach will be used. The linear-analytical approach is intended to make a comparison between theory and practice; first scientific literature will be gathered on the concepts, which is already done in the scientific background chapter, secondly information is gathered using interviews and resulting data is analyzed using the theoretical framework (Verschuren and Doorewaard 2007).

After the interviews the design approach by Verschuren and Hartog (2005) which describes the concept of a design cycle for design oriented research will be used. Starting with a first hunch, to initial requirements and assumptions, to a structural specification and prototype which needs to be implemented and evaluated.

The final phase of the research will use the 'evaluation research' approach as defined by Verschuren and Doorewaard (2007) which is to make sure an intervention has been successfully implemented for a specific case. Two distinctions can be made in this type of evaluation research, which is 'ex-ante' or 'ex-post' which respectively means before or after the intervention has taken place. In this case the evaluation research will be done before the DSS has been implemented. The validation will take place by verifying on internal and external validity of the DSS. The internal validity is concerned with whether the DSS is correct itself, and the

external validity is to check whether the right model has been built with regard to the stated problems.

4.2. Field Research Approach

The field research will define the design space which consists out of significant design variables and design options (Bouwman and Daas 2012), the design space will be defined using two research questions:

RQ2. What are the requirements that the intended users within TomTom impose on the DSS?

RQ3. Which stakeholders are currently involved or should be involved when balancing critical design issues from the technology domain?

The DSS framework as depicted in table 4-1 states all the components and the method of data gathering, for some components only scientific literature data was needed which is already gathered in the previous chapter.

Table 4-1 DSS components overview

#	Component	Data gathering	Done?
1	Model	Scientific literature	Yes
1a	Decision Options	Scientific literature	Yes
1b	User Preferences	Interviews	
1c	Uncertainty factor	Scientific literature	Yes
2	Data	Interviews,	
3	GUI	Interviewing of management and intended users.	
4	User	Interviewing of management.	

In order to answer research question 2 and 3 all key stakeholders should be known, the gathering of these stakeholders will be done using semi structured interviews and by applying the VIP framework in two ways (1) To map stakeholders and their business processes, information exchange and value, (2) To gather requirements from the stakeholders in a structured way. The insights gained in the literature and domain analysis will be addressed during the interview to sharpen the interview process and gathering usable and rich results. The field research will be performed in a sequential fashion starting with interviewing management on who the intended users will be, continuing with conducting interviews with the intended users of the DSS, ending with interviewing a selection of key stakeholders.

TomTom consists out of many actors, it is estimated that the mapshop platform alone has over 200 employees dedicated to development, daily maintenance, security, network operations etc. It is impossible to interview all the stakeholders within the time available for this thesis, therefore a *stakeholder selection* needs to be made that identifies the key stakeholders which give the richest information and are the closest to the scope of this thesis. The selection of stakeholders to be interviewed in question 2 and 3 are based on the management interview results and the results of the interviews held with the intended users.

To answer research question two and three the VIP framework needs to be operationalized, which is making each VIP component measurable. In this case a questioning framework needs to

be defined to address all VIP components. The VIP framework consists out of four pillars as seen in table 4-2, each of these pillars can be visualized in a specific manner which is related to the components.

Table 4-2 The four VIP framework pillars

Pillar	Components	Visualization
Actors	Actors, Information authorization and process unit boundaries.	Hierarchical organizational structure
Objects	Value objects, data objects, information objects, knowledge objects, business process behaviors.	Table overview
Interactions	Value activities, value goals, information flow and business processes.	Process flow, using blocks, arrows and user roles.
Dependencies	Value dependencies and business process dependencies.	Case by case basis

Once the intended users are known by questioning the management; the VIP components can be filled in. The second part of the VIP usage is the gathering of requirements; once the intended users and key stakeholders are identified the requirements can be specified. Please note that the given interview questions are guiding, most of the time the questions will be directly put forward to the interviewee, but as the unstructured nature of the interviews it is possible that the order and way it is questioned differ on a case by case basis. The semi structured nature of interviews might lead to inconsistencies, so an overview will be given on mapping the components to anonymous respondents which together form the qualitative support of the design space.

Generic Aspects of Interviews

The interviews need to be valid and reliable as this is one of the corner stones of research in general. The reliability of measurement instruments, which in this case are interviews, is most of the times measured in terms of repeatability. The interviews will be semi structured, thereby having guidelines on the concepts and questions to discuss, but still the interview can drift away from the topic. However with the questions as a guide the semi structured interviews can be conducted again, which will then lead to similar results. Reliability is a pre-condition of validity; validity means that the acquired results from the interview are actually the results that are wanted. It is the task of the interviewee to guide the interview in such a way the results are valid. There is a small risk of strategic answering since there might be fear of publication of the interviews in a report, when addressing these concerns in the beginning of the interview the strategic answering is kept to a minimum. All interviews will be recorded making the analysis easier and more thorough as it is lowers the chance of missing important aspects.

4.3. Design Research Approach

Within the design phase research phase a DSS will be designed and a way of visualizing the DSS will be developed, resulting in a conceptual DSS that needs validation. The DSS will be designed using the acquired results that are integrated in the design space.

RQ4. What is the business model DSS specification for use within the mapshop service platform roadmap process?

The first step is the design and development of the DSS, based on the design space, which includes the boundaries and requirements. A prototype will be created which contains a **simplified** version of the model for initial verification and validation. This prototype is a way of visualizing the DSS framework and field research results. After the theoretical design and practical prototype development an implementation manual needs to be written on the use of the DSS for the intended users, and a recommendation needs to be made to management on how to integrate the DSS within the existing processes. A proven design method by Verschuren and Hartog (2005) will be used.

4.4. DSS Evaluation Approach

In this phase the conceptual DSS will be evaluated on the given goals and by validating the DSS credibility will be increased. The associated research is as follows:

RQ5. What is the validity of the designed DSS for use within TomTom?

The fifth research question will be answered by a group interview session to identify potential shortcomings or missed actors. After this phase the end result will be an evaluated DSS which can be used within TomTom, the result thus answers the main research question. The validation phase alone is not enough to fully verify the DSS, but due to time constraints put out for a master thesis project it is decided that a group interview session will be sufficient for initial validation. The logical step that would follow the initial validation is a single test case in which the actors handle a single business case. The validation phase also explicitly mentions potential gaps or possible shortcomings of the system, so the DSS designer will have a clear overview of what to, and even more important, what not to expect.

5. FIELD RESEARCH RESULTS

Chapter five gives the field research results of the research questions two and three. First an introduction will be given on the research question and how the results fit into the design space. Secondly the results for each selected DSS component will be given and filled according to interview results, concluding with a set of requirements that can be used for validation in later phases.

5.1. Introduction of the design space

The design space is a superset of requirements, variables and components; in previous chapters literature has been selected and operationalized and now the design space will be filled even further. The field research contains the information of each component and will later serve in the design of the decision support system. The following research questions will be answered and the answers will form the design space.

RQ2. What are the requirements that the intended DSS users within TomTom impose on the DSS?

RQ3. Which stakeholders are currently involved or should be involved when balancing critical design issues from the technology domain?

The information was gathered using semi structured interviews; initially management was interviewed to determine the intended users, continuing with the interviews of the intended users and finally key actors in the mapshop platform landscape. In total 8 people were interviewed to derive the results; among which managers, information analysts, a developer, a security expert, and project managers. The interview results are ordered by DSS component thereby making a structured overview of the results. By structuring the interview results by component the DSS design will be more straightforward as the different DSS components are specified directly. Furthermore one assumption needs to be mentioned and that is the component of 'User preferences', the interviews will try to specify this component but it can only be specified up to a certain level. Once the DSS design is finished a validation step will make sure that the user preferences are met.

Each component of the decision support system leads to a set of questions which will be used as guidance during the interviews, this mapping of DSS components to questions can be found in the appendix. First a general question was asked about the daily work efforts, in what the main needed inputs and outputs are in order to operate, what are the main actors involved, continuing with questions regarding critical design issues that have been derived from literature. This leads to the mapping of stakeholders to these critical design issues. Finally there are specific questions on requirements and expectations. In table 5-1 the results are displayed of the interviews, there were 8 respondents in total, thereby covering all the relevant components by at least three persons each time.

Table 5-1 Overview of coverage of field research results.

Component(s)	Management	Information Analyst	Information Analyst	Information Analyst	Security Expert	Developer	Project Manager	Software Product Manager
Intended Users	✓						✓	✓
VIP pillar 1: Actors	✓	✓	✓	✓		✓	✓	
VIP pillar 2: Objects	✓	✓		✓		✓	✓	✓
VIP pillar 3: Interactions	✓	✓	✓	✓	✓	✓	✓	✓
VIP pillar 4: dependencies		✓	✓	✓	✓	✓	✓	✓
DSS requirements		✓					✓	✓
CDI: Security	✓	✓	✓	✓	✓			✓
CDI: Quality of Service		✓	✓	✓				✓
CDI: Integration		✓	✓	✓				
CDI: Accessibility		✓	✓	✓				
CDI: Management of User Profiles		✓	✓	✓				

5.2. Results for the DSS 'user' component

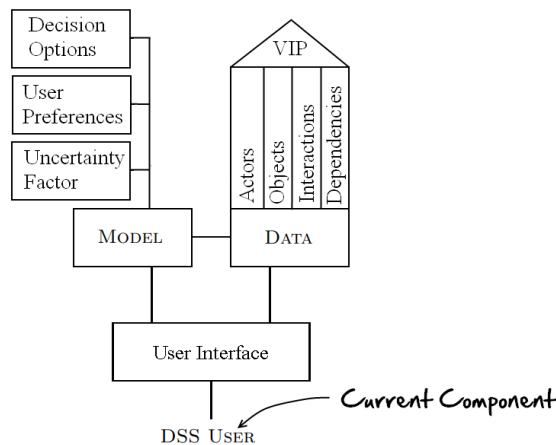**Figure 5-1 Specifying the DSS user**

Management identified that initially 'Information Analysts' will make use of the DSS, in the beginning the DSS will only be used within the mapshop team which currently has three Information Analysts. Eventually after validation and a testing period the DSS framework might be used by Information Analysts by other teams too in different segments of the mapshop service

platform facing similar challenges. This aspect gives an extra requirement; the DSS should be easily extendable to serve other teams in the future too. Next to the information analyst, a project manager and resource manager might also find it very interesting to use the DSS, but the primary focus is currently put on the information analyst.

The role of Information Analyst is to mature the new feature requests made by stakeholders into a solid set of requirements and user stories; the Information Analyst is the *spider in the web* between all the different actors and is the main source of information from the viewpoint of a developer. The role of 'information analyst' as it is used within TomTom is similar as a 'Product Owner' within the SCRUM project literature. The Information analyst will use the DSS to evaluate each new feature and to assess the impact of this new feature on the mapshop platform.

A second actor that was mentioned was the program manager; this actor is responsible for putting forward new business cases for their specific expertise. For example the program manager 'maps' will be an expert in that industry and tries to acquire revenue by the use of putting forward new business cases, when these new business cases require new service development the DSS tool will be of importance.

A project manager can also make use of the decision support system, as it allows him to see progress and bottlenecks over time. Furthermore in the current situation a project manager requests certain activities from the development team, and needs to sign off on these activities for it to progress to the next phase. It was also suggested that the DSS can incorporate the standard checklist framework already in use by TomTom, the Service Creation Framework (SCF), thereby lowering the overall administrative task for the project manager, as the SC Framework currently uses E-mail, word documents and PowerPoint for communication.

There is one software product manager (SPM) for the mapshop service platform, which decides on the roadmap and prioritization within the roadmap of the service platform as a whole. The SPM must communicate with both the information analysts and project managers to keep track of progress and potential setbacks. This activity of keeping track of all the different projects is a demanding task and a DSS that clearly delineates the activities needed for each new feature might lighten the workload, although more activities are added by adding the balancing of critical design issues.

The DSS user will initially be the Information Analyst and the interviews have been solely focused on the DSS user component being an Information Analyst, thereby omitting other potential future users. However if the framework is validated for use by the Information Analyst it is likely that with additional interviews to get data other DSS users can be supported, but this requires further validation. The decision to only focus on the Information Analyst in this stage is made with the agreeing with management.

5.3. Results for the DSS 'DATA' component

[The field research results have been removed from the public version of the thesis]

5.4. Matching critical design issues with stakeholders

The four pillars of the VIP framework have been filled, and this can now be aggregated into a higher level of the three horizontal layers, value, information and processes. The three horizontal layers of the VIP framework are value, information and business processes, which will now be used to map the critical design issues to the involved stakeholders.

Critical design issue: System Integration
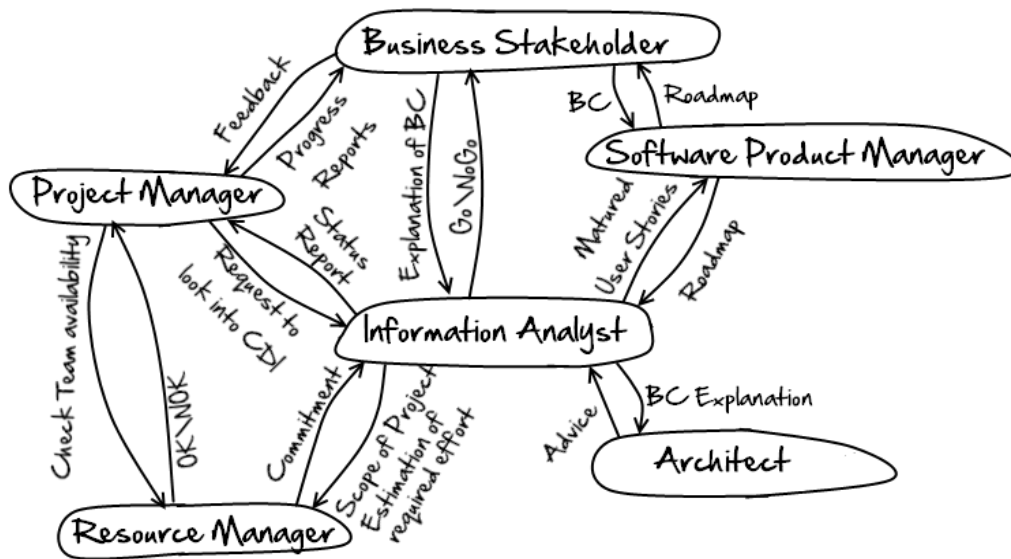
Figure 5-2 Mapping value, information and processes to the CDI System Integration.

During the interviews it was determined that the System Integration is currently decided upon by a discussion with the system architects in what is possible with regard to integration. Up till now the decision always has been to integrate with the existing mapshop platform. As different services within the mapshop service platform can be reused thereby shorting time to market, however the extent of the integration should be balanced. Based on this discussion the scope of the project can be determined, identifying the necessary development teams.

The level of integration of a feature is also dependent on the availability of resources, for example; a service might be integrated directly into an existing service A, but this needs to be done by developers who are working on service A. If this development team is unavailable a choice can be made to develop it separately from service A and then later create a link between the newly developed service and the existing platform.

It was mentioned that when the system architect knowledge is lacking on the finer intricacies the team lead regarding the affected service platform components should be included in the decision making.

[Other field research results are removed from the public version of the thesis]

5.5. Conclusion

The third research phase was to conduct a field study and to the data necessary to fill in the components of the DSS. The questions were answered using semi structured interviews, leading to a solid set of requirements from the DSS users and a specification of the earlier selected DSS components. The research questions for this phase and chapter were as follows:

RQ2. What are the requirements that the intended users within TomTom impose on the DSS?

RQ3. Which stakeholders are currently involved or should be involved when balancing critical design issues from the technology domain?

First the intended users of the DSS were identified, leading to the conclusion the initially information analysts will use the DSS for balancing critical design issues and maturing the business case. The remaining focus of the interviews focused on having Information Analysts in the center of the stakeholder framework. The stakeholder framework consists out of four pillars actors, objects, interactions and dependencies which were used to gather the data for the 'data' DSS component. The landscape of actors that play a role in the mapshop service platform development was composed and checked by interviewing key actors involved. Based on the landscape of actors an overview on data, information and knowledge objects and behavior with these objects was created. With all the knowledge on objects the interactions and dependencies were identified leading to a rich set of data that can be put into a database and thus the 'data' DSS component.

By having all this data available the mapping could be made between critical design issues and the actors involved. For each critical design issue in the technology domain the value exchange, information exchange and business process was mapped. The findings on the 'user preference' component lead to insights in what the user wants from the decision support system next to creating more viable and mature business cases.

Both research questions were answered leading to enough available data for continuing with the next research phase in which the DSS design will be specified.

6. DESIGN OF THE DSS

This chapter specifies the initial design of the decision support system and thereby answers research question four. First an introduction will be given on the research question and how the previously specified design space will be used to design the DSS. Secondly additional requirements are given that were derived from scientific literature and field research results, which form a superset of requirements that are applicable to the entire DSS. Thirdly the DSS design will be specified in theory, finalizing the complete DSS design for use within TomTom. After DSS design finalization a simplified prototype will be made which only looks at the information analyst viewpoint and is a one dimensional representation of the DSS, within this prototype mockups will be sketched as a way of visualizing the DSS framework. After specification and prototype creation an implementation guideline will be created, concluding with a prototype DSS proposal that needs to be verified and validated.

6.1. Introduction

The combination of DSS model components and the field research results need to be mended together to form a DSS design that can be used within the TomTom roadmap process. The design of the decision support system has an associated research question attached which will be answered using a design approach.

RQ4. What is the business model DSS specification for use within the mapshop service platform roadmap process?

The design process by Verschuren and Hartog (2005) will be used to design the decision support system. The process of designing the decision support system has six stages (1) the first hunch, (2) requirements and assumptions, (3) structural specifications, (4) Prototype, (5) Implementation and (6) Evaluation. The first hunch is the initial stage of the designing process which should have as a main result a small set of goals that the design should adhere to. This stage is already covered by the problem statement and research goals stated in chapter one. The second stage should have as a final goal a specification of the requirements and assumptions, Verschuren and Hartog (2005) identified three main requirement categories, functional requirements, user requirements and contextual requirements. And similar to the requirement categories it also goes for 'assumptions'; assumptions about the user, contextual assumptions and functional assumptions. The requirements and assumptions will be elaborated upon using literature findings and interview results. After the requirements and assumptions stage the DSS will be specified, which will be mainly a theoretical approach on how to combine, integrate and specify the DSS based on the requirements, assumptions and the previously created DSS model. The realization of the decision support system will be a simplified prototype version of the model for the use within TomTom.[1] The simplified decision support system can be used for an

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[1] The realization of the complete model in a fully functional prototype within the time period given a master thesis research project is unrealistic and out of scope. However as much care is taken in the creation of a prototype, it does not resemble the finer intricacies of the underlying theoretical model and is therefore unsuited for a large discussion, as the complete DSS incorporating the proposed model will be much larger.

initial validation. A question that automatically stems from research question four is on how to implement the DSS? The implementation will look at where the model should be applied in the roadmap process and will give guidelines on usage based on the prototype and theoretical model. The final stage is the evaluation stage, in which the DSS will be validated, which will be done in chapter seven.

Within the upcoming chapters the role of a 'DSS designer' is used, this role can be seen as a person who is responsible for design and implementation. When trying to apply the research results in organizations, one person should be appointed DSS designer to guide the DSS design and DSS implementation. By using a 'DSS designer' perspective in the design process the process towards a DSS design can be generalized, regardless of field research results.

6.2. Requirements and Assumptions
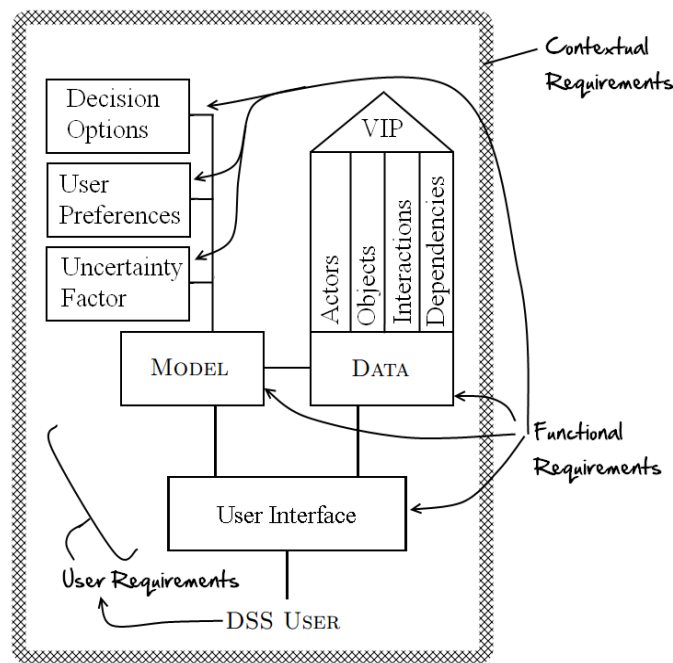
Figure 6-1 Three types of DSS requirements

As a DSS designer it is important to notice two differences in requirements gathering throughout this research, firstly there are requirements that can be applied to the entire DSS, including all components. And secondly the requirements that only apply to the 'user preferences' component, which is the component that identifies the preferred outcomes of balancing the critical design issues. Within this subchapter the requirements and assumptions are discussed that concern the DSS as a whole, and thus also incorporate the user preferences component. According to the design cycle of Verschuren and Hartog (2005) there are three categories of requirements, namely user requirements, contextual requirements and functional requirements. Functional Requirements are defined as; "...*functional requirements indicate the functions that the artifact should fulfill or enable to perform once it is released, given the goals*" (Verschuren and Hartog 2005). For example a functional requirement of a mobile phone system, is that it would allow for answering calls. In case of the DSS the functional requirements stem from the literature research.

The user requirements of an artifact are the requirement that the user imposes on the artifact; for example that the mobile phone can make calls in a timely fashion and has an easy-to-use user interface. The contextual requirements are imposed on the artifact by external factors, such as political, economic, juridical and/or social environment, the main source of this requirement category is the TomTom context. Combining the three types of requirements will lead to figure 6-1.

A second aspect identified by Verschuren and Hartog (2005) are the assumptions about the artifact. The designer of the artifact should specify what the conditions are of correct operation of the finally proposed artifact, in order to have the desired outcome. Implicit assumptions about the artifact should be made explicit and can be categorized in three categories; assumptions regarding the future users of the artifact, the contextual assumptions and the functions the artifact will fulfill. For example, as the DSS is designed for specific user roles in mind, when TomTom reorganizes and certain user roles might change meaning the DSS might lose its value as it might not fulfill the intended goals anymore. By making the assumptions explicit the long term usage of the DSS will be more viable. The requirements and assumptions are derived from scientific literature and logically follow from the field research results and will be discussed per category.

Contextual Requirements

Verschuren and Hartog (2005) indicate that political, economic, juridical and/or social context are externally imposed (and thus contextual) requirements on the artifact, it is believed that these requirements do not hamper DSS design but do play a role when trying to specify the components. The contextual requirements stem from the problem statement and the conclusions drawn when discussing the domain and literature, as these form the context of DSS operation and DSS design.

The DSS design should adhere to the TomTom guidelines of development practices and good conduct rules, which logically leads to the artifact being correct in a juridical sense. The contextual requirement is that a DSS should be created, that fits into the existing TomTom roadmap process from business case to capitalization. The DSS is only concerned with critical design issues that stem from the technology domain as the project scope stated. Additionally it is implied by management a contextual requirement that the DSS can be extended later to also support other teams working on the mapshop service platform, but also on other service platforms within TomTom. Furthermore extension capabilities to other domains like service, organizational and finance is expected, with the incorporation of their associated critical design issues is expected.

User Requirements

The user requirements are based on interviews and indicate on how the DSS should operate, it also indicates the wishes of the model outcome, thereby coupling part of the user requirements to the user preferences and thus desired outcomes of the DSS. The user preferences are based on the interviews, but also the initial task given when starting the research. The main DSS outcome preference is to make TomTom more innovative with viable business models.

A user requirement stemming from the field research is the wish that the DSS should not be an administrative burden. Most interviewees did not feel the desire to engage in a time consuming activity to balance the critical design issue. The intended users requested to have a 'lightweight' decision support system that was able to capture the main goals, but leave the finer intricacies to their own insights.

A second user requirement was the wish that the DSS should be able to track business model maturation progress in terms of staging. As within TomTom a stage gating process, called SCF framework is used it would be convenient to implement this stage gating into the DSS and make it a coherent set of checklists.

Finally Information Analysts also suggested that sometimes certain critical design issues are not applicable, or should be allowed to be omitted due to overlapping with SCF framework or nature of the requested new feature. Keeping track of progress and accountability was specifically mentioned during the field research and thus should be incorporated in the DSS design.

Functional Requirements

The functional requirements of the DSS are gathered using literature and interviews, as some requirements are contradicting or overlapping, a discussion on the requirements is necessary. Some authors of scientific literature on decision support systems have specified requirements or goals which the DSS must adhere (Sprague 1980). Theses insights from literature are significant as they can be seen as fundamental requirements of the DSS. It is believed that when incorporating the requirements that result from literature a higher quality will be achieved as more aspects of the DSS are being covered. Based on research by Sprague (1980) a number of managerial goals imposed on the DSS can be formulated:

- ❖ A DSS should provide support for semi structured or unstructured decision making.
- ❖ A DSS should provide support for users at many levels within the organization.
- ❖ A DSS should support decisions that can be classified as interdependent as well as those which are independent.
- ❖ All phases of the decision making process should be supported.
- ❖ A DSS should support a variety of decision making styles and processes, and not be dependent on only one type of decision making process.
- ❖ A DSS should be easy to use.

Based on the literature research the following structure of the DSS was defined and poses as the structure of the DSS, as is used throughout this thesis and can be seen in figure 6-1. Furthermore the following requirements were identified that apply to the DSS specific components. (1) The model component consists out of three sub components, 'decision options', 'user preferences' and 'uncertainty factor'. The decision options consists out of the critical design issues identified using literature research. The uncertainty factor will mainly be based on the assumptions made when designing the DSS, and should be explicitly mentioned in the DSS user interface. (2) The data component; the data gathered using the VIP framework should be codified in a database. It should be possible to add new data to the database by means of the user interface, as the landscape of actors is dynamic by nature. (3) The user interface component; within the thesis

introduction it is decided that the user interface could either be an excel sheet or a website application. In this regard the best would be the website interface as this allows for easy access and collaboration. By using a website as a user interface the administrative burden on actors will go down as less time is required in filling in documents and emailing this to the necessary people. By using e-mail it is possible that actors will receive information that doesn't concern them as actors will be included generously by most senders in order not to miss people. Furthermore tracking down decision making by using a website is less time consuming compared by using an e-mail client as the website is specifically dedicated for this specific task.

Contextual Assumptions

It is an assumption that a DSS will be the path to a solution of bringing TomTom a step closer to delivering more network value and thus increasing revenue. However the DSS is not validated in this aspect at the moment and a DSS might not be the best solution; it must be seen as an initial effort to bring order to the complexity that exists within the actors of the mapshop service platform. The DSS will be validated in chapter seven, however the DSS designer has to keep the contextual assumption in mind that the DSS is not proven as of yet and needs to incorporate validation steps presented in chapter seven.

Intended User Assumptions

Based on the field research results it was identified that the intended users of the DSS will be the Information Analysts. From a technical point of view it is possible to give each actor that was mentioned in the stakeholder analysis a personalized overview on activities to engage in. It is an assumption that the user is mentioned in the stakeholder analysis, and is thus visible in figure 5-3 of the mapshop actor landscape, if this is not the case the DSS will not function properly as no personalized view will be available.

Functional Assumptions

The DSS will assume that its function is to balance critical design issues for the technology domain; it is unsuited for other tasks than this particular purpose. However it is required for it to be extendable and the given requirements foresee in this need, the initial requirements are for balancing the critical design issues within the technology domain of business models for the TomTom mapshop service platform. A second assumption is when extending the DSS to include other domains the model would yield similar effects. Within the prototype and scope of the thesis it is specifically chosen to incorporate the critical design issues from the technology domain only. The incorporation of other critical design issues from the remaining STOF domains within the DSS will need further verification and validation.

Conclusion

Based on the requirements gathering table 6-1 can be derived which will be used throughout the design phase. All requirements are written down in a SMART fashion, being specific, measureable, attainable, relevant and timely, this leads to requirements that can be tested for compliance. Within table 6-1 two types of activities are defined: 'actor activity' which is an activity between two actors, and a 'value activity' which consists out of a number of 'actor activities', in this case a 'value activity' is always the balancing of a critical design issue.

Table 6-1 Requirements

#	Origin	Requirement
REQ1.1	Contextual	DSS should fit within TomTom roadmap process of mapshop service platform.
REQ1.2	Contextual	DSS should be extendable to other domains next to technology, for example service, organizational and finance.
REQ1.3	Contextual	DSS should be extendable to incorporate additional critical design issues.
REQ1.4	Contextual	DSS should be extendable to cope with other development teams.
REQ1.5	Contextual	The user interface of the DSS must be in English.
REQ2.1	User	DSS should not become an extra administrative 'burden'.
REQ2.2	User	DSS should be able to incorporate the SCF stage gating Framework
REQ2.3	User	DSS should be able to keep track of progress and accountability of users.
REQ2.4	User	Certain critical design issues may be omitted setting them to 'Not Applicable'.
REQ3.1	Functional	The DSS model consists out of the following components: Decision Options, User Preferences, and Uncertainty Factor.
REQ3.2	Functional	The Uncertainty Factor is filled with the Assumptions made about the system.
REQ3.3	Functional	The user interface must be a website.
REQ3.4	Functional	The user must be able to create projects
REQ3.5	Functional	Each project should have a progress status indication
REQ3.6	Functional	The user must be able to assign features to this project
REQ3.7	Functional	Each feature should have a list of value activities
REQ3.8	Functional	Each value activity should have a list of actor activities
REQ3.9	Functional	Each actor activity should have a progress status indication
REQ3.10	Functional	Login functionality is required to access the DSS
REQ3.11	Functional	Each actor has a personalized view, but can also view the total overview.

The list of requirements leads to the following use cases; a use case is a way of describing activities that an actor can perform on a system, in this case the DSS. The use cases can be seen as an extension of the requirements and are a step closer towards specifying, without completely

specifying how it should be implemented, it is at least made clear what should be implemented. The use cases are displayed in figure 6-2 and the user is an Information Analyst. The DSS designer should create separate use cases when trying to incorporate other users than an Information Analyst.
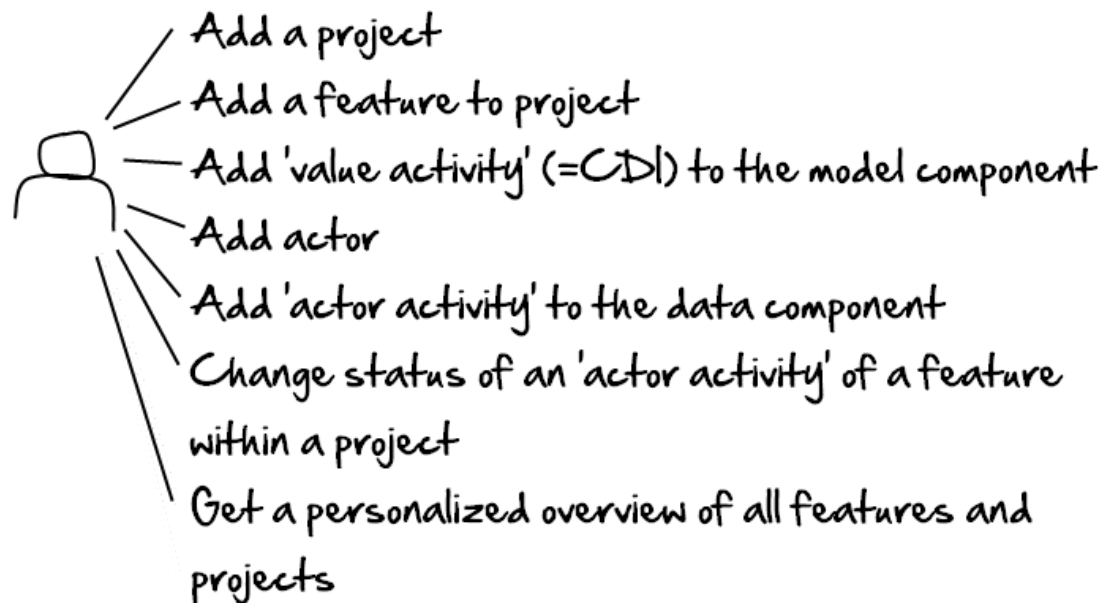
Figure 6-2 The different use cases of a DSS user

The user wants to be able to add a project and attach features to this project, as features are the actual business case that is being put forward by the business stakeholder. When creating a new feature the list of value activities and actor activities will be populated and presented to the user. A value activity is a critical design issue that needs balancing actions, so called actor activities. Furthermore there are a number of administrative tasks, which is the possibility to add actors, add value activities and add separate actor activities which need to be coupled to the value activities. The actual usage of the system is in getting a personalized overview of all features and projects, and the ability to change the statuses of actor activities within features.

6.3. Structural Specifications

The assumptions and requirements have been listed and the structural specification of the decision support system can now be designed. The role of a 'DSS designer' is continued upon as a person that takes care of DSS design and implementation. By using the viewpoint of a DSS designer the specification stated in this chapter will be made transferrable to other departments within TomTom or even companies. According to Verschuren and Hartog (2005) a number of distinctions can be made when specifying and artifact. The artifact can be divided into systems and subsystems, for example the system of a car consists out of a fuselage, tires and an engine. The sub systems of a car are for example the cylinders and the tire vents. Another distinction can be made on the design depth, initially a general architectural design needs to be created, which then leads to a specific detailed design. As the architecture of the DSS is defined by means of literature research in chapter three, the focus currently is on the detail design and implementation specifications of the DSS, leading to a specification that can be used by developers to implement

the DSS. The structural specification will be discussed using a detail design approach, which indicates that important tradeoffs of technologies are discussed. The starting point is 'User Interface' which is the component that presents all other components to the DSS user. The requirements and use cases specified in the previous subchapter will be used to discuss the direction to take when specifying the DSS and usability of the user interface.
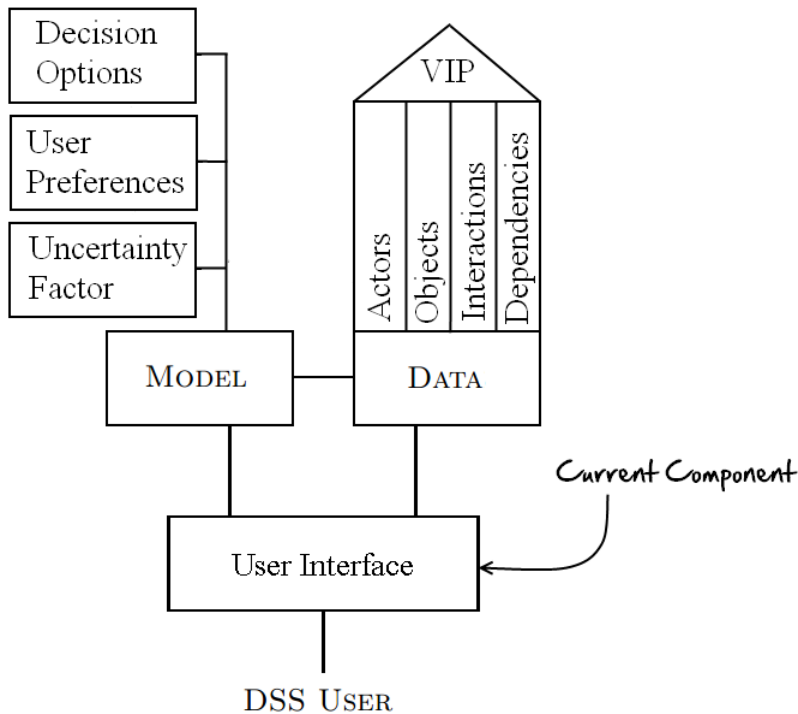
Figure 6-3 The DSS 'User Interface' component

The user interface must be a website so it allows for collaboration over the internet or TomTom intranet. There are many programming languages available for creating websites, among which are Java, Ruby and PHP, which are all languages that are commonly understood by TomTom developers. It is up to the DSS designer to choose a programming language that fits the existing requirements and is commonly available within a company.

The user interface must contain login functionality to keep track of which user is using the system, when the current user is known it will lead to many significant advantages. The user will get a personalized dashboard overview of projects that he/she is assigned to, instead of merely seeing all projects and features that are currently available. It is up to the DSS designer to cope with the level of secrecy required within an organization. Certain projects can be on a need to know basis, thereby preventing unauthorized users from getting to know progress or activities. Secondly the accountability when signing off critical design issues will be made possible when the user is known. Furthermore the initial overview page should give a clear indication of projects and features, and the feature status in terms of stage.

The model component

The DSS model component is concerned with how to integrate the decision options, the user preferences and the uncertainty factor. In order to fill in these components and presenting it by means of the user interface, a distinction should be made between a 'value activity' and an 'actor activity', the value activity consists out of a number of actor activities. An actor activity is between two actors and has a two directional information process, as can be seen in figure 6-4. A value activity is in this case the balancing of a critical design issue, and consists out of a number of actor activities which originate from the field research results.
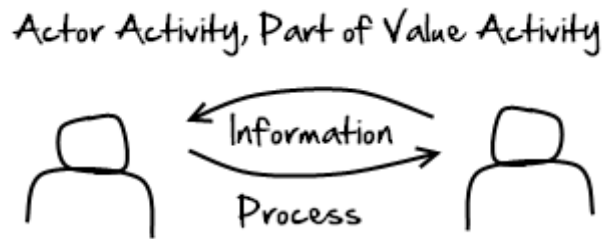
Figure 6-4 A single 'actor activity', which is part of a greater 'value activity'.

The challenge in specifying the user interface is the presentation towards the user while keeping it usable. Each actor activities can be combined in one line within the decision support system as is displayed in table 6-2, leading to a complete value activity. In table 6-2 the value activity of balancing the critical design issue Security is portrayed, a similar display can be used for the user interface, as it has combined all three subsystems of the 'model' component. The 'owner' is the actor who initiates the information process.

Table 6-2 Example of value activity, combining the three 'model' subsystems

Value Activity: Balancing the Critical Design Issue Security				
Uncertainty Factor: <uncertainty factor statements>				
Owner	**Status**	**Deliverable**	**To**	**Deliverable back**
<User_id>	<status info>	<information>	<user_id>	<information>
<User_id>	<status info>	<information>	<user_id>	<information>
<User_id>	<status info>	<information>	<user_id>	<information>

The overview presented in table 6-2 combines the three 'model' components, namely 'decision options', by specifying the value activity on top; in this case the balancing of the critical design issue security. The 'user preferences' component adhering to the requirements, which are the activities that are in this case needed to balance the critical design issue security. And the uncertainty factor statements that are important for a user to realize when gathering all the information. The model component presents the list of value activities by means of the user interface.

Decision Options

The decision options are the critical design issues derived from scientific literature, and are thus; Security, Quality of Service, Integration, Accessibility, Management of User Profiles. The critical design issues should be put in a database with at least the following fields as mentioned in table 6-3. By using such a table structure it allows for expansion of critical design issues that are related to other domains, such as service, organizational and finance. The items in table 6-3 will form the main headlines of the value activities of the model displayed with the user interface.

Table 6-3 Critical Design Issues Database table; 'value activities'

Id	CDI	Question	Tradeoff	Domain
1	Security	How to arrange secure access and communication?	Ease of use vs. abuse and privacy concerns	Technology
2	Quality of Service	How to provide for the desired level of quality?	Quality vs. costs	Technology
3	System Integration	How to integrate new services with the existing system?	Flexibility vs. costs	Technology
4	Accessibility	How to realize technical accessibility to the service platform?	Open vs. closed system	Technology
5	Management of User Profiles	How to manage and maintain user profiles?	User involvement vs. automatic generation	Technology

User Preferences

The preference is that all the actor activities are signed off, so that the balancing of the critical design issue has taken place. This leads to the requirement of a status overview for each activity, to be able to track progress of the actor activity and thus make deductions of the progress on the value activity as whole. For each actor activity the following statuses can be used:

1. OK\Done, activity is finished.
2. In progress, activity owner is working on activity to generate deliverable\information.
3. Waiting, activity owner is waiting on return information from other actor.
4. Not started, the activity has not been started yet.
5. Not applicable, the activity is deemed unnecessary and will be omitted.

By incorporating the requirements three new tables need to be generated in the database namely; projects, features and feature status. The projects overview only contains a unique identifier and a project name; features can then be linked to this unique project identifier. The feature status overview can be linked to the features list, storing all the status information of actor activities.

Uncertainty Factor

The uncertainty factor can be mentioned once per feature overview and should contain the following elements; (1) the list of assumptions, (2) Boundaries and scope of the DSS design project. The list of assumptions previously created should be codified into a text entity, which can be included on every feature page. The user should be made aware of is the dynamic nature of the landscape of actors. Once the actors are codified in the database, they should hold true for a limited amount of time, as personnel joins or leaves TomTom this can create gaps or inconsistencies with the balancing actions that are required. Based on the findings the following text is created and should be included on every feature page.

Please note the following uncertainty factors when using the DSS

1. The DSS incorporates a model, and attempts to incorporate reality to an utmost extent, however in the end it stays a model and might thus be faulty or incomplete in certain situations.

2. The DSS is developed using design issues that stem from the technological domain only, and is currently not tested for use in other parts of organizations, namely services, finance or organizational aspects.

3. There are no iteration loops present when balancing critical design issues, when information is incomplete to properly continue with decision making, it is up to the user to pursue the information required again.

The DSS data component

The data component consists out of two database tables; (1) the entire list of actors in the mapshop service platform landscape, (2) the list of interactions these actors have with their associated objects. These database tables are depicted in table 6-4 and 6-5, the actor ID in the 'actor activity' refers to the column in the personnel dataset. The personnel dataset can be extended to include further fields, for example a link to the personal intranet pages within the company. The optional extension of the personnel table is marked with the alternating lines.

Table 6-4 Personnel table

ID	Name	Skype	E-mail	Intranet page	
<User_id>	<name>	<Skype address>	<email address>	<webpage>	

Table 6-5 Table containing actor activities.

Value Activity	Owner	Status	Deliverable	To	Deliverable back
<Associated value activity>	<actor_id>	<status info>	<information>	<actor_id>	<information>

6.4. Prototype

After the specification of the DSS components a prototype can be created for initial verification and validation. A software prototype can have many forms, one of them being a set of non-clickable mockups, or an almost implementable version of the software package (Verschuren and Hartog 2005). For the current prototype a combination will be made between a way of visualizing the DSS components and a clickable mockup, leading to a software package that allows for feedback and a rich evaluation by users. The presented mockups logically follow out of the requirements from previous sub chapter and component specification during the field research. For each mockup the highlights will be discussed in what component it brings forward. Furthermore it is made explicit what is not inside the mockups, not implemented or skipped requirements. In this case a one dimensional single actor viewpoint prototype of the model will be created, meaning it is personalized only for one user and can't be used by other actors yet. Three mockups will be presented that have been created, of which screenshots have been made; the dashboard, the administration panel and the feature page.

The Dashboard

The dashboard is the initial page the user sees after logging into the decision support system, it contains a personalized list of projects and features, as can be seen in figure 6-5. The dashboard should consist out of a number of elements that are based on the requirements, and additional elements for usability. The current view consist out of the list of projects and associated features, it has a status indication of the percentage of completion. The left side contains quick links of common tasks. The dashboard overview corresponds with the use case: "get a personalized overview of projects and features".

[Figure removed in the public version of this thesis]

Figure 6-5 The prototype dashboard overview

The administration panel

The administration panel is used for maintenance and less common activities. The administration panel is displayed in figure 6-6. The administrative use cases mentioned in figure 6-6 are made available in the menu on the left; by clicking on such an item the corresponding action can be performed. In this case the adding of an actor activity is shown. It contains a dropdown list of all currently entered value activities, which are the critical design issues that need balancing. The owner and thus initiator of the actor activity can be chosen together with the wanted deliverables. Finally the selection can be made of whose input or deliverable is required to balance the value activity.

[Figure removed in the public version of this thesis]

Figure 6-6 The prototype administration panel overview.

The feature page

Initially the user is presented with the dashboard page containing an overview with all features and projects. When clicking on a feature from the list the feature overview page is presented containing detailed information about the required balancing activities. The feature page lists the project name, feature name, the business stakeholders and scope. Furthermore it contains the Uncertainty Factor component, the value activities are the user preferences and the actor activities are the decision options within these value activities. In figure 6-7 a mockup is displayed of the feature page, displaying the DSS components. For each actor activity a status can be picked for keeping track of progress.

[Figure removed in the public version of this thesis]

Figure 6-7 The prototype feature panel overview

6.5. Implementation Guidelines

The DSS designer has to create implementation guidelines to put the design DSS into use (Verschuren and Hartog 2005). Initially the guidelines on how to implement the DSS are given from a viewpoint of integrating it into any organization regardless of TomTom. Eventually zooming in into TomTom and how it should be implemented within the mapshop service platform actor network. When implementing a decision support system the following aspects need to be taken into account: management guideline on the location and integration within business processes, training of users and technical deployment of the DSS itself.

Management guideline on Location and Integration within Business Processes

The integration of the DSS into the business processes is a task for management and the users of the DSS, the discussion on whom will use it needs to be decided upon by a decision making process initiated by the DSS designer and management. Companies that are working on service platforms most of the time have rigid development processes in place; however the threshold before entering the rigid development process, which is the roadmap process, might be vague. The DSS is designed to be positioned before the rigid development process initiate, thereby giving it room for business case maturation in its fullest without committing itself to a development team yet.

In the case of TomTom the DSS will initially be used by the Information Analyst, which is according to SCRUM literature the 'Product Owner'. But usage can later be extended to other users, dependent on demand and validity of the application. The created prototype can and should be used by Information Analysts only.

Training of users

It is identified that properly trained users can be the most critical component when trying to create effective decision support systems (Bairu, Ogle et al. 2006). It is suggested to have an initial presentation of the system before implementation, followed with a hands-on experience session with the intended users. The believe that a training is expensive and time-consuming doesn't contradict the argument that inexperienced actors making use of the DSS might make

wrong decisions or take longer than usual to make decisions, which also costs time and money. In the case of TomTom the DSS will be presented during the validation session, in which an initial contact will be made with the prototype. Within the initial presentation management should be attending together with the intended users, which are the Information Analysts. When adding more users to a finalized DSS these should be trained accordingly to also understand the required critical design issue balancing activities.

Technical Deployment

The implementation of the DSS can't proceed if there is no technical architecture present to serve the DSS to the users; a server, database and an intranet connection are minimum requirements for technical implementation. Based on the used programming language and technical implementation other requirements might also apply to the technical architecture. The task of technical implementation should be initiated by the DSS designer. Within TomTom the prototype will be run on a simple web server, but when developing the actual DSS the system will be placed within the production environment which is continuously monitored for correct operation. Furthermore a choice has to be made regarding the programming language and technologies involved, there is a significant amount of scientific research in this field (Bray 2006)

6.6. Conclusion

The fourth research phase was to create a DSS design from the gathered data in the literature study and field research results. The design approach by Verschuren and Hartog (2005) was used to create a structured and valid way of designing a DSS. The process of designing the decision support system had six stages (1) the first hunch, (2) requirements and assumptions, (3) structural specifications, (4) Prototype, (5) Implementation and (6) Evaluation. The requirements and assumptions of the DSS are made explicit, which lead to a structural specification of a complete DSS. An initial prototype is put forward which is a limited version of the complete design, but can be used for initial validation. A number of implementation guidelines have been created, mentioning the position of the DSS within the business processes, the training of DSS users and the actual software deployment. The implementation guideline is on a general level, trying to facilitate future DSS designers that are trying to create similar DSS for business model maturation. The final step is evaluation which will be in the next chapter. By having used a design approach the following research question for this phase and chapter is answered, which was as follows:

RQ4. What is the business model DSS specification for use within the mapshop service platform roadmap process?

The DSS specification needs to be evaluated before it can be implemented; both in terms of internal validity (verification) and external validity that it actually solves the problem statement, the next chapter will evaluate the DSS on these items.

7. EVALUATION

This chapter will evaluate the DSS design on internal and external validity. First an introduction will be given on the corresponding research question and why validation is necessary. Secondly the internal validation, the verification, will be looked into by specifically making sure that the model itself has been built in the right way. Thirdly the model validity will be checked, whether it actually solves the problem stated in the problem statement. Fourthly an overview will be given on the level of instantiation and generalization possible with the DSS model, finally concluding with the answer to the raised research question.

7.1. Introduction

It is very likely that one of the first questions management will ask the DSS designer is whether the model has been validated. If the model isn't validated it is unlikely to be adopted into an organization as the model is not validated to solve the real world problems; thus the model will be sent back to the drawing board. The main challenge in validating the DSS model is to ultimately be able to give a positive advice for management to go ahead with implementation as the model will increase business model viability. The following research question is raised to answer the validity of the designed DSS:

RQ5. What is the validity of the designed DSS for use within TomTom?

Based on the work of Verschuren and Doorewaard (2007) two types of validity can be determined, internal validity and external validity. The internal validity is also called verification, and answers the question: "Has the system been built right?", and the external validity should answer the question a level further: "Has the right system been built?" The research question will be answered in a two-step approach, first looking into verification, make sure the research approach, methodology and results are a logical result without ambiguity. Potential oversights should be made explicit so the DSS designer is able to detect these when trying to apply the model in other settings than sketched in the problem statement. Secondly the validity of the end result DSS, if it actually meets intended requirements and results; thereby checking if the model addresses the right problem, provides the correct information to solve the problem and the model will actually be used.

7.2. Verification

The internal validation of a model is based on empirical argumentation, the quality of definitions and the explicit focus it gives on the research topic (Verschuren and Doorewaard 2007). The argumentation structure of the report will be discussed to make sure the internal validity is correct. Verification should ensure that the model, in this case the finally proposed DSS design, doesn't contain errors or oversights and that the specification is complete without making mistakes when implementing the model (Macal 2005). The verification will follow the same steps as taken in the report, starting from chapter three.

Firstly the direction towards a decision support system that supports business model maturation should be verified. The DSS components are based on the literature study, in which three main

decisions have been made; the choice of business model outline, the choice of DSS components and the choice of stakeholder framework. The business model framework stems from the mobile services domain, although it is believed that TomTom operates in this domain, it might not match perfectly with the mapshop service platform, and it is possible that another business model framework might be more suitable for TomTom and the mapshop service platform. The critical design issues have been derived from scientific literature directly related to the chosen business model framework, and therefore deemed applicable; however it is possible that critical design issues change over time for the technology domain due to for example; additional research. The DSS components have been selected using scientific literature, in which a combined overview is presented from literature findings, leading to a finalized DSS given in figure 3-1. The selected stakeholder framework (the VIP framework) is validated for external stakeholder analysis, but is used for internal stakeholder analysis. It is an opportunity to test the stakeholder framework for internal usage; however this might pose a risk as it is currently untested for internal stakeholder analysis.

Secondly the methodology and field research findings in which remaining DSS components were filled need verification. The data was acquired using semi structured interviews, using an answer sheet for guidance, leading to an increase in topic coverage. The field research results correspond with table 5-1, which couple the number of interviews with the data needed for DSS specification. By providing table 5-1 the validity of the interview results can be determined as it states how many people have provided answers for the requested topics. By interviewing management first stating the intended users of the DSS, and then narrowing down on key actors, it is logically assumed that the correct set of actors has been interviewed. However as much care is taken to make sure that all key actors are included in the model, it is possible that some actors are missed. An evaluation and external validation step is needed to make sure that all relevant actors are included in the model and thus decision making. It is also possible that certain actors gave strategic answers to questions, thereby leading to a bias in the model, but as in table 5-1 can be seen all data has been cross referenced, minimizing strategic answering the a large extent. The inclusion of more managers and information analysts would have led to a higher validity of the system, but due to scope on the mapshop service platform and time constraints the current sample selection has been made.

The DSS design is created using a proven design method by Verschuren and Hartog (2005) with the purpose of increasing validity and also providing evaluation guidelines to assess this validity. Furthermore the DSS design explicitly mentions assumptions about the DSS design, increasing the internal validity. A prototype is created to get an initial indication of model reliance and correctness; this prototype can be used for partial external validation only.

To conclude on the question: "How are we sure we build the system right?" is that based on the argumentative structure presented in this thesis and the explicitly mentioned decisions regarding the direction of solution the right system has been built. A DSS designer facing similar challenges has to keep the verification steps in mind, to make sure the model correctness is guaranteed to the utmost extent.

7.3. Validation

Validation is needed to make sure the proposed DSS meets the intended goals and gives accurate solutions for the identified problems. In order for management to proceed with DSS implementation it needs to have a rigorous validation check to make sure the proposed system is credible and is highly likely to deliver the value which is promised by the DSS designer. The external validation will cover the theoretical approach on how to validate a DSS, but will also partly validate the designed DSS for use within TomTom. The partial validation of the designed DSS will be done using a group interview of TomTom actors.

The direction towards a decision support system is based on the problem statement and challenges TomTom is facing as identified by management. It might be the case that these challenges are wrongly interpreted or overstated, thereby choosing the direction of a DSS while another solution might have provided better results. It is therefore important to mention that the initial problem assessment is key in the decision of the road to take towards a solution. Management and DSS designers facing similar challenges must check if the proposed DSS model is the best solution when there are alternative solutions present.

The proposed DSS model for TomTom can be partially validated by presenting the prototype to the interviewed actors, thereby requesting feedback, possible new insights and missed aspects. By having a group interview the validity and credibility of the system will be increased. A DSS designer should also present the prototype to the actors, before starting actual implementation as is mentioned in the design approach by Verschuren and Hartog (2005). By presenting the prototype of the DSS only a partial validation will be done, namely only of the prototype aspects instead of all DSS aspects. All DSS aspects can later be evaluated by implementing it within the roadmap process with an initial small base of users, slowly expanding to cover multiple business model domains and balancing factors as critical design issues.

It is too early to answer the question "has the right system been built?", as the prototype is a smaller fraction of the complete DSS. As currently only the critical design issues from the technology domain are used, the complete DSS needs further validation in order to become credible and definitively answer the question whether the right system has been built or not.

A manager and two information analysts were part of the group validation session; one of the information analysts was not part of the interviews in the field research. The validation results are ordered into four groups; general remarks, remarks on the field research results, remarks on the prototype design, remarks on the implementation.

All remarks will be aggregated and processed on a higher level than initially discussed, thereby providing the DSS designer with key pointers of focus during DSS design.

General Remarks on the DSS Purpose

There were two general remarks made on the DSS design within the group validation session. The first is the agreeing on the problem statement and that a DSS should aid in attaining higher business model viability. The gap within the process as stated in figure 3-9 is a concern of all the validation participants, the usage of scientific literature to structure decision making within this

gap is positively received. The second general remark was that the DSS is perceived as a checklist of value activities that need to be agreed upon when trying to balance the critical design issues. All persons in the group validation agreed that such a checklist, although sometimes not completely adhering to reality, is a structured way of improving the roadmap process.

Remarks on Field Research Results

The actor landscape as stated in figure 5-3 contains a duplicate entry namely 'Licensing' and 'Intellectual Property and patenting', this was missed before as different actors gave it different names and placed it differently in the actor overview. The correct one is 'Intellectual Property and Patenting' which also contains the Licensing department. Furthermore within TechOps there is another department called 'Deployment which is responsible for deploying new software builds to the server environment. These oversights have no further consequences for the balancing of critical design issues from the technology domain.

A second remark was that the mapping of critical design issues to the actors is currently not specific enough in terms of deliverable exchange. For each deliverable exchanged between actors the minimum requirements should be specified and in what form it should be delivered. For example the 'explanation of a business case' could either be in the form of a document or a group meeting; this should be made explicit within the DSS.

Remarks on the Prototype

The prototype proved to be useful during the validation session as the DSS became more tangible. The amount of received feedback increased when the prototype was presented, the feedback will pose useful for the DSS designer as it is has more focus on the implementation level of the DSS. Most remarks on the prototype were on the usability of each actor activity. The remarks were the following:

- ❖ Add the possibility to add a comment to each actor activity.

- ❖ Add the possibility to include links to external resources, such as the internal wiki page, issue tracking system or document sharing service.

- ❖ Change the possible status options from 'user friendly' to TomTom internal standards as used in the issue tracking system; which results in 'In progress', 'Blocked' etc.

- ❖ Add possibility to add a special status, separate from the status options already presented. This can be in the form of tags that can be added to an actor activity.

- ❖ The possibility to add additional actor activities on the fly that are needed for balancing critical design issues.

- ❖ Certain value activities to balance critical design issues can be handled within one meeting; this should also be made possible in the DSS.

- ❖ Initially a general actor is assigned to an actor activity; this should be changeable later when the actual actor is assigned.

❖ The difference between a Functional Requirement and Non Functional Requirement should be made more explicit in the DSS, as this can lead to ambiguity.

Remarks on DSS Implementation

The DSS is designed to fit within the TomTom roadmap process and this needs validation. In the group validation session the following elements were mentioned;

❖ The DSS is designed in such a way that it will fit in the roadmap process, and it is deemed necessary for increasing business model viability.

❖ The DSS integration within the roadmap process can be done for three particular actors in mind at the moment, the information analyst, the project manager and the software product manager. These three people all benefit directly from the DSS when including it in the roadmap process. The benefits that are mentioned are a quick overview on progress, the improved quality as certain activities are forced to be done as they are made explicit. The total time of administration overhead will go down as less emailing is required.

The DSS should however be extended in order to increase the level of fit in the roadmap process, and also to increase value of the DSS when using it in the roadmap process.

❖ *Who* decides when the balancing of critical design issues is finished, and the business case as a whole should go forward in the process towards actual implementation?

❖ *How* does the decision maker arrive at the conclusion that the balancing actions are finished? Is simply doing all the value activities enough, or should there be one final meeting?

❖ What is the actual deliverable solution, what kind of output will there be delivered at the end of the critical design issue balancing activities?

❖ Is there a sign off necessary? If yes, what kind of sign off would be required? The discussed sign off possibilities were; (1) sign off on all activities when marked 'finished' in the DSS, (2) sign off on deliverables per actor activity or (3) sign off regarding the final outcome of the balancing activities.

7.4. Instantiation and Generalization

The DSS is designed for use within the TomTom mapshop service platform roadmap process by Information Analysts. The term instantiation in this regard describes the usage of the DSS for each business case that needs to be balanced within the roadmap process. When specifically asked at the group validation session, it was indicated that sometimes an Architect can take up more activities than an Information Analyst, but this is dependent on a case by case basis. By making it possible to dynamically assign actor activities to different actors this will be made possible. Within the validation session it was believed that the DSS would support almost all business case proposals that are put forward within the roadmap process.

The level of generalization is different for parts within this research. The DSS model in figure 3-1 is generalizable as it was derived from scientific literature. The addition of the STOF model makes the further work only applicable to the mobile services domain. The field research findings are not generalizable and are only applicable to the mapshop service platform landscape within TomTom. The DSS model as a whole can be aggregated to a higher level for businesses coping with similar challenges as stated in the problem statement, but further validation is necessary.

7.5. Conclusion

The fifth research phase was to validate the initial DSS solution and to propose a final DSS that has enough credibility for continued evaluation within TomTom. The final research question is answered by first checking the internal validity, whether the model itself is correct, continuing with the external validity to check if the DSS meets the intended goals. The group validation resulted in a significant amount of feedback and remarks, thereby leading to the conclusions which answer the fifth research question.

RQ5. What is the validity of the designed DSS for use within TomTom?

The DSS was well received and all group validation participants indicated that a DSS could be used to attain a higher viability for new service development. This thesis and the proposed DSS can serve as a starting point for improving the roadmap process. More actors and information is needed to also incorporate the financial aspects of the DSS.

The field research results are considered valid after the implementation of the additional remarks. However care must be taken in the timeliness of these field research results as TomTom is operating in a dynamic environment in which actors can change on the fly.

The DSS prototype was used in a way to force a deepened discussion on the DSS, in which all group validation participants could easily participate due to the more 'tangible' nature of a prototype. A number of remarks have been made which leads to the conclusion that another iteration of the prototype is necessary. Also a number of remarks on DSS implementation lead to the conclusion that the guiding process of implementation needs more refinement.

The instantiation of the DSS framework is concluded to be complete enough for use in new service development within the mapshop service platform teams. However as previously is concluded that another iteration of the DSS design is needed the instantiation needs to be readjusted for the next design iteration. The DSS design is specifically made for TomTom, however the theoretical model as presented in figure 3-13 is generalizable as it is completely based on scientific research.

8. CONCLUSION

This chapter will present the conclusions on all sub research questions and thereby also answer the main research question that was derived from the problem statement, making the circle complete from problem to proposed solution. Secondly a list of future research topics is discussed and what parts of the model need further validation to increase credibility for future implementation. Finally reflecting on the proposed DSS solution for TomTom and from a personal viewpoint.

8.1. Research Findings

This section will discuss all sub research questions, concluding with the main research question raised from the problem statement.

> *RQ1. What is the current state of the art knowledge regarding critical design issues and decision support systems in the context of new service development?*

The state of the art knowledge was initiated by starting from DSS literature in which a generalized DSS framework is created. The DSS framework consists of a number of components which are filled in using state of the art scientific literature regarding new service development and a stakeholder framework. The result from the first research question is figure 8-1, which combines all the state of the art literature into one framework overview.
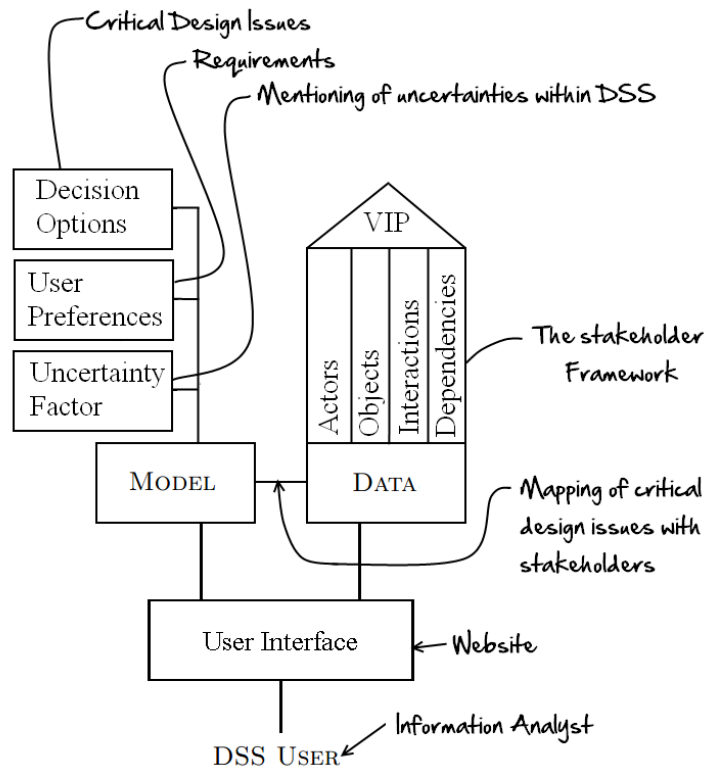

Figure 8-1 The combination of state of the art scientific literature into one model

The framework in figure 8-1 is used throughout the research with the goal to completely specify all components. Once all the components are specified the main research question is answered.

A selection was made to only incorporate critical design issues from the technology domain. Furthermore a stakeholder framework was chosen that normally is used for mapping organizational stakeholders only; in this research it was used in an intra-organizational stakeholder context. From a theoretical perspective the DSS framework is extendable in two regards; the critical design issues from other STOF model domains can be included. And stakeholders outside the organization of TomTom can play a role in the balancing of critical design issues.

The second research question is answered using semi structured interviews in which the requirements and user preferences of the intended DSS users are identified. Based on the field research results and the design phase a superset of requirements that are imposed on the DSS can be specified.

> *RQ2. What are the requirements that the intended users within TomTom impose on the DSS?*

A categorization framework is used in which three types of requirements were identified; contextual requirements, user requirements and functional requirements. Furthermore the assumptions about the DSS were explicitly mentioned in order to understand the DSS environment for correct DSS usage. Within the validation chapter additional requirements were raised that need to be integrated into one coherent set of requirements for the next iteration of the DSS proposal.

The answer to research question two is the combination of the field research results and the group validation session. The requirements printed in *italic* stem from the group validation session, as can be seen in table 8-1.

Table 8-1 Requirements

#	Origin	Requirement
REQ1.1	Contextual	DSS should fit within TomTom roadmap process of mapshop service platform.
REQ1.2	Contextual	DSS should be extendable to other domains next to technology, for example service, organizational and finance.
REQ1.3	Contextual	DSS should be extendable to incorporate additional critical design issues.
REQ1.4	Contextual	DSS should be extendable to cope with other development teams.
REQ1.5	Contextual	The user interface of the DSS must be in English.
REQ2.1	User	DSS should not become an extra administrative 'burden'.
REQ2.2	User	DSS should be able to incorporate the SCF stage gating Framework
REQ2.3	User	DSS should be able to keep track of progress and accountability of

		users.
REQ2.4	User	Certain critical design issues may be omitted setting them to 'Not Applicable'.
REQ2.5	User	The status of an actor activity should adhere to TomTom standards as used in the issue tracking system.
REQ2.6	User	A comment can be added to each actor activity
REQ3.1	Functional	The DSS model consists out of the following components: Decision Options, User Preferences, and Uncertainty Factor.
REQ3.2	Functional	The Uncertainty Factor is filled with the Assumptions made about the system.
REQ3.3	Functional	The user interface must be a website.
REQ3.4	Functional	The user must be able to create projects
REQ3.5	Functional	Each project should have a progress status indication
REQ3.6	Functional	The user must be able to assign features to this project
REQ3.7	Functional	Each feature should have a list of value activities
REQ3.8	Functional	Each value activity should have a list of actor activities
REQ3.9	Functional	Each actor activity should have a progress status indication
REQ3.10	Functional	Login functionality is required to access the DSS
REQ3.11	Functional	Each actor has a personalized view, but can also view the total overview.
REQ3.12	Functional	It should be possible to add a custom status message to an actor activity
REQ3.13	Functional	Links to external resources can be included to each actor and/or value activity.
REQ3.14	Functional	It should be possible to add additional actor activities, when the balancing activities are already started.
REQ3.15	Functional	A 'value activity' can be closed as a whole when it is balanced in one meeting, skipping the actor activities.
REQ3.16	Functional	An actor activity can also be created with a general role, instead of a specific person. This can be specified later during the balancing.

The main requirements as part of the 'User Preferences' DSS component is the increase of business model viability. To attain a higher viability a number of value activities to balance critical design issues are combined in a checklist.

The third research question is answered using semi structured interviews, in which first all relevant actors in the mapshop service platform landscape are mapped. These actors are all

internal actors within TomTom. The stakeholders list is limited to the balancing of critical design issues from the technology domain, as this is the initial scope of the thesis.

RQ3. Which stakeholders are currently involved or should be involved when balancing critical design issues from the technology domain?

The total set of actors within the mapshop service platform landscape is greater than is needed for the balancing of critical design issues from the technology domain. The actor landscape can serve as a starting point for inventarisation for other actors when trying to include critical design issues from other domains, such as services, organization and finance. The key actors needed for balancing the technological critical design issues are identified as the; business stakeholder, resource manager, information analyst, Software Product Manager, System Architect, Project Manager, Privacy Expert, TechOps Security, TechOps servers, and the TechOps monitoring department. These actors are identified from figure 8-2 as core actors that have a significant impact on business model viability as they are included in the balancing of critical design issues. Within the DSS design actors can be added on the fly when deemed necessary but the set stated above will be fixed into the DSS logic at this point in time.

[Figure removed in the public version of this thesis]

Figure 8-2 The resulting stakeholder landscape of the TomTom mapshop service platform.

The fourth research question is answered using a design approach based on Verschuren and Hartog (2005). The DSS specification is based on the findings of the previous research questions, and the challenging part was in creating a user interface. A compromise was made between a way of visualizing the DSS and the creation of clickable mockups. This user interface is called the prototype and was used for validation purposes.

RQ4. What is the business model DSS specification for use within the mapshop service platform roadmap process?

The DSS was specified using four steps; requirements and assumptions gathering, structural specifications, implementation guidelines and the creation of a prototype. The requirements were mostly gathered using the field research phase, additionally contextual and requirements from literature were added to the DSS design space.

The structural specification is as presented in figure 8-1, and is completely specified as indicated by the arrows. The stakeholder framework was used to specify the DSS 'Data' component, in which the results have been presented in figure 5-8 till 5-12. The DSS 'user interface' is the starting point from the user perspective, which consists out of three elements; the dashboard, a feature overview and the administration panel. Based on these elements the intended user, which is the Information Analyst, can manage the balancing activities required for each new feature development.

The implementation of the DSS within the roadmap process is given in figure 8-3. In order for the DSS specification to be implemented within TomTom the proposed DSS specification needs to be validated.

RQ5. What is the validity of the designed DSS for use within TomTom?

The validity of the proposed DSS solution is checked on four levels; the internal validity, the external validity, instantiation and generalization. The internal validity is a precondition for the DSS proposal to be externally valid as well. The main conclusion regarding the validity is that a second iteration is needed in the DSS design and proposal before implementation can go forward. There were a number of remarks that need additional processing to bring the DSS prototype a level further. The remarks made during the validation session are not processed into a new DSS proposal due to time constraints.

With the finishing of the validation session a final conclusion can be drawn of the main research question:

How to specify a fitting business model decision support system to assist TomTom in balancing critical design issues during new service development?

There are four main conclusions; (1) there is a need for a higher focus on service development within TomTom, (2) A DSS should aid in attaining a higher viability for new service concepts. (3) An initial DSS is proposed that is fitting and aids in attaining this goal. (4) Further validation and implementation steps are required in order for the DSS to live up to its value.

The need for an increased focus on profitable new service development becomes apparent as sales of personal navigation device are in a declining trend. And TomTom identified a high growth potential for the mapshop service platform for which new viable business models are needed that boost the mapshop service platform potential. All actors that have been interviewed underlined the need for new service development efforts.

The significance of services for TomTom raises the need for a decision support system that aids in balancing the critical design issues that concern the viability of new service concepts. A DSS should aid in attaining a higher viability for new service concepts.

An initial DSS is proposed that should be integrated into the TomTom roadmap process as displayed in figure 8-3. The proposal consists out of the DSS itself, implementation guidelines for management regarding the process, pointers on user training, technical development and technical deployment steps. The implementation guidelines are specific for management to guide them through the actual implementation of the DSS into the roadmap process. Part of implementation is a user training session and technical deployment. As the DSS is currently designed but technically not yet developed a number of recommendations have been given to aid in developing the decision support system.
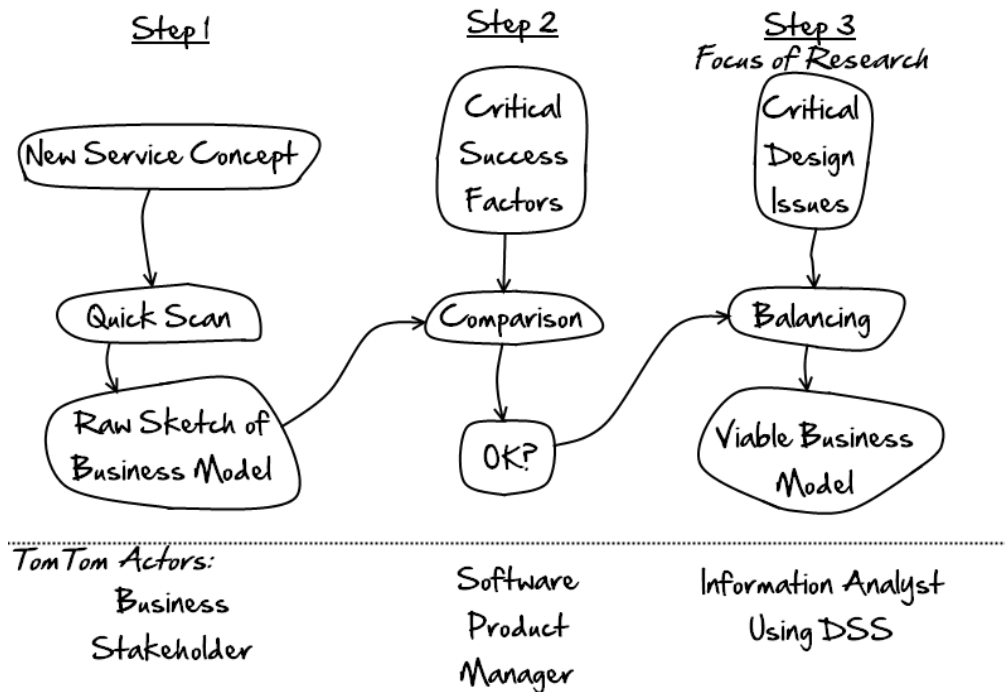
Figure 8-3 Positioning the DSS within the roadmap process.

The initially proposed DSS was validated using a group validation session in which actors were asked about the field research results, prototype and implementation steps. Important remarks were made which lead to the conclusion that another iteration of the DSS is needed in order to fully specify a DSS that should aid in attaining a higher business model viability.

8.2. Future Research

When trying to implement the DSS within TomTom it would be interesting to also support other critical design issues that were derived from the STOF model, namely from Service, Organization and Finance domain. Therefore this research can be broadened to also incorporate critical design issues that stem from other business model domains. It is also important to realize that these domains are interdependent and thus this research is lacking in balancing between these domains, future research should be able to integrate these different domains into a single DSS.

The VIP framework can benefit from a number of improvements as discussed in chapter one; (1) further analysis of operationalization, (2) empirical evaluation of the framework in a different environment, (3) and visualization of the conclusions of the VIP analysis. This thesis has addressed all three of these issues thereby contributing significantly to this framework and its use. The VIP framework is operationalized for use in the field research thereby contributing to the operationalization aspects. It was operationalized using four types of mapping; actors, objects, interactions and dependencies. The VIP stakeholder framework within this thesis is used as an intra-organizational tool, which turned out to be satisfactory for this research although the stakeholder framework is validated for inter organizational use only. Thereby the framework is evaluated in a different environment then its original scope. Further testing is necessary for VIP framework if it holds valid for internal stakeholder analysis, and the basis is set for trying to

create a stakeholder framework that both can include intra as inter organizational aspects. And the visualization techniques used in this paper can be used for other VIP stakeholder analysis too, and can serve as a starting point for an improvement in stakeholder mapping visualization techniques. However future research is necessary to further refine and clarify the raised shortcomings of the VIP stakeholder framework.

TomTom is operating in a dynamic setting and the DSS should be able to cope with this changing environment. Future research should look into an additional aspect of timeliness of DSS, the time aspect was not apparent in the theoretical search while trying to define the DSS concept and it was not apparent in the implementation phases. More research is needed in the iterative process of balancing the critical design issues and changing market environment; and how this can be handled within a DSS.

The research can also be broadened to include critical success factors into the DSS, even in the case of TomTom that would seem a worthwhile path of researching as of an initial glance the critical success factor list fits neatly into the roadmap process. However more research is necessary to include this into the DSS and to integrate it into the roadmap process.

The visualization techniques of the proposed DSS requires more research on how people want to use a DSS and how the DSS should be visualized in a way for optimum user experience.

8.3. Reflection

A lot of choices have been made during this project regarding the scope of the project, selected research methods and used literature. Together with the exciting time at TomTom a lot has been learned in the past few months. A critical reflection on the work so far together with personal learning points will give potential future researchers a helpful insight when making decisions of their own when starting a thesis project. I would like to address a number of issues I stumbled upon in different phases of this thesis, and will state how these were solved.

Much time was spent in the more conceptual phases of this thesis, as it proved very difficult to accurately pinpoint and phrase the problem TomTom was having. Once the problem was framed, a direction of research should be chosen; which is in turn a very iterative process on what step to specifically focus on. To give an example the research initially was started to look into critical success factors for the mapshop website, but by discussing with management and relevant stakeholders a choice was made to focus on a process improvement regarding the critical design issues. The main learning point is that a conceptual phase can take a long time, and that pro-active discussions are needed to give focus to the research. The iterative nature of defining the scope proved to be challenging but with each iteration the thesis project gained shape. Furthermore one can learn from books describing research methods as written by Verschuren and Doorewaard (2007) to guide in the thesis shaping process.

A case study is incomplete when the domain surrounding the case study is not defined. Chapter two specifically aimed at guiding the reader in understanding the main challenges TomTom is facing with its service offerings. Much information can be found on the internet, but sometimes it is better just to find the right person who is at home in the market. Luckily within TomTom there are a lot of people who know all the intricacies of the dynamic competitive ecosystem.

The literature phase was challenging as there is a lot of literature available which leads to an information overload, as all articles are interesting but not necessarily needed for the thesis. Again this is an iterative process in which clear choices need to be made, which stem from the problem statement and direction of solving. Eventually the decision was made in continuing with the methodology section, thereby continuously updating the literature section. The literature section is always being updated when new insights are gained during the project.

To specify a research methodology, in this case semi structured interviews, is important as this will have implications for the generalizability and future use of the project. The chosen research methods was based on the book by Verschuren and Doorewaard (2007), however looking back a questionnaire within TomTom could also have been used, thereby addressing a significant amount of people; making the DSS implementation directly possible.

The interviews that were conducted during the field research phase were sometimes unstructured. By conducting more interviews more information became available, leading to different insights in previous interviews. The validation session therefore is a solid way of making sure all relevant aspects are covered.

During the design phase a prototype was developed, and it was suggested early on that this prototype might 'steal' the focus of the actual DSS framework. As the prototype is just a simplified way of visualizing the DSS framework, it might bias people in the actual framework behind it. However the prototype in the form of clickable mockups made it really tangible for most people, which led to rich feedback.

Finally I hope that by answering the main research question the new business model viability at TomTom will be increased. And that the scientific community will benefit from the new insights gained during this thesis project.

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Appendix

Interview Questions

In table 0-1 the interview questions regarding research question two are depicted, and thereby form the operationalization of the VIP framework. The questions are divided among the different actors, 'M' stands for management, 'I' for Intended users and 'S' for stakeholder. By ordering the questioning in this fashion management and intended users interviews will serve as a rich foundation for starting the interviews with the stakeholders.

Table 0-1 Interview questions regarding research question 2

Component	Associated question(s)	M	I	S
DSS, the intended user	Who will use the DSS?	X		
VIP stakeholder framework pillar 1: Actors Actors, Information authorization and process unit boundaries	Who are the actors in the mapshop service platform landscape? What is the hierarchical structure between the actors? What are the teams? Who is able to authorize decisions?	X		
VIP stakeholder framework pillar 2: Objects Value objects, data objects, information objects, knowledge objects, business process behaviors	What role does each actor have? What is the data, information and knowledge each actor has? What value does each stakeholder role deliver?	X		
VIP stakeholder framework pillar 3: Interactions Value activities, value goals, information flow and business processes	What are the activities of each actor? What are the actor goals? What is the flow of the previously gathered information?	X		
VIP stakeholder framework pillar 4: Dependencies Value dependencies, trust dependencies and business process dependencies	What are the deliverables you need to have in order to operate? What deliverables do you need to generate to other stakeholders, for them to operate?		X	X

		M	I	S
DSS requirements	What are the requirements of the DSS?		X	X
	What are the expectations?			

The interview questions to answer research question 3 are depicted in table 0-2, and are only asked to the intended users and stakeholders. These questions won't be asked to technical management as they are not in the role of handling with critical design issues.

Table 0-2 Interview questions regarding research question 3

Component(s)	Question	M	I	S
Critical Design Issues	What are typical critical design issues that you have for the service platform? What deliverables do you need to generate to address these CDI's?		X	X
Critical Design Issues	Are there currently any stakeholders particularly associated with these CDI's? If yes, which stakeholders are associated with the CDI's? If not, which stakeholders should be associated with the CDI's?		X	X

Table of Actor Roles and Objects

Table 0-3 Actor roles, data, information, knowledge and value.

[Table removed in the public version of this thesis]