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DESIGNING RADIO IN A PERSONALIZED WORLD

Abstract

Like other industries, radio broadcasting is affected by a digital transformation and is currently undergoing major changes. Radio broadcasting agencies experience a shift from the classic linear stream that comes out of the kitchen radio to non-linear personalized playouts on smart devices. Many broadcasting agencies are experimenting how to innovate their offerings, but designing personalized radio is not straightforward. Media libraries of radio broadcasters that are available nowadays on the internet are often considered as dull and boring, as they often just consist of single items or put items in random sequence. Editorial tasks or are often missed out in personalized radio, and in comparison to classic radio, the resulting mix in often not appealing. We contribute a design science artefact that considers requirements from different stakeholders – listeners, broadcasting agencies and the public – and present design requirements and design principles with a corresponding architecture for personalized radio.

Keywords: Digital radio, personalized radio, public-service remit, design science.

1 Introduction

Like other industries, radio broadcasting is affected by a digital transformation and is currently undergoing major changes. Whereas music and film industry are already advanced in the process of digital transformation due to pent-up pressure to rearrange their business models, radio broadcasters had experienced less pressure so far, but now try to leap up by providing their content on mobile devices as a first step towards digital transformation. As music and film industry made significant advances, the radio industry also more and more feels the pressure to innovate.

Broadcasting agencies are facing increasing competition for listeners' attention by new music streaming services and new multimedia platforms. Spotify reported 159 million (Spotify, 2018) active users in 2017 and had 70 million paid subscribers in January 2018 and is the market leader for music streaming services in many countries (TechCrunch, 2018). The more popular music and video streaming services become, the less popular radio consumption will become in relation, as listeners' time and attention are limited resources. Broadcasters react by inventing new channels to distribute their content, partnering with other broadcasters, and building up own software departments. Joint projects like radioplayer.uk or radioplayer.de of both public and private radio broadcasters show that the industry breaks up old political comprehensions to open up for change. Few radio broadcasters that represent the peak of innovation like the National Public Radio launched groundbreaking apps that combine appealing interfaces with cutting edge technologies like recommender systems and managed to renew their appearance with digital products and services.

Many broadcasting agencies are experimenting how to innovate their offerings. While this is necessary to build up experience and knowledge regarding new digital technologies and their possibilities, single agencies may run the risk of missing the "big picture" of digitally transformed radio, and may fall short of innovating the industry as a whole. As a comparison, in music and film industry not only single organizations changed, but the whole industry, as ancestral business models almost became extinct. Similarly, it might also be necessary for radio broadcasters to be able to compete. Radio broadcasting is a billion-euro-industry[1] (Ofcom, 2015; Statista, 2016; US Census Bureau, 2016) and reaches from 60 up to 90 percent of the population of all ages (IfD Allensbach, 2016). But already today, most consumers only buy new radios when they buy new cars (Macavock, 2017). Broadcaster urgently need to innovate their offerings, but designing personalized radio is not straightforward. Media libraries of radio broadcasters that are available nowadays are often considered as dull and boring (Heidmeier, 2015). Hence, we ask:

RQ: How to design personalized radio for public broadcasting services?

The remainder of this paper is structured as follows: In the next section, we define what we mean by radio and present related work to personalization of radio. After that, we briefly depict our design science approach and point out how we elicited design requirements. The subsequent section presents the design principles and a corresponding architecture. Afterwards, we briefly depict our instantiation and a first evaluation. We conclude with a discussion, limitations and further research.

Definition of Radio in this Paper. Radio has different meanings. Radio could denote pure music services, a mixture of spoken-word content and music, or represent journalistic radio only. Also, specific variants like talk radio exist. In some countries, radio stations may also have a special political purpose. In this paper, we consider radio as journalistic radio, with a mixture of spoken-word content and music. We also focus on public radio, as the requirements for public radio differ from the requirements for private radio.

[1] 134 billion US$ of the U.S. broadcasting industry and 3.3 million € revenues of the German broadcast industry in 2014

2 Related Work

Not much research has been done on personalized radio. Publications about radio recommendation sometimes cover music recommendation only, e.g., (Hayes and Cunningham, 2001; Dziczkowski, Bougueroua and Wegrzyn-Wolska, 2009; Hecht et al., 2012; Zaharchuk, Ignatov, Konstantinov and Nikolenko, 2012; Turnbull et al., 2014; Ignatov, Nikolenko, Abaev and Poelmans, 2016), as the term radio is also frequently used for pure music streaming services. Focusing on radio in terms of spoken work, Liu et al. (Liu, 2014) propose an approach about recommender systems that suggest which linear radio channel to switch to in the car. Also Moling et al. propose a client side recommender system that suggests which radio channel to switch to (Moling, Baltrunas and Ricci, 2012).

Xie et al. (Xie et al., 2013) propose a mobile application that allows users to listen to personalized radio with focus on news. Casagranda et al. propose a hybrid content radio (Casagranda et al., 2015), enhancing the traditional broadcast radio experience and augmenting it with context-aware and personalized audio content from the internet, considering context like the listener's emotional state and activity, geographical position, and weather.

Schatter and Zeller (Schatter and Zeller, 2007) research on radio recommender systems with the focus on Digital Audio Broadcasting (DAB). Ala-Fossi et al. (Ala-Fossi et al., 2008) and Anderson (Anderson, 2012) also present studies about future delivery technologies of radio, but without placing a lot of emphasis on personalized content.

Considering radio program management, the book of Eastman and Ferguson presents an in-depth view on media programming (Eastman and Ferguson, 2012). Keith (Keith, 2012) specifically outlines program management for radio purposes.

3 A Design Science Approach for Personalized Radio

3.1 Methodology

Our research follows design science principles (Hevner et al., 2004; March & Smith, 1995). Design science is a well-known research approach in IS and has been reemphasized in the last years (March and Smith, 1995; Gregor and Hevner, 2013). At the core of design science is the iterative design with continuous reflection and incremental refinement (Hevner et al., 2004; Takeda, Veerkamp, & Yoshikawa, 1990). Whereas many scholars have proposed guidance how to conduct design research (e.g., Hevner 2007; Iivari 2015; Jones and Gregor 2007; Nunamaker et al. 1990; Peffers et al. 2007), our research design reflects the ideas of Vaishnavi and Kuechler (2015). So far, we conducted one design cycle only. In the end, we contribute a level 1 design science contribution in the terminology of Gregor and Hevner (2013).

3.2 Identifying Meta Requirements

To elicit design requirements, we did not solely focus on user requirements. Rather, in a public radio context, the requirements of all stakeholders have to be regarded. So, we first considered the positions of all stakeholders for personalized radio (in the sense of publicly financed, journalistic radio as described above): the broadcasting agencies, the listeners, and the public. In discussions with a major radio broadcasting agency, we elicited the following stakeholders and their requirements. From those stakeholder requirements, we deducted meta requirements, as we could not directly translate them into design requirements. Those meta requirements are still abstract and need to be broken down to more specific design requirements, but they help to structure the field.

Stakeholder requirements	Meta Requirements (MR)
Both listeners and broadcasting organizations are interested in an attractive radio program, so that listeners would engage with the radio service. Non-linear radio programs should therefore contain personalized content.	**MR1:** Non-linear radio should contain personalized content.
Radio broadcasters complain that personalized content only does not yet make a good mix. The radio content that is offered today on the broadcasters' websites are cutouts from the linear radio program. Putting these items into any sequence does not make the same listening experience as classic radio provides. Music, jingles, in-between-talks and live call-ins are missing, and the sequence of items is not edited by radio editors. Therefore, media libraries are often considered as dull and boring. Personalized radio does not necessarily have to copy the classic radio experience, but it should provide an enjoyable mix of content to make radio attractive.	**MR2:** Personalized radio should offer an enjoyable mix of contents.
Public broadcasters have to fulfil a public-service remit in return for receiving public funding. The public-service remit is usually written down in legal documents and include neutral media coverage and the duty to correspond to the democratic, social and cultural needs of the society. In particular, public broadcasters have to take care that listeners do not end up being in filter bubbles (Pariser, 2011).	**MR3:** Personalized radio should comply with the requirements of the public-service remit.

Table 1. Stakeholder requirements and meta requirements.

In the following, we depict each of the three meta requirements in further detail.

3.3 MR1: Personalization of Content

To elicit design requirements for the personalization of content, we first analyzed the specifics of radio and the environment of public radio broadcasters. Public radio broadcasters enjoy the benefit of receiving public financing. In order to balance this advantage they have in comparison to private broadcasting agencies, their content is designated for limited availability. Often, content of public broadcasters is only available for 6 months. This however poses a problem for recommender algorithms. As the media library would be completely exchanged every 6 months, collaborative filtering based algorithms would have a hard time finding similarities between user behaviors. If, for example, a user engaged with the radio service 6 months ago, a collaborative filtering algorithm would not be able to find similarities to a user interacting today as the consumed items do not overlap. In recommender systems literature, this would refer to a continuous cold-start problem or temporal dynamics (Ricci, Rokach, Shapira and Kantor, 2011) of the item base. A first design requirement (DR) regarding personalization of radio is therefore:

DR1.1: If items have limited availability on the audio library, content-based filtering should be used rather than collaborative filtering techniques.

Radio consists of a heterogeneous mixture of diverse contents and formats, such as news, talks, interviews, stories, radio plays, audio dramas, concerts, biographies, and long features. In contrast to music recommendation, where pieces are mainly characterized by a genre and an interpreter, radio pieces are much more multifaceted. Apart from the diversification in formats, we also find diversification in topics (sports, music, politics, science, etc.), topicality (news vs. timeless content), depth with regard to content (funny, serious, in-depth, etc.), and duration (from less than a minute to more than one hour).

A personalized radio playout has to cope with this diversity of content. Also, practitioners have the requirement that subgroups of content have their own recommendation technique or, at least learn

the user's behavior independent from each other. A user not interested in biographies of musicians might well be interested in other content about music. The diversity of radio content therefore feeds the assumption that groups of contents should be manageable separately, each having their own recommendation algorithms. Therefore, we formulate the second design requirement as follows:

DR1.2: Different recommender algorithms should be allowed for different types of content.

As of today, only time of day and day of week can be reflected in the linear radio program. For mobile radio, more context factors are relevant like location, habits of the user, surrounding noise, surrounding light, activity, movement, temperature, weather, availability of bandwidth, output device, and other context parameters. Context-sensitivity may therefore influence both which content is played and in which sequence. A rich context-sensitivity is still more on the wish list of broadcasting agencies than on the requirements list. But broadcasters will move towards the goal to provide their personalized listening experience in a sophisticated, context-sensitive way.

DR1.3: Personalized radio should be context-sensitive.

In a second design cycle, we plan to elaborate the requirements in further detail, i.e., which content-based filtering algorithms suit radio best, which algorithms to choose for which type of content, and which context factors to include in which way.

3.4 MR2: Enjoyable Mix of Contents

In the first design cycle, we draw upon existent research as we noticed during literature review that research already exists – however not university research but company research. BBC Research & Development initiated a research project called "Understanding Editorial Decisions" (Sommers, 2016) as a subproject of the overarching project "Editorial Algorithms" in 2014. While we identify design requirements with our own approach and refine requirements in a second design cycle, for the first cycle we relied upon existing research as initial design requirements (Sommers, 2016). In the following we present those design requirements that we considered as relevant for the radio domain.

DR2.1: Content in a mix should origin from several sources, never from one single source.

DR2.2: A compilation should offer a good mix of topics.

DR2.3: A good compilation should be assembled sensitively. News about a train crash should not follow advertisement for trains.

DR2.4: A good compilation should not be too serious, but also include light or funny items.

DR2.5: A good compilation has some unifying theme in focus, but also some randomness.

While these design requirements serve as an initial set, we feel they are not elaborate enough and not specific enough for personalized radio. In a second design cycle, we follow an interview-based approach to elicit design requirements together with radio editors. Radio editors often have some templates at hand that they use to structure their radio shows, so called broadcasting clocks (e.g., see National Public Radio, 2003). In the second design cycle, we also aim for understanding how broadcasters can manage to transport their brand recognition via personalized playouts, as this is strongly interconnected with editorial decisions.

3.5 MR3: Compliance with Public-Service Remit

For the first design cycle, we carved out requirements from the relevant legal document that describes the public-service remit of radio broadcasters of one country. For this purpose, we analyzed the German interstate treaty of broadcasting and tele-media (ITBT), the "Staatsvertrag für Rundfunk und Tele-medien" in its 19th version from June 1st, 2016, by means of qualitative data analysis. Before coding the document, we set up a coding frame. Considering the requirements for public broad-

casters, we found two levels addressed by the ITBT: a) content production and b) content composition.

Content production: Content has to be produced according to requirements mentioned in the ITBT, e.g. media coverage has to be independent and objective, content checked for truth, produced according to journalistic standards etc.

Content composition: The sequence of the content items is what makes up the radio program. Therefore, the program composition might also account for the emergence of filter bubbles.

In a non-linear playout, the produced content pieces themselves cannot be changed as they are given as atomic items; the only possibility to create a multitude of personalized programs automatically is by composing content pieces in different ways. Therefore, we focus on the content composition and neglect the content production. For coding purposes, we established a simple coding framework with just two codes: a) concerns content production and b) concerns content composition. Two coders performed the coding procedure independently. After coding, assigned codes were discussed, and differences resolved. In the following, we only present the requirements that concern the content composition, i.e. the program compilation. In the end, we elicited 7 requirements.

DR3.1. Comments must be separated and clearly distinguishable from reports (§ 10 (1)).

DR3.2. The service offer of public broadcasters should include information, education, culture, and entertainment (§ 11 (1)).

DR3.3. The service offer should give a comprehensive overview over international, national, and regional events in all essential areas of life (§ 11 (1)).

DR3.4. The service offer should be balanced (§ 11 (2)).

DR3.5. The service offer should reflect the diversity of opinions (§ 11 (2)).

DR3.6. The service offer should support the process of forming a free and individual opinion and therefore fulfil the needs of a democratic, social and cultural society (§ 11f (4)).

DR3.7. Broadcasters must offer counterstatements of an affected person in equivalent way. For the linear program, the counterstatement should be sent in an equivalent time slot in equivalent length. For the non-linear program in tele-media (especially internet), the counterstatement must be offered as long as the original statement in direct connection to it (§ 56 (1)).

The requirements presented were derived from the ITBT of a single country. While this serves as initial requirements for a first design cycle, we will adjust the requirements with requirements from different countries by analyzing the relevant legal documents on an international level. Realigning the requirements in a second design cycle will make the design process applicable to more general contexts and more robust.

4 Constructing Design Principles

In order to meet the design requirements, we constructed a generic architecture that incorporates several design principles (DP). We depict the architecture in Figure 1 and describe the design principles it contains.

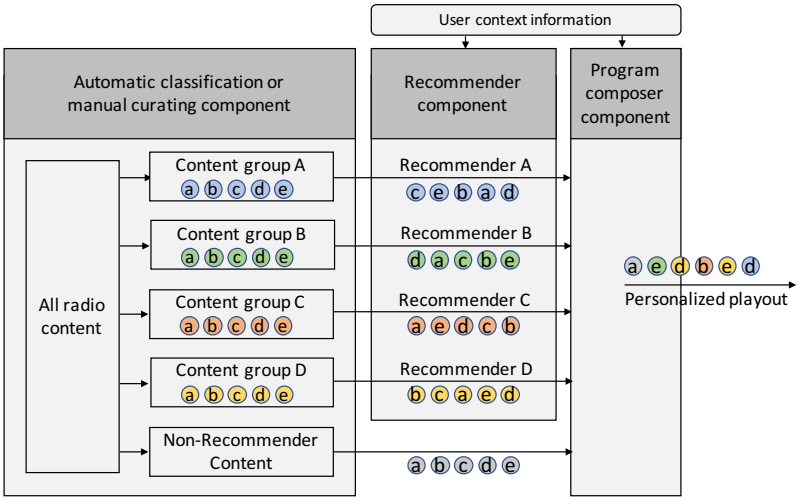

Figure 1. A generic architecture for personalized radio that reflects design principles.

DP1: Different content groups should be treated by specific recommender algorithms. All radio content should be automatically classified or manually curated to form several content groups beforehand. With the classification component and the recommender component (left and middle in Figure 1), DR1.2 can be met. Also, DR3.2, DR3.3 and DR 3.5 are addressed, as the content groups allow to classify according to the requirements.

DP2: Personalized radio should contain non-recommender content. Non-recommender content can be, for example, news, that should not be incorporated in the recommendation process, in order to decrease the risk of filter bubbles. DP2 therefore addresses DR3.6.

DP3: As the last component, a program composer component should exist that addresses all meta-requirements, i.e. requirements referring to the public-service remit (MR3), requirements referring to an enjoyable mix (MR2), and the requirements to play out personalized content (MR1).

DP4: User context information should be reflected in both the recommender component and the program composer component. Some context factors might already be taken into account within the recommendation process, others should be reflected in the mixer component. DP4 addresses DR1.3.

The four design requirements are reflected in the architecture (Figure 1). The program composer component plays a special role, as it needs to meet almost all requirements. Requirements from the public-service remit might, at least in parts, conflict with the idea of personalization and the idea of providing an enjoyable mix of content. The program composer component therefore needs to reflect what makes a good program compilation (all DR2.x), needs to consider a balanced mixture of international, national and regional content (DR3.3 in conjunction with DR3.4), also a mixture of information, culture, education and entertainment (DR3.2 in conjunction with DR3.4), further requirements of DR3.x, and at the same time allow for personalization (all DR1.x). As the program composer component needs to address several requirements, more design cycles are needed to further develop the design of the program composer component.

5 Instantiation and First Evaluation

We built a prototype including frontend in the form of a mobile phone app (Figure 2). The prototype did not allow browsing for certain content, but assembled a stream automatically that suits the interests of the listeners. The recommender system in the backend learned from every interaction (skip, like, dislike, etc.) and personalized the radio stream accordingly. The prototype was connected

to the media library of a major German public broadcaster and was fed with recent items from the past three weeks. Participants did not need to create a login to use the app. After we were sure that the prototype was a stable release, we evaluated the prototype with test listeners. 40 Participants were asked to use the app for two weeks in April 2018 and give qualitative feedback.

Most participants were happy with the overall experience. However, most were also unable to determine whether the recommended items in their personalized radio stream represent good recommendations or not. The proper function of a recommender algorithm in a setting of 40 users and several thousand items is indeed questionable. That is why we regarded the test as a pretest and aim to evaluate our prototype with a larger set of test listeners in the second design cycle.

Figure 2. Developed prototype app.

6 Discussion, Limitations and Further Research

In this paper, we presented a design science approach to personalized radio. The main contribution of the paper is a level 1 design science contribution in the terminology of Gregor and Hevner (2013). We gave a detailed picture on design requirements and illustrated our design principles with a generic architecture that allows to meet the design requirements. One of the strength of our research is the connection of our research activities with a large German broadcaster, which allows validation in practice, a good access to test listeners, and access to productive media libraries.

Our approach has however some limitations. First, we so far did perform one design cycle only. Also, we did not develop a higher-valued level 2 design theory (according to Gregor and Hevner (2013)), as we feel that we need more design cycles to do that. Further design cycles might also allow to generalize to public media broadcasting and not just focus on radio. The second limitation is, our qualitative evaluation could not specifically address all the features of our implementation, especially the quality of recommendations, as the ratio of users to items was too low. We therefore need to conduct an evaluation with a larger group of listeners. As a third limitation, we need to address that we did not take into account so far how radio services should look like in the future, which may result in further requirements. It is still an open question whether personalized radio should keep

some of the characteristics of the classic radio experience, or if new requirements dominate when building the personalized radio of the future.

Further research has to deeper dive into the areas depicted in this paper and focus on research considering the public-service remit on an international level, and how to design a program composer component. Also, further research needs to better understand editorial decisions in order to automate them. Furthermore, radio broadcasters might be interested in keeping their brand recognition in personalized playouts, i.e. the profile of a radio station that makes listeners tune in. Still, beneath open questions, this paper may hopefully serve as a basis for further research on personalized radio.

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