DESIGN IMPLICATIONS FOR TECHNOLOGY-MEDIATED AUDIENCE PARTICIPATION IN LIVE MUSIC

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ABSTRACT

Mobile and sensor-based technologies have created new interaction design possibilities for technology-mediated audience participation in live music performance. However, there is little if any work in the literature that systematically identifies and characterises design issues emerging from this novel class of multi-dimensional interactive performance systems. As an early contribution towards addressing this gap in knowledge, we present the analysis of a detailed survey of technology-mediated audience participation in live music, from the perspective of two key stakeholder groups - musicians and audiences. Results from the survey of over two hundred spectators and musicians are presented, along with descriptive analysis and discussion. These results are used to identify emerging design issues, such as expressiveness, communication and appropriateness. Implications for interaction design are considered. While this study focuses on musicians and audiences, lessons are noted for diverse stakeholders, including composers, performers, interaction designers, media artists and engineers.

1. INTRODUCTION

Mobile, ubiquitous, and sensor based technologies have created new possibilities for interactive performance systems in live music. Approaches to design interactive systems particularly for audience participation are diverse and have implications for art, technology, and science [1–10]. Most published studies present systems and their evaluation in the context of interactive live performances, but lack any substantial analysis of general design implications beyond specific use cases.

This paper explores more generally the design space of technology-mediated audience participation, which we abbreviate throughout this paper as *TMAP*. Implications are considered from a range of stakeholder perspectives.

To investigate this hypothesis and identify potential design implications for TMAP, the present study focuses on stakeholder perspectives around motivation, behaviour, and opinion of spectators and musicians in relation to live music and TMAP. The following four research questions are considered:

1. What are the musical preferences, motivations, and behavioural tendencies of spectators and musicians in live concerts?

2. How do spectators and musicians use mobile technology during live concerts?

3. What are the concerns of spectators and musicians regarding TMAP?

4. What implications for the design of TMAP can be identified?

Addressing these questions on the basis of the survey results has the potential to contribute to new knowledge in two ways. Firstly, by the identification and characterisation of design issues in this emerging area of interaction design, and secondly, by encouraging a focus by designers on underexplored strategies and areas of attention within technology-mediated audience participation.

2. RELATED WORK

Audience participation using technically mediated systems has been conducted in a variety of ways. In an early work in 1977, *Radio Net* [1] asked thousands of people all over the United States to use their telephones in a networked performance to create sounds for a live radio broadcast. Around 25 years later, Levin [11] used an audience's mobile phones to collaboratively create the concert *Dialtones*. Both examples were primarily intended as works of art to stand for themselves.

More recently, mobile devices [2, 4], smartphones in particular [5, 7, 8, 10], and other sensory mechanisms [3, 9] have been used to let spectators participate in performances. In some, but not all of those studies, the researchers were interested in gathering feedback from the audience about their experience.

In two studies [2, 4] the audience was surveyed after the performance and gave feedback about technical issues with the system such as responsiveness and latency. By contrast, in the case of Lee et al. [7] spectators were asked to report back on experiential and aesthetic issues, for example respondents noted that they "felt connected to the music

and other musicians" (p.454). In all of these cases, however, the feedback was focused on particular aspects of the provided system for audience participation or the specific performance concept.

In contrast, Mazzanti et al. [8] propose six metrics to describe and evaluate concepts for participatory performances at a more general level. They directly address aspects of participatory performances conceptually and technically, although, still tied closely to their particular Augmented Stage platform and to participants' feedback collected during evaluation.

With the piece *Experimence* [12], we followed a different approach and composed a song having audience participation in mind. We reflected on the creative process of this composition and concluded with rather general variables. These variables describe considerations for a composition before having any particular technology for such an interactive performance system available.

In most published studies, participants' feedback about technology-mediated audience participation (TMAP) across different studies is generally positive [2–4, 6, 7]. Feedback in such studies tends to be limited to particular technical systems and tends to be focused on details of interaction modalities and desired improved or additional features. Audiences often express a wish for more control [3, 6]. Musicians, however, appear to be far more sceptical towards new ways of audience participation [6]. However, the literature does not contain much evidence or discussion about these concerns on the musicians' side.

Overall, musicians and audiences have distinctive requirements, as does musical coherence, and there can be wide variation among both groups. As examples in literature suggest, the effective design of TMAP generally requires balancing knowledge from diverse perspectives and taking into account requirements of different roles in live music performance.

The present study is unusual in surveying these requirements from two different perspectives and without any particular TMAP concept or technology in mind. The aim was to identify general design implications as well as potential design strategies for future case studies.

3. SURVEY

The survey was designed to be conducted online using the free open source software LimeSurvey [1] . Participants could choose between a German or an English version.

3.1 Questionnaire Design

The questionnaire begun with questions about basic information, followed by questions about music-related information in general and live music in particular, and finally focusing audience participation in live music. We decided to use these four sections to guide the participant through the survey step by step from very general questions to very particular ones concerning audience participation.

In the second part of the questionnaire the participants had to rate various statements from their point of view and

[1] https://www.limesurvey.org (last access 15.05.2017)

Question	Spectators	Musicians
Age (younger than 29)	59%	47%
Gender (male)	57%	80%
Education (college or higher)	43%	70%
Playing an instrument or vocal training (yes)	75%	100%
Attending or playing concerts (once/month or more)	52%	21%

Table 1. Demographics

experience using different Lickert scales [13, 14]. These statements were primarily informed by literature investigating the experiences of spectators attending musical live performances [6, 15]. The original questionnaire as well as detailed survey results are available in Appendix B in [16].

3.2 Analysis Approach

For the analysis of the results, descriptive statistics and quantitative methods were used. Ways of presenting these results include bar charts showing frequencies of responses as percentages of the whole sample [17]. This analysis approach concerned mainly results presented in 4.1 and 4.4. For questions which allowed a wide range of response options, statistical measures of central tendency [2] were calculated for easier interpretation [18]. Results of these questions are presented in 4.2, 4.3, and 4.5.

4. RESULTS

The survey was carried out online over a period of three weeks resulting in 254 responses. For the analysis, incomplete responses (27) were excluded, which left 227 complete datasets (169 spectators, 58 musicians).

Different channels, mainly Austrian and British, were used to distribute the survey link. Among these channels were mailing lists of universities, music-related projects and communities, personal contacts of involved researchers, and social media. Furthermore, a distribution by companies in the music business (e.g. labels, concert organiser), music related magazines and broadcasting stations was requested. These inquiries mainly remained unconfirmed, though.

4.1 Demographics and Music-Related Information

Musicians and spectators were separately analysed. Table 1 gives a demographic overview of the dataset. In both target groups about half were younger than 29 and there was a good balance among spectators between male and female, while the musicians were predominantly male. Three quarters of all spectators (75%) played instruments or had vocal training. The musicians were not explicitly asked, whether they had a musical training or not. This was assumed, based on their decision to fill out the survey as a musician.

[2] median (Md), mode (Mo), and interquartile range (IQR)

4.2 Motivation

The motivational intentions of spectators and musicians show some interesting differences when agreeing or disagreeing to particular statements. Most spectators agreed, that they want to have a unique and special experience (89%), that they like to be part of an audience (83%), and that they think live music is better than listening (81%). Most spectators disagreed with being involved in the show (49%), but also 32% are neutral about this involvement. Furthermore, many spectators agree to meet other people at concerts (78%) and express themselves to show excitement (71%). For musicians it is very important to be on stage (91%) and play music publicly (90%). Most of them also want to create a unique and special experience (84%). The latter is a statement that no musician disagreed with. 40% of the musicians agree to involved spectators in the show. The statements with the most negative responses are focus on show (41%) and improvise on stage (29%).

4.3 Behaviour

To study the behaviour of spectators and musicians during two different kind of songs, survey participants had to rate 14 statements according to how often they see themselves acting alike during a concert. The scale for this rating was 0 = never, 1 = sometimes, 2 = often, and 3 = every time.

According to these numbers, spectators are likely to close their eyes and stand still, listening to the music carefully during a slow song but never during a fast song. Most musicians often close their eyes during certain parts of a song and stand still to enjoy the playing during a slow and sometimes during a fast song.

Behaviour most spectators often show is clapping hands, waving hands in the air, singing along, moving and dancing, and tapping the beat with the foot. A behaviour that most people never do regarding both song types are moshing around in the mosh pit, grabbing a lighter and waving it in the air, and using a camera or phone. Most spectators never use any kind of devices and even the distribution of values is small.

The interquartile ranges calculated for the rating results show that there is a wider distribution of values with statements of what most spectators do every time (e.g. sing along) or what they never do (e.g. shout/whistle). In addition, the modes do not equal the medians.

Musicians also rated how they see themselves playing the two different kinds of songs on stage. Musicians often close their eyes at certain parts of the song, stand still, enjoy playing, and make announcements before/after song when playing a slow song. For a fast song the behaviour is different. Most musicians often watch the reaction of the audience while playing, smile at certain spectators, and move around on stage. Three statements rated by the musicians, "make announcements before/after song", "watch reaction of audience while playing", and "smile at certain spectators", are amongst those rated highest for both song types. The majority of the musicians does most of these actions often.

Frequency	Mobile phone	Smart phone
More than 10 times	2%	4%
4-9 times	2%	8%
1-3 times	32%	53%
never	62%	30%
no answer	2%	5%

Table 2. Spectators' phone use during concerts

Purpose	Musician use
recording by yourself	24%
creating visuals or projections	3%
displaying something (e.g. lyrics, musical score)	17%
a device for playback reasons	17%
an instrument to play with	12%

Table 3. Musicians' use of mobile computer devices on stage

4.4 Mobile Technologies

The use of mobile technologies during live concerts was the next part of this survey. Table 2 summarises the frequency of the spectators' use of mobile phones. According to the results, most spectators use their mobile phones rarely or never during performances.

Spectators use their phones for diverse reasons during a concert. Most of them never use their phones expect for making pictures. The low interquartile range for most purposes indicates that at least some spectators use their mobile phones sometimes for different purposes.

Musicians were not only asked about their phones, but how often they use them and if they also use other mobile computer devices for their performances. Slightly more than a quarter (28%) already used a smart phone during a performance and 7% does so every concert. More than a third (38%), have used laptops and a tenth (10%) use them for every performance. Tablet computers on stage were used at least once by 12%. Particular purposes musicians use their mobile devices for are listed in Table 3.

4.5 Opinion about TMAP

The last survey part asked the participants about their opinion on TMAP. As in previous sections, survey participants again had to rate whether they agree or disagree with different statements using a five-step scale. The first series of statements was formulated as "I would like to influence..." for spectators and "The audience could influence..." for musicians.

Overall, most spectators tend to agree more on influencing elements of sound (e.g. volume) or dramaturgy (e.g. song selection) in a live concert. Most musicians tend to agree on letting the audience participate in visuals (e.g. lights) or dramaturgy as well, but strongly disagree on an influence of sound.

Most spectators tend to agree with having a certain influence on the general volume or the volume of certain instruments referring to sound and the choice of songs in

the category dramaturgy (Md=3/Mo=3; 3 is 'tend to agree'). The statement "volume of certain instruments" even has an interquartile range of 1, which indicates a lower distribution and a more stable tend to agree. In most cases spectators have a neutral opinion. Musicians have much stronger opinion. Most of them tend to agree with being able to influence visuals or dramaturgical elements. Except of "general volume" most disagree on all statements within the category sound.

Finally, survey participants had to rate statements about how TMAP could actually work. These statements included general strategies to involve the audience, concrete examples for participation and actual technologies that might be used.

Among the group of spectators is one statement that clearly stands out, "the artist meets the expectations of the audience" as most spectators strongly agree with it (Md=4/Mo=4) and the values are not much distributed (IQR=1). Most spectators could also imagine using phonometers to measure the noise level and making a certain creative contribution. With sensor technology, they could imagine cameras for visual recognition and floor sensors. Most spectators disagree with voting, controlling sound or visuals actively, or providing personal data (e.g. heart rate). In most cases, musicians have a similar opinion as the spectators or they agree even stronger than audience members. With active sound control or sensor data, however, they strongly disagree.

5. DISCUSSION

The survey presented in this paper explores the design space of technology-mediated audience participation (TMAP) in live music from the perspective of two key stakeholder groups (musicians and audiences). We continue to discuss the previously described survey results and revisit the four research questions. By answering the first three research questions and discussing notable tendencies of the results, we will identify implications that concern the design of TMAP.

In particular, we look step by step at noticeable differences of statistical values in the results and draw conclusions in relation to TMAP. We will finish the discussion by revisiting the fourth research question and take the outcomes of the whole survey into consideration to elaborate and propose implications for design of TMAP. To start the discussion, we address the first research question: What are the musical preferences, motivations, and behavioural tendencies of spectators and musicians in live concerts?

5.1 Music-Related Information

Looking at the musical training of spectators, three quarters stated they play instruments. This number is relatively high, bearing in mind that those who filled out the survey as spectators do not consider themselves as musicians. The fact that 75% of the spectators have musical training supports the responses' credibility of this survey regarding music-related questions to spectators. Furthermore, these numbers highlight the issue of musically trained spectators among the audience, or more general, to consider possible skills among the audience for the design of TMAP. We refer to this as *skilfulness*.

A little more than half of the surveyed spectators attend live concerts at least once a month, which is a good amount of people regularly experiencing live music. In the case of musicians only a fifth plays concerts with the same regularity. If we invert this number, it means the majority of the musicians play live concerts less than once a month. This is not as high as one could think of, when asking people who consider themselves as musicians. A possible explanation could be that a certain number of musicians have above-average experiences and regularly play live concerts, but do not make a living out of music. Following this assumption, the aforementioned one fifth could be considered as professionals, which seems to be appropriate for someone who plays a concert every month or even more often. For the design of TMAP this means it is important to consider the professional level of musicians and their live performances. In conclusion, we refer to this as *masterfulness*.

5.2 Motivation to Play or Attend Live Concerts

The participants' motivation in relation to live concerts showed strong agreements in terms of having a distinctive experience. For spectators the strongest motivation for visiting concerts is to have a unique and special experience. Similarly, most musicians want to create a unique and special experience. Additionally, spectators agreed, that live music is better than listening to records. This raises the implication of *distinctiveness*. It refers to the distinctive experience TMAP should create in a live concert.

Following the previous implication, this suggests that TMAP should always create a distinctive experience. However, at the same time only few spectators agreed to be involved in a show. Musicians on the other hand are more prepared to involve the audience but this is still the second lowest among their ratings. In addition, many spectators want to focus on music without distraction, while most musicians agree on focusing on playing music. Strictly speaking, we can interpret this as an indication that people are not really interested in TMAP. Although, it could also mean that we should focus on a well-considered and unobtrusive involvement of spectators and musicians when utilising TMAP to create a unique live music experience for everybody involved. This highlights an implication for the design of TMAP we call *obtrusiveness*.

Two other statements sharing high agreement among the spectators are about being part of an audience and expressing themselves to show excitement. Again, having TMAP in mind, this indicates the importance of the spectators being able to act expressively and identify themselves with the whole audience. This leads to *expressiveness*, which means the design of TMAP needs to consider forms of interaction that enable the spectators to be expressive, whether as individuals, in smaller groups, or as a whole audience. In parallel, Mazzanti et al. [8] refer to expressiveness with their dimensions 'Active/Passive Audience Affinity' and 'Audience Interaction Transparency' to some extent.

The social context was also identified as important. We interpret the high agreement of spectators to meet other

people as *sociability*. This sociability refers to social aspects in relation to TMAP. For example, there could be a certain social motivation to enable TMAP from the side of the artist or to participate as a spectator. Either way, it allows spectators to socialise to some extent, whether this is with friends or meeting other people.

Spectators want to have a unique experience and prefer live performed music. Most important for musicians is to be on stage and play music publicly. This very high agreement among musicians to be exposed on stage and the wish for liveness among the audience raises the implication of *exposure*. This not only highlights the importance for musicians to be on stage, but also the need to design TMAP in a way that considers the exposed situation of musicians.

5.3 Behaviour at Live Concerts

Behaviour at live concerts for both spectators and musicians is related to the expressiveness, as discussed above. However, we can see certain differences in behaviour for different song types. This shows that the spectators' and musicians' behaviour depends on songs and the mood they create among spectators, and this raised the implication of *mood*. The challenge for the design of TMAP is to consider the mood and the resulting behaviour of a participating audience as well as the musicians. For instance, some audiences might have a certain mood-driven behaviour a priori (e.g. according to a style of music) and others might change their behaviour according to a particular song that creates a different mood (e.g. the hit of a band versus a new song no one knows).

The wide distribution of values with statements of what spectators do every time (sing along) or what they never do (shout/whistle), supports the assumption of a higher distribution of ratings for these statements. This means that although most spectators always sing along, there is a certain number of spectators who will not always do it. We call these anticipated differences regarding the behaviour among spectators *diversity*.

It is clearer however that spectators do not tend to use objects during a concerts. Three statements are among the four lowest rated ones (using a lighter, phone or camera). In addition, these three are the only ones among all behaviours requiring an object or specific thing. This raises the implication of *objects*, which means we need to consider the role of tangible interfaces in the interaction design for TMAP.

Musicians show that they like to communicate with spectators whether passively, when smiling at them or watching their reaction, or actively, when making announcements. We argue that all of them show some sort of appreciation to the audience. While making announcements has also an informational purpose, the other two show that most musicians care about their spectators, whether by just observing them to see a reaction or actively smiling at them. As we know from Lee at al. [7], spectators report feeling "connected" (p.454) when experiencing TMAP. We call this the implication of *communication*. When TMAP actually happens during a live concert, it most likely needs some sort of communication, whether it is done by the musicians themselves, by a moderator, or in a self-explanatory way.

5.4 Mobile Technologies during Live Concerts

The second research question was: How do spectators and musicians use mobile technology during live concerts? With the implication of objects, we already looked on phone use in relation to the behaviour during songs. Additional survey results show that only 56% use their phones at least once during a live concert. The only reason why spectators use their phones in particular is to take pictures. Most spectators never use their mobile phones for any other purpose. In conclusion, we define this as *readiness*. For TMAP this means we need to consider to what extent an audience is ready for a particular participation. This readiness could be in terms of general availability (e.g. having a device such as a mobile phone that is capable of something) or in terms of a certain knowledge or habit (e.g. using the mobile phone for a particular purpose).

In general, musicians do not use mobile technology for their performances often. What we do not learn from the results, are the reasons why most of the musicians do not use mobile technologies for their performances. This might be for practical reasons because they just do not need them for artistic purposes, but it could also be kind of refusal. In conclusion, we raise the implication of *openness*. This openness is somehow similar to readiness but focuses more on the musicians' relation towards technology as an important part of TMAP.

5.5 Opinion About TMAP

With the third research question we asked: What are the concerns of spectators and musicians regarding TMAP? Overall, most spectators tend to agree more on influencing elements of sound (e.g. volume) or dramaturgy (e.g. song selection) in a live concert. Most musicians tend to agree on letting the audience participate in visuals (e.g. lights) or dramaturgy as well, but strongly disagree on an influence of sound. Interpreting the figures, it is noticeable that most spectators do not care too much about visuals, while most musicians would somehow offer them the chance to participate in light effects, for instance. Regarding sound most spectators would like to have some influence, while most musicians do not want the audience to influence sound. In relation to TMAP we call this *appropriateness*. This means the actual impact that happens through the participation on some performance element has to be chosen and designed in a way both spectators and musicians can live with.

From the result we know that most spectators tend to agree on influencing the sound to some extent. When asked, if they could imagine using a smartphone app to control the sound actively, although, most spectators strongly disagreed. In a similar contradictory way, most spectators tend to agree on influencing the choice of songs, but strongly disagree on using a smartphone app for voting. This inconsistency raises the implication of *contradiction*, which describes the challenge to find a compromise to resolve a contradictory situation. In the same way other studies report that audiences wish to have more influence when experiencing TMAP while musicians tend to be sceptical towards giving them more control [3, 6].

Most spectators and musicians tend to agree that it would make a live concert more exciting if the audience could make a certain creative contribution. Musicians agree on that even more strongly. We do not know which form of creativity musicians had in mind when they rated the statements. If we consider sound as one of the most important creativity-related aspects of a live concert, it contradicts the musicians' refusal of an impact on sound, as we already know. In conclusion, we define the implication of *creativity* dealing with the challenge to what extent TMAP is or has to be a creative contribution to a live concert.

5.6 Implications for Design of TMAP

The final research question builds up on the previous three to draw conclusions: What implications for the design of TMAP can be identified? By answering the previous three research questions and discussing the results of all survey sections step by step, we identified 16 implications concerning the design of TMAP in live music. Some of them primarily address either spectators' or musicians' requirements, others concern both.

In some cases, we identified these implications by drawing together notable results of the survey questions and sections and by considering spectators' as well as musicians' motivation, behaviour, and opinion. Hence, some implications might overlap to some extent, e.g. *readiness* and *openness*. Both address attitudes and habits of the spectators and musicians in relation to technology that might have an impact on the design of TMAP. Nonetheless, readiness highlights more the technological availability and habits of spectators, while openness rather bears the musicians' relation towards technology.

Besides readiness and openness, especially *obtrusiveness* showed a potential scepticism in relation to TMAP on both sides. Although, various case studies in literature [2–4, 6, 7] report mostly positive feedback from participants who really experienced TMAP at live concerts. This indicates a certain difficulty to envision TMAP without experiencing it as our survey participants did.

From a structural point of view, these implications stand by themselves rather than being a complete set of design strategies. However, they are an important step to generalise design strategies around TMAP and to serve as a well-founded starting point for actual design processes. Furthermore, these implications for the design of TMAP complement the range of design implications derived from particular case studies as the ones presented during the discussion of related work.

5.7 Limitations

The survey presented in this paper investigates a diverse range of aspects that concern the design of TMAP. While the results we discussed mainly address a series of general design implications beyond specific use cases, we do not know much about demographic data, for which population the results are representative, and if study participants had prior experience with TMAP. It can be difficult to imagine the implications of TMAP for those who have never experienced such an interactive performance. This is a limitation

in terms of what we have learned about the participants' opinion about TMAP as we cannot judge if people answered based on their expectations or prior experience.

Although, all design implications are derived from the survey results in the same way, they address the design of TMAP on different levels. Some of them are more obvious for design (e.g. distinctiveness, sociability, expressiveness), while others are more difficult to consider and orient to (e.g. mood, openness).

6. CONCLUSION

In the existing literature, identification of issues for the design of technology-mediated audience participation (TMAP) in live music has been mostly based on concrete case studies and derived from case-specic feedback of participants. This has resulted in an identifiable gap in design knowledge. Consequently, we conducted an online survey to collect quantitative data about live music and TMAP on a more general basis, detached from any particular case study. The results were based on 227 complete responses of spectators and musicians, analysed through the use of descriptive statistics. With a step by step discussion of these results across survey sections and both target groups, we identied 16 key issues for the design of TMAP in live music. These issues are skilfulness, expressiveness, diversity, objects, readiness, masterfulness, exposure, communication, openness, creativity, distinctiveness, obtrusiveness, sociability, mood, appropriateness, and contradiction.

The most desired idea by spectators was to select songs played during a concert by using TMAP. Visuals in general are sometimes offered by musicians as an element for control by TMAP, but do not concern audience members so much. In the case of sound, audience members mostly wish to control the volume of the music, whereas the musicians mostly reject any inuence on sound.

Finally, there are preferences about particular technologies for audience participation. Candidate technologies include recognition systems such as cameras, oor sensors, and phonometers. In the case of smartphone technologies in particular, opinions are divided.

6.1 Future Work

Throughout the discussion, we found additional possible design directions to be investigated in further studies. These rather concrete design ideas concern the possible impact on performance elements and technological preferences. In general, musicians agree with a creative contribution from the audience. We cannot draw further conclusions on the results about how this creative contribution might look. Thus, it should be a potential focus for further studies.

As mentioned in the limitations section earlier, little demographic information is known about the sample of survey participants. This could be a good starting point for further studies to investigate specific target demographic groups (e.g. based on knowledge, experience, or genre).

Methodologically, future work could explore people's opinion by using qualitative methods. In this way, we could

better understand why some ideas for TMAP are preferred and others are not.

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