

Intertwined Development of Business Model and Product Functions for Mobile Applications: A Twin Peak Feature Modeling Approach*

- Technical Report -

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Abstract. Mobile app stores like Apple’s AppStore or Google’s PlayStore are highly competitive markets for third-party developers wanting to develop successful applications. During the development process, many developers focus on the multitude of product functions but neglect the business model as an equally important part. This, in turn, raises the question of how we intertwine the business model and product functions during the development process to ensure a better alignment between the two. In our paper, we show this intertwined development by adapting the concept of Twin Peaks to the business model and product functions. Based on feature modeling as an abstraction layer, we introduce the concept of a Business Model Decision Line (BMDL) to structure the business model decisions and their relation to product functions structured in a Software Product Line (SPL). The basis of our feature models is the analysis of top listed applications in the app stores of Apple and Google. To create and modify both models, we provide an incremental feature structuring and iterative feature selection process.

In this technical report, we show the intermediate domain engineering steps of our BMDL and SPL together with detailed decision options. Moreover, we explain the building blocks of the BMDL which are missing in our research paper and show their validity based on streaming applications.

Keywords: Intertwined Development · Twin Peaks · Feature Model · Business Model · Product Functions

1 Introduction

Mobile app stores like Apple’s AppStore or Google’s PlayStore are highly competitive markets for third-party developers wanting to develop successful applications. During the development process, many developers focus on the multitude

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of product functions but neglect the business model as an equally important part. As a result, developers often fail to meet customer needs, leading to unnecessary development costs and poor market penetration. This, in turn, raises the question of how we intertwine the business model and product functions during the development process to ensure a better alignment between the two.

In our paper, we show this intertwined development by adapting the concept of Twin Peaks [11] to the business model and product functions. Based on feature modeling as an abstraction layer, we introduce the concept of a Business Model Decision Line (BMDL) to structure the business model decisions and their relation to product functions structured in a Software Product Line (SPL). The basis of our feature models is the analysis of top listed applications in the app stores of Apple and Google. To create and modify both models, we provide an incremental feature structuring and iterative feature selection process. This combination of abstraction layer and development process supports third-party developers to build successful applications both from a business and a product perspective.

In this technical report, we show the three intermediate domain engineering steps (Study Existing Material, Analyse Existing Applications, Abstract Existing Features) of our BMDL and SPL together with detailed decision options. Moreover, we explain the building blocks of the BMDL which are missing in our paper [4] (Key Partners, Key Activities, Key Resources, Cost Structures) and show their validity based on streaming applications.

In the following, Section 2 describes our detailed research approach to derive the BDML and the SPL. Section 3 shows our Business Model Decision Line with the missing explanations, which validity is shown by concrete examples in Section 4. Finally, in the Appendix, we list our analyzed mobile applications of Apple’s AppStore and Google’s PlayStore.

2 Research Approach

In the paper, we show the development of the business model and product functions based on feature models as an abstraction layer. For the feature models, we need to perform a domain engineering to collect the main features of mobile applications. This initial comprehensive set of features can be extended by the third-party developer to customize the feature models for his application.

For domain engineering, we are using a 3-step extraction method based on a taxonomy development method by Nickerson et al. [10]. The method of Nickerson can be used to classify objects based on their common characteristics. We model each business model decision and product function as a characteristic of a mobile application. To use the method, we need to define meta-characteristics and ending conditions together with empirical-to-conceptual and conceptual-to-empirical iteration steps.

The meta-characteristics are the most comprehensive characteristics that can be used as the basis for the choices in the taxonomy. Based on this meta-characteristics, we are running combinations of empirical-to-conceptual and

conceptual-to-empirical iterations. After each iteration, the taxonomy is checked against objective and subjective ending conditions. While objective ending conditions can be assessed, subjective ending conditions leave space for interpretation.

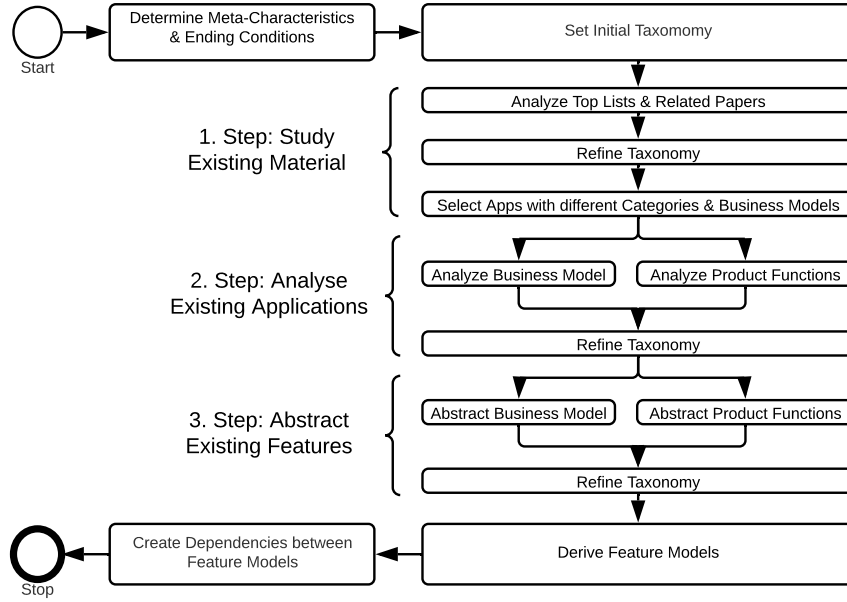


Fig. 1. Creation Process of the Feature Models

The creation process of the feature models can be seen in Figure 1. It consists of the initialization of the process, followed by three execution steps (Study, Analyse, Abstract / see next sections) and ends with the deriving of the feature models and the creation of the dependencies.

At the beginning of the process, we need to define the overall meta-characteristics together with the ending conditions. To model the business model decisions we are using the nine building blocks of the Business Model Canvas [12] as the most-comprehensive characteristics. We refine these blocks by the categories of the book Business Model Generation [12] to support the information extraction process. The objective ending conditions are the examination of all selected applications and papers for the corresponding execution step. As subjective conditions, we want to create an appropriate and cross-application usable model that be easily extended in terms of a reactive software product line.

At the end of the process, we derive the feature models of the business model decisions and the product functions. Based on that, we create dependencies between these models. The result of the process is the BMDL and the corresponding SPL for the domain of mobile applications.

2.1 First Step: Study Existing Material

In the first step, we get an overview of different types of apps and their business model. The step can be divided into the substeps of analyzing the top lists and related papers, the refinement of the taxonomy and the selection of apps with different categories and business models.

Analyze Top Lists & Related Papers In the first substep, we analyze the top listed applications of mobile ecosystems and related papers. Within the conceptual-to-empirical iteration, we analyze selected literature [1,3,5,7-9,13,14] from a literature search by Jazayeri et al. [6]. In their literature review, Jazayeri et al. discover the features of IT Service Markets. One of the extracted features is the business model which related paper we have inspected. After that, we selected the papers which we found relevant for the business model of the third-party developers. In the empirical-to-conceptual iteration, we look at the information of 150 apps from the top lists of Apple’s AppStore and Google’s Play Store. On the 11th February 2019, we discovered the 25 top free, top paid and top grossing applications, which are shown in Appendix A of this report. After the elimination of duplications, there were 126 applications left, which content in the store we have analyzed. The combined result of the conceptual-to-empirical and the empirical-to-conceptual iterations can be found in Figure 2.

Refine Taxonomy In the second substep, we refine the taxonomy of the business model decisions. Here, we change the previous structure of the book Business Model Generation [12] for the building blocks of Key Activities, Key Resources, and Key Partners because the predefined categories (e.g. Human & Financial in Key Resources) did not match to the requirements for the business models of third-party developers. Moreover, we divided the Cost Structures into the cost fields (e.g. Development, Support) instead of the costs structures (e.g. Fixed Costs, Variable Costs). The refined result can be seen in Figure 3.

Select Apps with different Categories & Business Models In the third substep, we group the applications to different categories to analyze the business model of an expressive subset. By analyzing the content of the 126 applications, we found the six categories of Messengers, Social Networks, Streaming Services, Trading Services, Information Services, and Games. In Table 1, we have sorted the identifier (see Appendix A for corresponding applications) of the applications into the categories.

After the sorting, we choose a subset of three applications out of every category, whose have major differences in their business model:

- **Messengers:** For the messengers, we choose the Facebook Messenger [GF1], WhatsApp [GF8] and SnapChat [GF10]. While the Facebook Messenger is bundled with the Facebook App and uses Advertisements as a revenue stream, WhatsApp and SnapChat use different revenue streams (e.g. Chatbots, Filter Advertisement).

<p>Key Partners</p> <ul style="list-style-type: none"> - Strategic Alliances - Advertisement Partner - Manufacturing Partner - Infrastructure Provider - Payment Provider - Content Provider - Store Provider - Cooperation - Joint Venture - Buyer-Supplier 	<p>Key Activities</p> <ul style="list-style-type: none"> - Production - Develop Hardware - Develop Software - Produce Content - Platform / Network - Negotiate Licenses - Manage Infrastructure - Plan Marketing - Support Customer - Problem Solving <p>Key Resources</p> <ul style="list-style-type: none"> - Physical - Infrastructure - License Agreement - Developer License - Content - Brands - Intellectual - Human - Financial 	<p>Value Propositions</p> <ul style="list-style-type: none"> - Newness - Performance - Customization - Customization for own Needs - Design - Price - Low Price - Money-Back Guarantee - Task Support - Cost Reduction - Risk Reduction - Accessibility - Privacy - Anonymous Usage - Personalized Experience - Convenience / Usability - Frictionless User Experience - Multi-Sided-Market - Quantity of other User Side - Quality of other User Side 	<p>Customer Relationships</p> <ul style="list-style-type: none"> - Customer Acquisition - Advertisement - App Addon - Customer Retention - Locked-In - Big Customer Base - Leveling - Direct Feedback Mechanism - Boosting Sales <p>Channels</p> <ul style="list-style-type: none"> - Awareness - Evaluation - Positive Ratings & Reviews - Freemium - Purchase - In-Store - Out of Store 	<p>Customer Segments</p> <ul style="list-style-type: none"> - Mass Market - Niche-Market - Segmented - Gamer - Singles - Young People - Diversified - Multi-Sided Market - Social Networks - Content Creator - Content Consumer - Marketplace - Buyer - Seller 	<p>Revenue Streams</p> <ul style="list-style-type: none"> - Asset Sales - Hardware Addons - Preorders - App - In-App - Remove Ads - Additional Features - User Information - Brokerage Fees - Transaction Fee 	<p>Cost Structures</p> <ul style="list-style-type: none"> - Fixed Costs - Software Development - Hardware Development - Developer License - Variable Costs - Customer Support - Infrastructure Administration - Marketing Planning 	<p>Revenue Streams</p> <ul style="list-style-type: none"> - Usage Fee - Advertising - In-App-Advertisement - Subscription Fees - Membership - Advanced Features - Lending / Renting / Leasing - Licensing - Donations
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Fig. 2. Business Model of the first Iteration Step

Key Partners <ul style="list-style-type: none"> - Advertisement Partner - Manufacturing Partner - Infrastructure Provider - Payment Provider - Content Provider - Store Provider 	Key Activities <ul style="list-style-type: none"> - Develop Hardware - Develop Software - Negotiate Licenses - Manage Infrastructure - Produce Content - Plan Marketing Campaigns - Support Customer 	Value Propositions <ul style="list-style-type: none"> - Newness - Performance - Customization - Customization for own Needs - Design - Price - Low Price - Money-Back Guarantee - Task Support - Cost Reduction - Risk Reduction - Accessibility - Privacy - Anonymous Usage - Personalized Experience - Convenience / Usability - Frictionless User Experience - Multi-Sided-Market - Quantity of other User Side - Quality of other User Side 	Customer Relationships <ul style="list-style-type: none"> - Customer Acquisition - Advertisement - App Addon - Customer Retention - Locked-In - Big Customer Base - Leveling - Direct Feedback Mechanism - Boosting Sales 	Customer Segments <ul style="list-style-type: none"> - Mass Market - Niche-Market - Target Group - Gamer - Singles - Young People - Multi-Sided Market - Social Networks - Content Creator - Content Consumer - Marketplace - Buyer - Seller
Key Resources <ul style="list-style-type: none"> - Infrastructure - License Agreements - Brands - Content - Developer License - Content - Brands 	Revenue Streams <ul style="list-style-type: none"> - Advertisement - In-App-Advertisement - Brokerage - Transaction Fee - Donation - Subscription - Membership - Advanced Features 	Channels <ul style="list-style-type: none"> - Awareness - Evaluation - Positive Ratings & Reviews - Freemium - Purchase - In-Store - Out of Store 	<ul style="list-style-type: none"> - Delivery - In-Store - Out-Of-Store - After Sales - Regular Updates 	Cost Structures <ul style="list-style-type: none"> - Customer Support - Development - Software - Hardware - Infrastructure - Management - Provision
<ul style="list-style-type: none"> - License Agreements - Brands - Content - Developer License - Marketing Campaign Costs - Production - Hardware - Content 	<ul style="list-style-type: none"> - Sale - Hardware Addons - Preorders - App - InApp - Remove Ads - Additional Features 			

Fig. 3. Refined Business Model of the first Iteration Step

Table 1. Categorization of the Mobile Applications

Category	Identifier of the Mobile Applications
Messengers	[GF1], [GF8], [GF10], [AF19]
Social Networks	[GF3], [GF6], [GF13], [GG1], [AG17]
Streaming Services	[GF7], [GF12], [GF13], [GF20], [GF21], [GP23]
Trading Services	[GF15], [AF22], [AF23]
Information Services	[GF5], [GP4], [GP5], [GP6], [GP9], [GP10], [GP12], [GP14], [GP15], [GP17], [GP18], [GG4], [AF10], [AF13], [AP5], [AP6], [AP8], [AP9], [AP20]
Games	[GF2], [GF4], [GF9], [GF11], [GF16], [GF17], [GF18], [GF19], [GF22], [GF23], [GF24], [GF25], [GP1], [GP2], [GP3], [GP7], [GP8], [GP11], [GP13], [GP19], [GP20], [GP21], [GP22], [GP24], [GP25], [GG2], [GG3], [GG5], [GG6], [GG7], [GG8], [GG9], [GG10], [GG11], [GG13], [GG14], [GG15], [GG16], [GG17], [GG18], [GG19], [GG20], [GG21], [GG22], [GG23], [GG24], [AF2], [AF3], [AF8], [AF9], [AF12], [AF14], [AF16], [AF18], [AF20], [AF21], [AP1], [AP2], [AP3], [AP4], [AP7], [AP10], [AP11], [AP13], [AP14], [AP15], [AP16], [AP18], [AP19], [AP21], [AP22], [AP23], [AP24], [AP25], [AG2], [AG5], [AG6], [AG11], [AG13], [AG15], [AG16], [AG18], [AG19], [AG20], [AG21], [AG22], [AG23], [AG24], [AG25]

- **Social Networks:** For social networks, we choose Tinder [GG1], TikToc [GF3] and LinkedIn [AG17]. Tinder sells premium features and has singles as a specialized target group. TikToc sells coins as In-App-Currency and focuses on a young target group. LinkedIn sells different premium subscriptions and focuses on professionals as a target group.
- **Streaming Services:** For streaming services, we choose Netflix [GF7], YouTube [GF20] and Spotify [GF13]. Netflix has a subscription model and uses exclusive content as a key resource for their business. YouTube is a Two-Sided-Market with content creators and content consumers. Spotify divides between free and paid accounts.
- **Trading Services:** For the trading services, we choose UBER [AF23], Amazon [AF22] and Let’s Go [GF15]. UBER is a Two-Sided-Market for drivers and their guests, which transfers their payments outside the ecosystem to avoid store provider fees. Amazon is an additional application for Amazons marketplace and receives payments by selling products and mediating sales. Let’s Go is a C2C marketplace for used products which receives revenue by selling premium functions.
- **Information Services:** For information services, we choose Google Maps [AF10], Weather Pro [GP12] and Human Anatomy Atlas [AP5]. Google Maps is a free app that aggregates different information about locations. Weather

Pro is a paid app for weather information. Human Anatomy Atlas is a paid app for education content which offers additional In-App Purchases.

- **Games:** For games, we choose Fortnite [AF9], Bloons TD 6 [AP7] and Bumper.io [AF8]. Fortnite uses strong branding for mouth-to-mouth marketing and In-App-Purchases as a revenue stream. Bloons TD 6 is a paid app with additional In-App-Purchases. Bumper.io is a free game with advertisements which can be removed with an In-App-Payment.

2.2 Second Step: Analyse Existing Applications

In the second step, we conduct a deeper analysis of the product functions of the selected apps and their business models. The step can be divided into the substeps of analyzing the business model and product functions of existing applications and the refinement of the taxonomy.

Analyse Business Model & Product Functions In the first substep, we analyze the business model decisions and product functions using a conceptual-to-empirical and a empirical-to-conceptual iteration. In the conceptual-to-empirical iteration (C2E), we review literature (papers, analyses, news articles), which we obtain using Google Search. Within the empirical-to-conceptual iteration (E2C), we execute the selected apps and analyze their business model. To support the analysis we use the St. Gallen Business Model Navigator [2]. The analyzed features of the business models are shown in Table 2, 3 and 4.

The results of this step are the extended business model taxonomy without value propositions in Figure 4 and the product functions and value propositions of the different categories in Figure 6.

Refine Taxonomy In the second substep, we refine the taxonomy of the business model decisions. Here, we change the categorization of Customer Segments by introducing the Interaction Type and the Market Size. Moreover, we group the Customer Relationships of Ranking and Leveling into Gamification. The refined result can be seen in Figure 6.

2.3 Third Step: Abstract Existing Features

In the third step, we abstract the business model decisions and product functions to create a domain model for our taxonomy. The step can be divided into the substeps of abstracting the business model and product functions and the refinement of the taxonomy.

Abstract Business Model & Product Functions In the first substep, we abstract the product functions of the different application to a domain model. Moreover, we derive the generalized value propositions from the existing value propositions of the first step and the discovered value propositions of the second step. The product functions and value propositions can be found in Figure 7.

<p>Key Partners</p> <ul style="list-style-type: none"> - Advertisement Partner - App Developer - Manufacturing Partner - Infrastructure Provider - Payment Provider - Content Provider - Store Provider 	<p>Key Activities</p> <ul style="list-style-type: none"> - Develop Hardware - Develop Software - Negotiate Licenses - Manage Infrastructure - Produce Content - Plan Marketing - Support Customer 	<p>Customer Relationships</p> <ul style="list-style-type: none"> - Customer Acquisition - 3rd-Party-Integration - Advertisement - Coupons - Single Sign-On - App Addon - Customer Retention - Locked-In - Big Customer Base - Leveling 	<p>Customer Segments</p> <ul style="list-style-type: none"> - Mass Market - Content Consumer - Niche-Market - Content Consumer - Target Group - Gamer - Singles - Young People - Multi-Sided Market - Social Networks - Content Creator - Content Consumer - Marketplace - Buyer - Seller - User Type - Private User - Professional User
<p>Key Resources</p> <ul style="list-style-type: none"> - Algorithms - Brands - Content - Infrastructure - License Agreements - Developer License - Content - Brands - Patents 	<p>Channels</p> <ul style="list-style-type: none"> - Awareness - Distributable Codes - Store Position - Word-of-Mouth - Evaluation - Positive Ratings & Reviews - Freemium - Purchase - In-Store - Out of Store 	<p>Revenue Streams</p> <ul style="list-style-type: none"> - Advertisement - In-App-Advertisement - Brokerage - Transaction Fee - Payment Fee - Donation - Subscription - Membership - Advanced Features 	<p>Revenue Streams</p> <ul style="list-style-type: none"> - Sale - Hardware Addons - Preorders - App - In-App - Remove Ads - Additional Features
<p>Cost Structures</p> <ul style="list-style-type: none"> - Customer Support - Development - Software - Hardware - Infrastructure - Management - Provision - Licenses - Developer License - Content Brands 	<p>License Agreements</p> <ul style="list-style-type: none"> - Brands - Content - Developer License - Marketing Campaign Costs - Production - Hardware - Content 		

Fig. 4. Business Model of the second Iteration Step

Messengers	Social Networks	Streaming Services	Trading Services	Information Services	Games
Product Functions - User Management -- Register -- Reset Password -- Login -- Logout - User Interaction -- Messages -- Contacts -- Status -- Profiles	Product Functions - User Management -- Register -- Reset Password -- Login -- Logout - User Interaction -- Messages -- Profiles -- Friendships - Content View -- Search - Content -- Rate -- Comment -- Add -- Edit -- Delete	Product Functions - User Management -- Register -- Reset Password -- Login -- Logout - Streaming View -- Highlights -- Recommendations -- Categories - Stream -- Watch -- Rate -- Comment	Product Functions - User Management -- Register -- Reset Password -- Login -- Logout - Marketplace -- Categories -- Search - Product - Buy - Sell - Rate - Review	Product Functions - Information View - Categories - Locations - Filter - Search - Information - View	Product Functions - User Management -- Register -- Reset Password -- Login -- Logout - Information -- Ranking -- Settings - Interaction -- Game -- Upgrades
Value Propositions - Endless Contacts - Share Everything - Smooth Integration	Value Propositions - Get in Contact - Stay in Contact - Share Moments	Value Propositions - Access Unlimited Content - Cancel Anytime - Explore Personalized Experience	Value Propositions - Anything, Anytime, Anywhere - Reduce Shopping Costs - Increase Shopping Convenience	Value Propositions - All Information in One Place - Get Informed in Real-Time - Educate Yourself	Value Propositions - Play with Friends - Challenge Yourself - Endless Playing Time

Fig. 5. Product Functions of the second Iteration Step

<p>Key Partners</p> <ul style="list-style-type: none"> - Advertisement Partner - App Developer - Manufacturing Partner - Infrastructure Provider - Payment Provider - Content Provider - Store Provider 	<p>Key Activities</p> <ul style="list-style-type: none"> - Develop Hardware - Develop Software - Negotiate Licenses - Manage Infrastructure - Produce Content - Plan Marketing - Support Customer 	<p>Customer Relationships</p> <ul style="list-style-type: none"> - Customer Acquisition - 3rd-Party-Integration - Advertisement - Coupons - Single Sign-On - App Addon - Customer Retention - Locked-In - Big Customer Base - Big Content Base 	<p>Customer Segments</p> <ul style="list-style-type: none"> - Interaction Type - Single-User - Content Consumer - Single-Sided Market - Content Consumer - Multi-Sided Market - Social Networks - Content Creator - Content Consumer - Marketplace - Buyer - Seller - Market Size - Niche Market - Mass Market - Target Group - Gamer - Singles - Young People - User Type - Private User - Professional User
<p>Cost Structures</p> <ul style="list-style-type: none"> - Customer Support - Development - Software - Hardware - Infrastructure - Management - Provision - License Agreements - Developer License - Content Brands 	<p>Key Resources</p> <ul style="list-style-type: none"> - Algorithms - Brands - Content - Infrastructure - License Agreements - Developer License - Content - Brands - Patents 	<p>Channels</p> <ul style="list-style-type: none"> - Awareness - Distributable Codes - Store Position - Word-of-Mouth - Evaluation - Positive Ratings & Reviews - Freemium - Purchase - In-Store - Out of Store 	<p>Revenue Streams</p> <ul style="list-style-type: none"> - Advertisement - In-App-Advertisement - Brokerage - Transaction Fee - Payment Fee - Donation - Subscription - Membership - Advanced Features
<p>Customer Relationships</p> <ul style="list-style-type: none"> - Gamification - Leveling - Ranking - Self-Service - Direct-Feedback-Mecha. - Boosting Sales - Forced Stop 		<p>Revenue Streams</p> <ul style="list-style-type: none"> - Sale - Hardware Addons - Preorders - App - In-App - Remove Ads - Additional Features 	

Fig. 6. Refined Business Model of the second Iteration Step

Table 2. Business Model Decisions of Analyzed Applications: Part 1

Messenger	
Facebook Messenger	- Revenue Streams: Payment Transactions (via C2E: https://www.feedough.com/facebook-business-model-makes-money/) - Value Propositions: Endless Contacts (via E2C)
WhatsApp	- Value Propositions: Smooth Integration (via C2E: https://alejandrorioja.com/blog/how-does-whatsapp-make-money/) - Value Propositions: Save Privacy (via C2E: https://www.whatsapp.com/security/) - Value Propositions: Share Everything (via E2C)
SnapChat	- Key Resources: Patents (via C2E: https://techcrunch.com/2014/06/22/facebook-slingshot-snapchat-patents/)
Social Networks	
Tinder	- Customer Segments: Singles (via E2C) - Value Propositions: Get in Contact with Strangers (via C2E: https://medium.com/@monalisapaul.88268/tinder-business-model-how-does-tinder-make-money-498659f3f7cc) - Channels: Word-of-Mouth (via C2E: https://medium.com/the-mission/how-tinder-obtained-more-than-50-million-users-through-word-of-mouth-5d6105d24280) - Customer Relationships: Gamification (via C2E: http://alvomeia.com/5-marketing-lessons-from-tinder-app/) - Customer Relationships: Single Sign-On (via E2C)
TikToc	- Value Propositions: Share Moments (via E2C) - Customer Segments: Young People (via E2C)
LinkedIn	- Value Propositions: Stay in Contact (via E2C) - Customer Segments: User Type (via E2C)

Refine Taxonomy In the second substep, we refine the taxonomy of the business model decisions and product functions. Here, we choose a hierarchy level of three to get domain models for describing the structure of the business model decisions and product functions. The refined results can be seen in Figure 8 and 9.

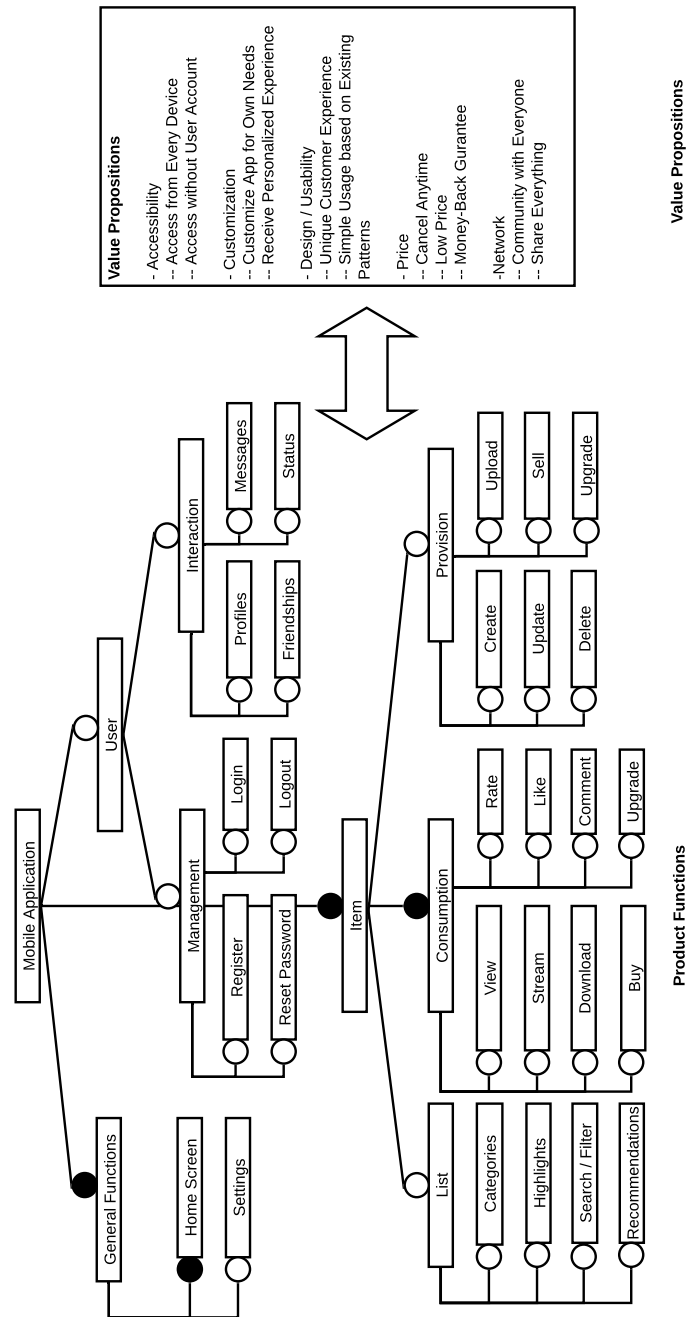


Fig. 7. Product Feature Model and Value Propositions

Table 3. Business Model Decisions of Analyzed Applications: Part 2

Streaming Services	
Netflix	- Value Propositions: Unlimited Content Access (via E2C) - Value Propositions: Available on Every Device - Customer Relationships: Self-Service (via C2E: https://www.businessmodelsinc.com/exponential-business-model/netflix/) - Key Resources: Algorithms (via C2E: https://www.businessmodelsinc.com/exponential-business-model/netflix/)
YouTube	- Value Propositions: Personalized Experience (via E2C) - Channels: Push Notifications (via E2C)
Spotify	- Customer Relationships: 3rd-Party-Integration (via C2E: https://support.spotify.com/us/account_payment_help/privacy/revoke-access-from-3rd-party-app/) - Key Partners: App Developer (via E2C)
Trading Services	
Uber	- Value Propositions: Reduce Costs (via E2C) - Channels: Coupons (via E2C) - Customer Relationships: Customer Support (via C2E: https://jungleworks.com/uber-business-model-revenue-insights/)
Amazon	- Value Propositions: Shop Convenient (via E2C)
Let's Go	- Value Propositions: Reduce Complexity (via C2E: https://www.feedough.com/letgo-business-model-how-does-letgo-make-money/)

Table 4. Business Model Decisions of Analyzed Applications: Part 3

Information Services	
Google Maps	- Value Propositions: All Information in One Place (via E2C)
Weather Pro	- Value Propositions: Get Informed in Real-Time (via E2C)
Human Anatomy Atlas	- Value Propositions: Educate Yourself (via E2C)
Games	
Fortnite	- Value Propositions: Play with Friends (via E2C) - Customer Relationships: Ranking (via C2E: https://medium.com/@RyanCropp/the-genius-of-fornites-business-strategy-94a174995ebe)
Bloons TD 6	- Value Propositions: Challenge Yourself (via E2C)
Bumper.io	- Value Propositions: Endless Playing Time (via E2C)

3 Business Model & Product Functions

In this section, we present the Business Model Decision Line (BMDL) together with the Software Product Line (SPL).

3.1 Business Model Decision Line

The canvas representation of the business model decisions can be seen in Figure 8. As a structure, we are using the Business Model Canvas, which consists of nine building blocks. In this technical report, we are describing the Key Partners, Key Activities, Key Resources, and Cost Structures. The Value Propositions, Customer Relationships, Customer Segments, Channels, and Revenue Streams are described in our paper [4].

Key Partners - Advertisement Partner - App Developer - Content Provider - Infrastructure Provider - Manufacturing Provider - Payment Provider - Store Provider	Key Activities - Develop Hard- & Software - Negotiate Licenses - Manage Infrastruct. - Produce Content - Plan Marketing Cam. - Support Customer Key Resources - Algorithms - Brands - Content - Developer License - Infrastructure - Patents	Value Propositions - Accessibility - Customization - Design / Usability - Price - Network	Customer Relationships - Customer Aquisition - Customer Retention - Boosting Sales Channels - Awareness - Evaluation - Purchase - Delivery - After Sales	Customer Segments - Interaction Type - Market Size - Target Group - User Type
Cost Structures - Development - Infrastructure - Licenses - Marketing - Production - Support		Revenue Streams - Advertisement - Brokerage - Donation - Sale - Subscription		

Fig. 8. Business Model Decisions for the Third-Party Developer

To support the value creation process the developer need work with different **Key Partners**. The most important partner is the *Store Provider*, which provides a developer license and the mobile ecosystem. Moreover, the developer can use partners for placing advertisements in the application (called *Advertisement Partner*), provide some content (called *Content Partner*) or process payments aside from the store (called *Payment Provider*). Also, the provision of the infrastructure (called *Infrastructure Provider*) or the manufacturing of additional hardware (called *Manufacturing Partner*) can be outsourced to these partners. The last partners are other *App Developer*, which can extend the product functions of the own application.

The **Key Activities** are used to describe the most important tasks of the developer. This is the development of hard- and software together with the managing of the infrastructure. Moreover, the developer needs to negotiate licenses for different resources like the developer program or content. This content can also be created directly by the developer. To attract new customer the developer needs also to plan marketing campaigns and support the customer to maintain the relationship.

The **Key Resources** are the most crucial resources which are needed to perform the value creation. The most important resource is the *Developer License* [9] which is needed to publish own applications within the store of the ecosystem. From a technical perspective *Algorithms* and *Patents* can be used to create a competitive advantage against other third-party developers. From a business perspective, this competitive advantage can also created through the usage of exclusive *Brands* or *Content* [3]. The last point is the *Infrastructure* which a developer can use for his applications. This infrastructure is crucial especially for applications with high user interaction like social networks.

The **Cost Structures** displays the different costs a developer can have to provide his application. From a technical point of view he needs money for the *Development* of the app and the providing of the *Infrastructure*. From the business perspective, additional money can be needed for the *Production* of content and hardware. For his competitive advantage, it might be necessary to close *Licenses* for key resources. To acquire new customers he needs money for *Marketing* [7] and a customer *Support* [3] to maintain the relationships.

3.2 Software Product Line

The SPL of the product functions can be seen in Figure 9. The SPL is described within our paper [4].

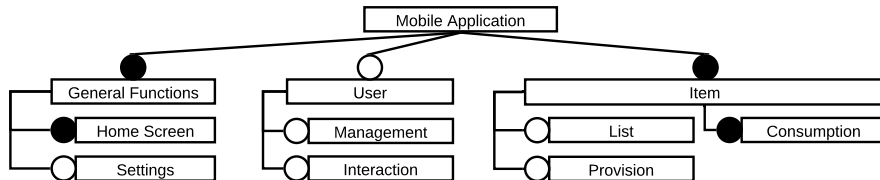


Fig. 9. Product Functions of Mobile Applications

4 Describing existing Mobile Applications with Feature Modeling

To show the validity of our approach, we provide concrete instances of the BMDL and the SPL for the streaming applications of Netflix, YouTube, and Spotify. For the BMDL, we show in Table 5 the instances of the Key Partners (KP), Key Activities (KA), Key Resources (KS) and Costs Structures (Co). The Value Propositions (VP), Customer Segments (CS), Channels (Ch) and Revenue Streams (RS) are shown, together with the corresponding instances of the SPL, in our paper [4].

Table 5. Describing the Streaming Apps based on the BMDL

Block	Decision	Netflix	YouTube	Spotify
KP	Advertisement Partner	-	Usage of In-App-Ads for Customer with Free Account	Usage of In-App-Ads for Customer with Free Account
KP	App Developer	No SDK	App Developer for SDK Integration	App Developer for SDK Integration
KP	Content Provider	Movie Studios, Production Partner	Movie Studios, Content-Creators	Record Labels, Independent Musicians
KP	Infrastructure Provider	Amazon AWS	Google Cloud Platform (Same Company)	Google Cloud Platform
KP	Manufacturing Provider	-		
KP	Payment Provider	Own Payment Provider additional to Store Provider		
KP	Store Provider	Partner for Developer License and Store Publishing		
KR	Algorithms	Different Algorithms for Personalized Recommendations		
KR	Brands	Own Brands for Netflix Originals	Own Brands for YouTube Originals	Own Brands for Podcasts
KR	Developer License	Developer License is necessary for Store Publishing		
KR	Content	Netflix Originals, Licensed Content	YouTube Originals, Content from Content-Creators	Exclusive Rights for some Podcast, Music Licenses
KR	Infrastructure	External Infrastructure	Internal Infrastructure	External Infrastructure
KR	Patents	Patents for different Product Functions		
KA	Develop	Development of Mobile Application		
KA	Negotiate	Negotiations for Content		
KA	Manage	Managing of Infrastructure		
KA	Produce	Production of own Content		
KA	Plan	Plan Marketing Campaigns		
KA	Support	Support Customer		
Co	Development	Development of Mobile Application		
Co	Infrastructure	Managing and Provision of Infrastructure		
Co	Licenses	Licensing of Content and Developer Account		
Co	Marketing	Marketing and Customer Acquisition Costs		
Co	Production	Production of Content		
Co	Support	Support of Customer		

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Appendix A List of Analyzed Apps

In this appendix, we list the mobile applications which we have discovered for our Business Model Decision Line (BMDL) and the corresponding Software Product Line (SPL). The initial list access was on 11th February 2019. The applications can be accessed with the following link structure:

- **Google’s PlayStore:** <https://play.google.com/store/apps/details?id={App Identifier}>
- **Apple’s AppStore:** <https://itunes.apple.com/us/app/{App Identifier}>

Appendix A.1 Google's PlayStore

In this appendix, we list the analyzed mobile applications of Google's PlayStore. Our analysis consists of the top free (see Table 6), top paid (see Table 7) and top grossing (see Table 8) applications.

Table 6. Top25 of Free Apps at Google's PlayStore

Identifier	App	App Identifier
GF1	Messenger – Text and Video Chat for Free	com.facebook.orca
GF2	Color Bump 3D	com.colorup.game
GF3	TikTok	com.zhiliaoapp.musically
GF4	PaintPop 3D	com.magjg.roundhit
GF5	HOOKED – Chat Stories	tv.telepathic.hooked
GF6	Instagram	com.instagram.android
GF7	Netflix	com.netflix.mediaclient
GF8	WhatsApp Messenger	com.whatsapp
GF9	Grass Out	com.fullfat.bw
GF10	SnapChat	com.snapchat.android
GF11	Words Story – Addictive Word Game	com.word.game.fun.puzzle.prison.escape.captain
GF12	Pandora Music	com.pandora.android
GF13	Spotify – Music and Podcasts	com.spotify.music
GF14	Facebook	com.facebook.katana
GF15	letgo: Buy & Sell Used Stuff, Cars & Real Estate	com.abtnprojects.ambatana
GF16	Tomb of the Mask	com.playgendary.tom
GF17	Crowd City	io.voodoo.crowdcity
GF18	Roblox	com.roblox.client
GF19	BitLife	com.candywriter.bitlife
GF20	YouTube Music - Stream Songs & Music Videos	com.google.android.apps.youtube.music
GF21	Hulu: Stream TV, Movies & more	com.hulu.plus
GF22	Homescapes	com.playrix.homescapes
GF23	Paper.io 2	io.voodoo.paper2
GF24	Pixel Art: Color by Number, Pixel Color(Pixel Pop)	com.bongolight.pixelcoloring
GF25	Google Play Games	com.google.android.play.games

Table 7. Top25 of Paid Apps at Google's PlayStore

Identifier	App	App Identifier
GP1	Stardew Valley	com.chucklefish.stardewvalley
GP2	Minecraft	com.mojang.minecraftpe
GP3	Wordfeud	com.hbwares.wordfeud.full
GP4	Ski Tracks	com.corecoders.skitracks
GP5	Baby Monitor 3G	com.tappytaps.android.babymonitor3g
GP6	Oei, ik groei!	com.domustechnica.oig10ad
GP7	Mini Metro	nz.co.codepoint.minimetro
GP8	Evoland 2	com.playdigious.evoland2
GP9	Navigation Pro: Google Maps Navi on Samsung Watch	smartwatchstudios.app.gears3navigation
GP10	WazzapMigrator	com.nbeghin.whatsappmigrator
GP11	Ticket to Ride	com.daysofwonder.tt.android
GP12	WeatherPro	com.mg.android
GP13	30 Seconds Officieel	com.asmodeedigital.thirtyseconds
GP14	Tasker	net.dinglich.android.taskerm
GP15	Torque Pro (OBD 2 & Car)	org.prowl.torque
GP16	Bloons TD 6	org.prowl.torque
GP17	Nova Launcher Prime	com.teslacoilsw.launcher.prime
GP18	Topo GPS Netherlands	nl.rdzl.topo.gps
GP19	Grand Theft Auto: San Andreas	com.rockstargames.gtasa
GP20	Poly Bridge	com.drycactus.polybridge
GP21	Motorsport Manager Mobile 3	com.playsportgames.mmm3
GP22	Evoland	air.com.shirogames.evoland12
GP23	Pocket Casts - Podcast Player	au.com.shiftyjelly.pocketcasts
GP24	RollerCoaster Tycoon Classic	com.atari.mobile.rctclassic
GP25	Game Dev Tycoon	com.greenheartgames.gdt

Table 8. Top25 of Grossing Apps at Google's PlayStore

Identifier	App	App Identifier
GG1	Tinder	com.tinder
GG2	Candy Crush Saga	com.king.candycrushsaga
GG3	Pokemon GO	com.nianticlabs.pokemongo
GG4	Google One	com.google.android.apps.subscriptions.red
GG5	Clash Royale	com.supercell.clashroyale
GG6	Coin Master	com.moonactive.coinmaster
GG7	Gardenscapes	com.playrix.gardenscapes
GG8	Guns of Glory	com.diandian.gog
GG9	Lords Mobile	com.igg.android.lordsmobile
GG10	King of Avalon: Dragon Warfare	com.funplus.kingofavalon
GG11	Candy Crush Soda Saga	com.king.candycrushsodasaga
GG12	Homescapes	com.playrix.homescapes
GG13	Idle Heroes	com.droidhang.ad
GG14	Clash of Clans	com.supercell.clashofclans
GG15	Rise of Kingdoms	com.lilithgame.roc.gp
GG16	Summoners War	com.com2us.smon.normal.freefull- .google.kr.android.common
GG17	Slotomania Slots - 777 Free Pokies Casino Games	air.com.playtika.slotomania
GG18	Hay Day	com.supercell.hayday
GG19	Huuuge Casino Slots - Play Free Slot Machines	com.huuuge.casino.slots
GG20	Empires & Puzzles: RPG Quest	com.smallgiantgames.empires
GG21	DRAGON BALL LEG- ENDS	com.bandainamcoent.dblegends
GG22	Brawl Stars	com.supercell.brawlstars
GG23	Last Shelter: Survival	com.more.dayzsurvival.gp
GG24	Township	com.playrix.township
GG25	Roblox	com.roblox.client

Appendix A.2 Apple’s AppStore

In this appendix, we list the analyzed mobile applications of Apple’s AppStore. Our analysis consists of the top free (see Table 9), top paid (see Table 10) and top grossing (see Table 11) applications.

Table 9. Top25 of Free Apps at Apple’s AppStore

Identifier	App	App Identifier
AF1	Tomb of the Mask	tomb-of-the-mask/id1057889290
AF2	Go Fish!	go-fish/id1398987473
AF3	Hello Stars	hello-stars/id1403455040
AF4	Instagram	instagram/id389801252
AF5	Snapchat	snapchat/id447188370
AF6	Messenger	messenger/id454638411
AF7	Facebook	facebook/id284882215
AF8	Bumper.io	bumper-io/id1402499966
AF9	Fortnite	fortnite/id1261357853
AF10	Google Maps - Transit & Food	google-maps-transit-food/id585027354
AF11	Netflix	netflix/id363590051
AF12	Word Link - Word Puzzle Game	word-link-word-puzzle-game/id1347684152
AF13	Gmail - Email by Google	gmail-email-by-google/id422689480
AF14	Ultra Sharp	ultra-sharp/id1417799395
AF15	Spotify - Music and Podcasts	spotify-music/id324684580
AF16	Helix Jump	helix-jump/id1345968745
AF17	WhatsApp Messenger	whatsapp-messenger/id310633997
AF18	TENKYU	tenkyu/id1189800250
AF19	Bitmoji	bitmoji/id868077558
AF20	Hole.io	hole-io/id1389111413
AF21	Looper!	looper/id1370475630
AF22	Amazon - Shopping made easy	amazon-shopping-made-easy/id297606951
AF23	Uber	uber/id368677368
AF24	Pandora: Music & Podcasts	pandora-music/id284035177
AF25	TikTok - Real Short Videos	tik-tok-including-musical-ly/id835599320

Table 10. Top25 of Paid Apps at Apple's AppStore

Identifier	App	App Identifier
AP1	Minecraft	minecraft/id479516143
AP2	Heads Up!	heads-up/id623592465
AP3	PlantSnap Pro: Identify Plants	plantsnap-plant-identification/id1234702272
AP4	Plague Inc.	plantsnap-plant-identification/id1234702272
AP5	Human Anatomy Atlas 2019	human-anatomy-atlas-2019/id1117998129
AP6	Facetune	facetune/id606310581
AP7	Bloons TD 6	bloons-td-6/id1118115766
AP8	Sky Guide	sky-guide/id576588894
AP9	Dark Sky Weather	dark-sky-weather/id517329357
AP10	Pocket City	pocket-city/id1330451888
AP11	HotSchedules	hotschedules/id294934058
AP12	Geometry Dash	geometry-dash/id625334537
AP13	The Game of Life	the-game-of-life/id1117405948
AP14	Papa's Freezeria To Go!	papas-freezeria-to-go/id824305459
AP15	Bloons TD 5	bloons-td-5/id563718995
AP16	Goat Simulator	goat-simulator/id868692227
AP17	SkyView	skyview-explore-the-universe/id404990064
AP18	NBA 2K18	nba-2k18/id1232808822
AP19	Afterlight 2	afterlight-2/id1293122457
AP20	Hear My Baby Heartbeat App	hear-my-baby-heartbeat-app/id1111420122
AP21	True Skate	true-skate/id549105915
AP22	Terraria	terraria/id640364616
AP23	Fantasy Football Draft Kit '18	fantasy-football-draft-kit-18/id1358124364
AP24	Five Nights at Freddy's	five-nights-at-freddys/id912536422
AP25	Teen Titans Go! Figure	teen-titans-go-figure/id1323070827

Table 11. Top25 of Grossing Apps at Apple’s AppStore

Identifier	App	App Identifier
AG1	Fortnite	fortnite/id1261357853
AG2	Pokemon GO	pokémon-go/id1094591345
AG3	Netflix	netflix/id363590051
AG4	Pandora: Music & Podcasts	pandora-music/id284035177
AG5	Candy Crush Saga	candy-crush-saga/id553834731
AG6	Toon Blast	toon-blast/id1176027022
AG7	Hulu: Watch TV Shows & Movies	hulu-watch-tv-shows-movies/id376510438
AG8	Roblox	roblox/id431946152
AG9	Clash of Clans	clash-of-clans/id529479190
AG10	Candy Crush Soda Saga	candy-crush-soda-saga/id850417475
AG11	Slotomania Vegas Casino Slots	slotomania-vegas-casino-slots/id447553564
AG12	Clash Royale	clash-royale/id1053012308
AG13	Toy Blast	toy-blast/id890378044
AG14	Homescapes	homescapes/id1195621598
AG15	Final Fantasy XV: A New Empire	final-fantasy-xv-a-new-empire/id1186994231
AG16	Gardenscapes	gardenscapes/id1105855019
AG17	LinkedIn: Network & Job Search	linkedin/id288429040
AG18	Design Home	design-home/id1010962391
AG19	Guns of Glory	guns-of-glory/id1274354704
AG20	Game of Thrones: Conquest	game-of-thrones-conquest/id1035712810
AG21	Big Fish Casino: Slots & Games	big-fish-casino-slots-games/id538212549
AG22	Episode - Choose Your Story	episode-choose-your-story/id656971078
AG23	Golf Clash	golf-clash/id1089225191
AG24	MARVEL Contest of Champions	marvel-contest-of-champions/id896112560
AG25	MLB Tap Sports Baseball 2018	mlb-tap-sports-baseball-2018/id1319072708