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Agile methodologies between software development and music production: an empirical study

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Over the past 20 years agile methodologies revolutionized Information Technology, offering tremendous opportunities for the development of Software Engineering as an independent discipline. More specifically, agile methodologies contributed to enhancing the effectiveness and the speed of the production process as well as to improving the productivity and motivations of software developers organized in high performing teams. The agile philosophy can be and has been applied in different contexts and across several domains. This work analyses the relationship between Agile methodologies used by software engineers and the practices pursued by musicians in their daily lives. Our findings suggests that collaborative, strongly planned software development life cycle models (such as Waterfall, V-model, iterative, and Spiral) are not adequate models to describe the daily practices of musical composers. This is because their work requires a lot of flexibility, which such models intrinsically lack, because they are oriented to ensuring some form of monitorable progress. Interestingly, our findings also show that nine out of 12 Agile Principles are consciously or unconsciously followed by musicians in their practices. This suggests that there are some deep connections between these two *prima facie* different fields, which are both very creative. Even though our findings await replication, possibly with larger statistical samples, they contribute to open up a new strand of research in the field.

KEYWORDS

software development, music, music production, agile methodologies, empirical investigation, agile methods

1. Introduction

Over the past 20 years agile methodologies revolutionized Information Technology (Beck, 1999; Beck et al., 2001; Messina et al., 2016; Ciancarini et al., 2018; Russo, 2021), offering tremendous opportunities for the development of software engineering as an independent discipline (Fowler et al., 2001; Russo et al., 2018b; Ciancarini et al., 2020; Verwijs and Russo, 2022). More specifically, such methodologies contributed to enhancing the quality and speed of the production process as well as to improving the productivity and motivations of software engineering teams (Ivanov et al., 2017; Succi and Ivanov, 2018; Tailong Jing, 2023). There are several agile methods. Even with different flavors, they find all their common denominator in the so-called Agile Manifesto (see Section 2.2). Agile methods represent a radical departure and a fundamental alternative to command-and-control-style views (e.g. waterfall-type development processes) traditionally adapted by scientific management (e.g., Taylorism Littler, 1978). Agile methods are increasingly spreading, being utilized across a wide range of industries and fields.

Consider the following examples (not related to the software development industry) as paradigmatic illustrations of this point. Tractor manufacturer John Deere recently started using agile methodologies to develop new machines. Car manufacturer Saab utilizes such methodologies to produce fighter jets and knock down sheer costs of military procurement for the Swedish government (Corral et al., 2013; Fronza et al., 2013). Mission Bell Winery, an American biotechnology company, uses agile methodologies to run business, regulate wine production, and organize warehousing[1]. It is therefore safe to assert that the agile approach has proven extremely beneficial to accelerate profitable growth for many companies (Moreira, 2013).

Yet, such an approach also offers a number of more general benefits, all of which have been extensively documented in the software development industry and beyond it. On the one hand, this approach can increase team productivity (Melo et al., 2013), maximize time efficiency (Rosenberg, 2010), improve customer engagement and satisfaction (Hanssen and Fægri, 2006), enhance organization by increasing cross-functional collaboration (Noguera et al., 2018) as well as contributing to build mutual trust (McHugh et al., 2011). On the other hand, the agile approach can minimize repetitive planning, excessive documentation, quality defects, and low-value product features (Kaur et al., 2015).

Agile, though, is not a panacea for all problems. It is most effective and therefore easiest to implement under specific conditions; those that are most commonly found in the software industry. Such conditions include: (i). that there is a problem to be solved and that the problem is intrinsically complex or "wicked" (Nerur and Balijepally, 2007); (ii). that the solutions to the problem are not readily available (hence unknown) at the time of its formulation; (iii). that, at least, some of the requirements of the product being developed to solve the problem will likely change during the production process; (iv). that the creative work involved in the process can be modularized and assigned to different developers working in parallel; and (v). that close collaboration between users and developers is not only possible but also recommended (Beck et al., 2001).

To better understand the potentials of the agile vision we analyzed the extent to which its fundamental principles are already applied, even if perhaps unknowingly, to another highly knowledge and technically intensive industry; namely music composition. Composing excellent music and writing high quality software exhibit several potentially interesting analogies. For example, they both require outstanding technical skills and a great deal of intuition, as well as enormous creativity. They also demand intensive practice and continuous efforts, which are practically never ending. They need to coordinate stakeholders at different levels and they require (among many other qualities) determination, motivation, and high focus (Barton et al., 2019). Yet, composing music and directing people (in playing or singing) is an ability that has a much longer history than producing software (Pfeiffer, 1982; Morley, 2002; Mithen et al., 2006; Adler, 2009). This means that there are a plethora of techniques, methods, and tools involved in musical ability, developed over many centuries of successful history (Zhang et al., 1999; Morley, 2013), that may not be found in software engineering. In this sense then, there are -potentially- plenty of opportunities for software developers for cross-contamination with such a field as well as for retrospective learning. A book by Cho (2010) explored the analogy between Jazz collaborative performances and agile software development (more on this below). In this research we aim to broaden and enrich Cho's perspective. Our hypothesis is that understanding the similarities between these two seemingly different fields and the degree to which agile practices are present in the music industry may provide helpful insights to more effectively manage the production of software.

Our goal in this paper is therefore as follows:

> to understand whether the work of musicians can be informed, inspired, and guided by agile methodologies; and, if so, the extent of such an influence.

Moreover, a positive answer to this question would create a strong binding between the management practices of musicians and of software development and would provide a encouragement to explore the harder issue of identifying practices in use in music that could be applied to software development.

To achieve our goal we performed an empirical investigation based on the most solid standards in the field (Missiroli et al., 2017; Russo et al., 2018a; Ciancarini et al., 2019; Russo and Stol, 2019, 2021; Cucolaş and Russo, 2023). The results pointed out many interesting analogies between the daily practices of software engineers and those of musicians, thereby contributing to open a profitable new strand of research in the literature.

This paper is organized as follows. Section 2 reviews the role of music in human life, summarizes the most important agile principles, and explains (*through the Jazz Metaphor*) how agile methodologies can be used in music production. Section 3 presents the overall methodology adopted in our empirical study- Section 4 describes the interview sessions. Section 5 illustrates the results of our investigation, contextualizes our findings, and critically discusses them. Section 6 points out potential shortcomings and various limitations affecting our work. Finally, section 7 presents a synoptic summary of what we have achieved, while sketching out possible future research directions.

2. Agile methodologies in music production

2.1. Music in human life

Music is an extremely valued feature of all known living cultures (Boer et al., 2011). Music pervades many aspects of our daily lives. People can listen to it for hours at home, at work, at the gym, at restaurants. People attend concerts and go to theaters to listen music played live. Music also accompanies popular TV shows, commercials, and all sort of movies. We actively listen to music while we travel by plane, train, bus, even on foot. We literally spend billions of euros buying it. It has been recently calculated that people, on average, spend approximately 15 percent of their waking

1 https://hbr.org/2016/05/embracing-agile Accessed on April 2022.

time with playing music[2]. It is therefore not surprising that music may come to serve important cognitive functions, from emotion regulation to self-expression, and social bonding (Levitin, 2006).

Moreover, music is an ancient practice with a very rich cultural history (Wulstan, 1971; Holmes and Coles, 1981; Tomlinson, 2015). The oldest known sets of musical instruments (a bone flute discovered in the Hohle Fels cave near Ulm, Germany and wooden pipes found near Greystones, Ireland) appeared in the archaeological record about 40,000 years ago (Holmes and Molloy, 2006; Conard and Malina, 2008; Conard et al., 2009). Nevertheless, it is reasonable to assume that a tendency to produce proto-music, in the form of vocalizations and rhythms (Morley, 2013; Kuhn, 2014; Diedrich, 2015), was already present among humans in the late mid-Pleistocene, roughly 400,000 years ago, and perhaps earlier (Mithen et al., 2006; Killin, 2017).

From that age music, as a cultural ability, evolved incrementally throughout modernity with crucial landmark steps (Sachs, 2008): a. the global dispersal from Africa, about 60000-100000 year ago; b. the production of the first primitive set of musical instruments (about 40000 years ago); c.the Holocene, about 12000 years ago, enabled by a series of changes (e.g. the agricultural shift and other technological innovations, such as the invention of pottery, writing, and metalworking) which determined an increased capability in producing high-quality musical instruments; and finally d. the ancient time (about 7000-6000 years ago) where the oldest known song was written in cuneiform script in Ugarit, Syria (West, 1994; Killin, 2014, 2016, 2018) and the first Neolithic bone flutes produced in Jiahu (Henan Province, China) (DeWoskin, 1998; Zhang et al., 1999, 2004).

From about 5000 years ago there is significant evidence that music started to spread even further (Galpin, 2011), for example, to the Hela civilization of Sri Lanka in the time of King Ravana (Lawergren, 1988) as well as to Iran and Egypt Klein (2000). Fragmentary evidence proves that the ancient Persians (under the Elamite Empire) possessed a very sophisticated musical culture (Galpin, 1929; Barnett, 1969; Kilmer, 1971). The Ancient Egyptians also had an archaeologically visible musical life, perhaps more even more visible than any other civilization that lived prior to them. 'Tombs and temple walls depict that musical scenes, including of singers, harpists, flautists, players of reed wind-instruments, lute and lyre players, drum and tambourine players, small groups of performers, clapping/dancing females, often accompanying processions or providing music at public feasts' (Goodall, 2013), p.9. This demonstrate that music played a fundamental role in the daily life of Ancient Egyptians (Manniche, 1991). (see Figure 1, below).

There is also evidence demonstrating a capacity for sophisticated musical production among early Aborigine Tribes in Australia (Gould, 1969). For instance, boomerangs were often used as musical clap-sticks (Stubington and Marika-Munuungritj, 2007) (see Figure 2, below). Likewise, songs were sang as mnemonic devices (sort of cognitive maps) to successfully navigate in barren desert environments (James, 2013), hence 'for tracing a route on Earth' (Norris and Harney, 2014 p. 141, p. 145).

FIGURE 1
Music in Ancient Egypt: Source Killin (2018).

FIGURE 2
Didgeridoo and clapstick players performing in the Northern Territory - source: Wikipedia.

Nevertheless, Greece was probably the place were music - in Ancient times at least - was better studied (think about the Pythagorean tuning of the diatonic scale) and held in the greatest respect (see Figure 3, below), with musical attitudes being

2 https://www.bls.gov/news.release/pdf/atus.pdf Accessed on 5 April 2022.

FIGURE 3
Greek amphora with musical scene - source: the Walters Arts Museum.

cultivated as fundamental virtues of free citizens (Williams and Williams, 1980; West, 1992; Bundrick, 2005).

Several Greek philosophers demonstrated an interest in the actual practices of real musicians (Klavan, 2021). In the *Republic*, Plato argued that the guardians of his ideal state ought to undergo substantial musical training (Pelosi, 2010). A similar understanding can be found in Aristotle, who in the *Politics*, emphasized the crucial importance of music in youth training, stressing the merits of musical education and practice in forging character traits and in developing a healthy mind (Simpson, 2000; Stamou, 2002).

In this section, owning it to lack of space, we cannot provide a much more detailed overview of the history and development of music as a cultural practice. The above mentioned discussion though, was instrumental to make a crucial point in the economy of this paper; namely, that music has, contrary to software development, a very long and rich history (Morley, 2002; Davies, 2012; Harvey, 2017).

Recently an interest arose in music composition as a social activity (Rennie, 2021). Music composition is traditionally regarded as an act of individual creation and personal expression; however, the technology for supporting (live) collaborative composition and performance is quite complex (McGrath and Love, 2017). Moreover, the introduction of digital platforms for teaching music as well as musical composition and performance has introduced a social dimension to musical creativity (Love and Barrett, 2014).

We also remark that the birth of new digital music industries and online providers, strongly software-intensive, like Spotify, has shown the importance of innovative, agile organizations in music management (Schwarz, 2018).

2.2. Agile principles

As mentioned in the introduction, agile methods have emerged in the last 40 years as a radical departure from mainstream (waterfall) Tayloristic approaches to software production and development. A seminal formulation of the Agile methodologies can be found in the Spiral Development Model developed by Barry Boehm (Boehm, 1988), and subsequently observed in the 12 Agile principles formalized around those seminal by a group of "agile gurus" in the so-called "Agile Manifesto" (Beck et al., 2001):

The Agile Manifesto – copied verbatim from Beck et al. (2001)

1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2. We welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
4. Business people and developers must work together daily throughout the project.
5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7. Working software is the primary measure of progress.
8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9. Continuous attention to technical excellence and good design enhances agility.
10. Simplicity–the art of maximizing the amount of work not done–is essential.
11. The best architectures, requirements, and designs emerge from self-organizing teams.
12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

There are several methods that claim to follow the principles of the agile manifesto, mostly developed by the authors of the manifesto itself, such as –among others: *Scrum*, which focuses on the power of iterative, incremental, and adaptive teamwork to manage complex work (Schwaber and Beedle, 2001), *Lean Software Development*, which concentrates on getting rid of redundant practices wasting time and resources while maximizing value to the customer (Poppendieck and Poppendieck, 2003), *Kanban*,

which emphasizes the need of developing lean and just-in-time manufacturing (Anderson, 2010), and *EXtreme Programming (XP)*, which strives to improve software quality by introducing a series of checkpoints at which new or modified customer requirements can be adopted (Beck, 1999).

2.3. Agile and music - a literature review

Having looked at the role of music in human life and introduced Agile Principles and Methodologies, we can now turn to analyse whether such methodologies (recently developed in the IT industry), can be meaningfully used in musical production and/or management. The analysis of this point is important as it will set up the scene for the experimental analysis conducted in our paper, which will aim at determining whether musical practices can in turn impact the daily practice of software developers.

We proceed with a literature review as follows, by:

- Selecting Keywords and Search Queries;
- Selecting Databases;
- Formulating Inclusion/Exclusion Criteria; and
- Finalizing our Reading Log.

During our exploratory investigation we searched, by using a series of relevant keywords (such as "musicians," "agile," "composers," "music," "agile methodologies," "programming") a number of academic databases and open access libraries, such as:

- ResearchGate
- Science Direct
- Web of Science

After individuating a large amount of potentially relevant papers, we then moved to analyse them. In this context, we performed two basic actions or steps:

- *Step one* included a quick review of the publications by Title, Keywords and Abstract (this allowed us to skim off a lot of irrelevant papers);
- *Step two* involved a precise analysis of the papers we preliminary selected (as in step 1 above). Such an analysis involved reading, a comparison in contents, the individuation of objectives and results, a reflection on the reliability of the findings etc.

We would like to note that the two steps above mentioned were performed by team members collectively at various points in time. These mutual, consistent, and progressive cross-checks were done to maximize objectivity, efficiency, and reliability; hence, to minimize potential mistakes or biases.

While selecting relevant research publications we also decided to consider only articles that satisfied the criteria we list below:

- Articles published after 1950. The main reason to consider 1950 as the starting point for our work is simple: the first writings in English about the Lean and Agile vision were published during the 1940 (Ohno, 1978). We decided to exclude any potentially biased information that could have come in the very first decade after the publication of the seminal papers on Agile in English. So, we focused only on papers published after 1950.
- Publications that indirectly answered our specific research questions.
- Publications that more directly answered our specific research questions.

We found only seven potentially relevant papers, namely (Sawyer, 1992; Bratteteig and Stolterman, 1997; Cloke, 2007; Suscheck and Ford, 2008; Cho, 2010; Lee, 2014; Barton et al., 2019). These papers mostly discuss the analogy between musical creativity and software coding. Only a couple of them, namely Suscheck and Ford (2008) and Cho (2010), discuss the issue of collaborative creativity in both fields, directly relating to agile development. Remarkably, both research works examine the jazz approach to musical creativity.

Since we found a very small set of relevant papers, we try to contextualize their results, starting with some basic observations. Many members of the Agile community seem to have a musical proclivity or a musical background (Cloke, 2007; Kniberg and Ivarsson, 2012). In addition, as noted above, there are indeed significant commonalities between music and software development, both of which draw on diversely skilled individuals, collaborating to create a common vision/product. In Lee (2014) a number of other similarities are listed. These include: i. music and software are both collaborative and individualistic activities; ii. music and software are both abstract media, iii. music and software both require interpretation and execution; iv. both music and software creation require competence and experience with a variety of technologies and styles.

This preliminary, rather anecdotal evidence, lead us to hypothesize that principles and methods developed within the agile approach could be successfully applied to music and, in turn, that certain musical practices could inspire and enhance the practice and performances of software developers (Gimenes et al., 2006).

To see whether this hypothesis can stand closer scrutiny, we next briefly discuss a case study involving jazz groups, which we believe can work as a potential metaphor for understanding the supportive organizational behavior described in agile software development methodology, thus to establish the point above mentioned. p Jazz is a type of music that is largely based on improvisation (Monson, 2009). In most jazz performances, jazz players typically make up their play on the spot. This requires considerable skills. Naturally, there is a huge variety in jazz styles and motives (Gridley, 1978; DeVeaux, 1991) and this is not the place to delve into this topic further; however, for the purpose of this paper, we can say that most jazz is usually very rhythmic, has a forward momentum called "swing," and that it typically uses "bent" or "blue" notes (Gioia, 2011).

Jazz groups, like other musical groups or ensembles, are characterized by adaptive (dynamical) process of music production (Borgo and Goguen, 2005). Jazz teams are also closely integrated and are composed by very skillful musicians (Sawyer, 1992).

In addition, jazz groups typically improvise (Bratteteig and Stolterman, 1997).

There are significant analogies between the process involved in the production of a jazz performance and those involved in the collaborative coding of a program. In Suscheck and Ford (2008) a jazz metaphor was used to study the organizational behavior of a team of software developers. More generally, one might venture to say that music itself can be understood as a sort of programming language (Marino and Succi, 1989). In music in fact, notes and symbols form a syntax that must be followed and the dynamics and tempo set the pace of the musical piece, in accordance with the correct musical context (genre) (Treitler, 1982).

Jazz, however, more than other musical genres is characterized by being based on improvisations. One might intuitively object that improvisation is necessarily incongruent with a structured, and formalized activity like that of coding a computer program. However, research in Computer Science has long emphasized the fact that coding is a highly creative process, with an intrinsic aesthetic and creative flavor (Sedelow, 1970; Knuth, 1984, 1997, 2011; Wallace, 1999; Cramer and Gabriel, 2001; Fishwick et al., 2003; Bond, 2005; Fishwick, 2008; Trifonova et al., 2008).

In addition, jazz as an art form requires the players to properly comprehend all theories, conventions, and themes characterizing a given piece of music (Mazzola and Cherlin, 2008). Likewise, jazz demands a strong collaboration among team members, as well as careful listening abilities, capacity of multitasking, and the ability to creatively improvise when needed (Gleiser and Danon, 2003). These traits or features of jazz can be said to be crucially important for a well-functioning software engineering team. It is not by chance that this understanding of jazz as a teaming tool has been explored in the context of collaborative software development (Suscheck and Ford, 2008; Cho, 2010).

Here, we want to delve into this analogy a bit more and specify further commonalities. A jazz ensemble typically consists of three main units: i. a piano or a guitar, ii. the bass, and iii. the drum/s. The bass typically provides to the ensemble the foundational chord and the tempo, while the piano or the guitar function as the glue of the ensemble and usually provide the rhythm and the melody. The drums perform percussions and therefore determine the feel of the ensemble. The drums can be understood as the conductor of a jazz ensemble (think about Art Blakey, Joe Jones, or Jeff Hamilton). An ensemble is usually successful if it strikes a balance between these three different units.

A software architect, like the pianist, can gently coalesce the team and keep the right balance between its members. A project manager or a scrum master, like a drummer, can set the pace of the work, leading and coordinating the group. Members of the development team, like the bass players, do their honest share of the work and can be considered as the backbone of any successful productive endeavor.

In addition, great jazz ensemble, like well-functioning software development teams, do distribute responsibility but are also organized in such a way to require that each person know their part, hence a reciprocal trust can be build. Members of an ensemble and software team developers, however, must also listen to and support each other. For example, When one person goes solos (either in music or in coding), the others adjust their performance in an effort to make the solo shine.

Furthermore, very experienced jazz musicians, like scrum masters or senior managers, know what the public like and can change the rhythm and style of their music accordingly, so go into new directions, knowing that the rest of the group can easily follow them because of their mastery of the subtleties of their craft[3]. Addressing emerging design problems or sudden and unusual users' requests with common architectures and approaches also helps software developers finalizing their products. In that sense, jazz and software are also very much aligned.

One may also say that the ethos of jazz ultimately requires players to be brave and dire; that is, to try out new things and to constantly experiment. This idea can also be found in software developer teams, especially in those teams using agile methodologies, where developers are often asked to "dare to be great" and express their opinion on the development process.

The preliminary conclusion we can draw from this analysis is that both musicians and software engineers -in their daily practices- can be guided by agile methodologies and principles. Building and expanding on this observation, we next describe our experimental protocol, which we developed to discover further analogies between these two seemingly different fields/professions, in the hope of improving the practice and the overall quality of software developers' performances.

3. Research method

In this section we explain the methodology we adopted and the steps we followed in our experimental protocol (Farina et al., 2022). These are as follow:

- Research study:
  - Determining the research questions;
- Interview sessions:
  - Developing a questionnaire;
  - Semi-structured interviews;
  - Structured interviews;
- Data Analysis;
- Data Interpretation;
- Analysis of Limitations and Shortcomings;
- Conclusion.

We first planned our study and formulated the research questions that inspired and guided our work. The research questions we formulated were heavily dependant on the ideas we explained and discussed in previous sections. Our research questions are:

3 https://base2s.com/how-successful-engineering-teams-function-like-a-jazz-combo/ Accessed on April 2022.

TABLE 1 Relation between agile principles and questions in our questionnaire.

Agile principle (number)	Questions (numbers)
1	1
2	2
3	3, 4
4	5, 6
5	7, 8, 9, 10
6	11, 12
7	13
8	14, 15, 16
9	17
10	18, 19
11	20, 21, 22, 23, 24, 25
12	26

RQ_1 *Are principles and ideas underlying agile methodologies also applicable to the daily practices of composers?*

RQ_2 *Are such principles and ideas actually followed (consciously or unconsciously) by composers?*

Having formulated our research question we then proceeded with the interview sessions. In this study, as noted above, we used both Semi-structured (SSI) and Structured interviews (SI). In the first part of the interview session, we adopted SSIs; that is, we offer our interviewees the opportunity to flexibly answer a series of open-ended questions in a natural environment. In the second part of the session, instead, we used SIs; that is, participants were asked to answer -in a standard form (yes, no, maybe)- a precise set of questions - a questionnaire, analysing the work of musical composers and testing its adherence to the principles of the agile manifesto-in a controlled environment.

The questionnaire can be considered as the most important research instrument for this work. In general, we can say that questionnaires are the most accurate and effective tools used by researchers worldwide to conduct exploratory work in any field (Yin, 2012). Designing an effective questionnaire for an interview, though, is not an easy task. The way in which the questions are defined, arranged and organized, and even presented to the participants may significantly affect the quality of the answers received (Creswell, 2013). For this reason, to minimize biases in the responses, redundancy and replication, we designed our questionnaire following the best practice in our discipline (Furnham, 1986; Podsakoff et al., 2003; Bond and Fox, 2013; Vannette and Krosnick, 2014).

Our questionnaire is organized in 12 parts each matching one of the aforementioned Agile principles.

In Table 1 below the reader can see to which Agile principles the questions contained in our questionnaire related to. The questionnaire is available as an Appendix 7.

In this context, it is worth noting that semi-structured and structured interviews are potentially affected by a number of issues and that both have advantages and disadvantages. However, this is not the place to discuss this issue. We devoted a whole section (section V. Limitation and Shortcomings) to analyse this point (and more on this below).

Having gathered and read the small set of papers we found in our review, which allowed us to get a better grasp of the sort of research that has been carried out in the field thus far, we defined our experimental protocol. We developed the interview schema shown in the Appendix, starting from the 12 Agile principles, which were rephrased in several questions and subsequently administered to musicians. We proposed the interview schema, collected the answers, and then started processing our findings and problematizing around our results.

Before we go on to discuss the analysis of our findings (which recall were obtained from structured and semi-structured interviews), we would like to note that the literature review confirmed our early intuition about the novelty and potential significance of this research. As we quickly found out, the relationship between software development in agile contexts and music composition has not been sufficiently investigated in the literature so far.

4. Details on the interview process

Our interview sessions were recorded (with permission of the participants involved) and safely stored on a private repository. We decided to record the interviews mainly for two reasons: i. to ensure more precise data collection and ii. to guarantee a smoother interpretation of controversial points that may have arisen during the interview process. The recorded conversations were tabulated in a relational google spreadsheet to generate clear and understandable outcomes.

We selected the participants in our study in accordance with the following criteria:

- The participant must have had, at least, 10 years of experience as a musician;
- The participants must have had, at least, 5 years of practical experience in musical composition for customers.

These criteria were adopted to ensure that the participants had significant musical competence and a sufficient degree of professionalism that allowed them to reliably work with clients; hence, to be considered *professionals* (not amateurs).

Seventeen subjects participated in our study. Figures 4–6 below aptly describe our sample. The sample consisted of mostly Russian speaking individuals (94% of the participants were ethnic Russians), mostly (but not uniquely) living between Moscow and Kazan, of which males (84 %) and females (17%), aged between 25 and 40 (average mean age 30). 83% of the sample size had universities degrees (such as Masters, PhDs, or Bachelors), almost equally distributed among humanitarian and scientific disciplines (see Figure 5). About 59% of the sample size were engaged in professions not directly related to music compositions; that is, although they were professionals they preferred working a different job. Some of the individuals selected for the study were recruited via online surveys, through popular social networks such as Facebook,

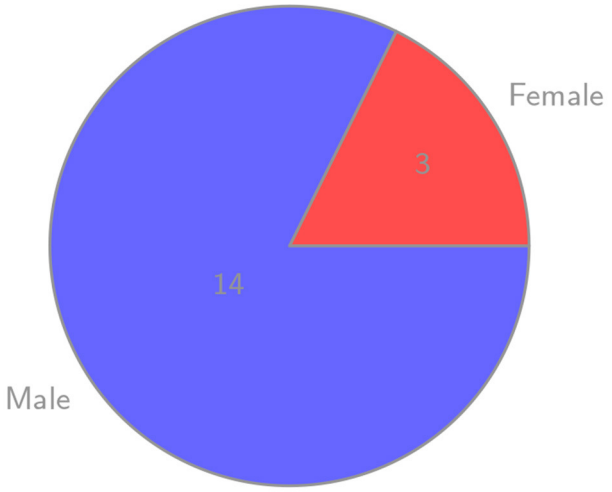

FIGURE 4
Gender of the interviewees.

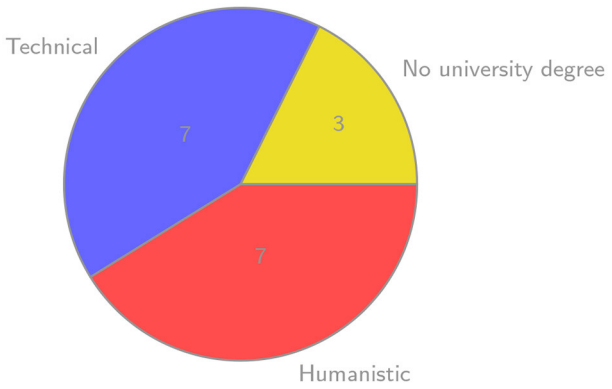

FIGURE 5
Profile of the education of the interviewees.

Instagram, VKontakte and Twitter (Russo, 2022). This ensured variability and the representation of diverse cultural stances. Other participants were enlisted for the study through indirect contacts, e.g. some participants were common friends or friends or friends.

Each interview session lasted, on average, 75 min. After performing SSIs, as noted above, we administered to the participants our questionnaire, which consisted of 26 questions and 24 sub-questions. Questions and subquestions were both open and closed. Our questions were inspired by the Agile Manifesto and were aimed at determining the specific relations between the work of musical composers and Agile methodologies.

5. Analysis and discussion

Having described our results, we now analyse them to determine their adherence to the Agile Manifesto. Figure 6 summarizes our findings.

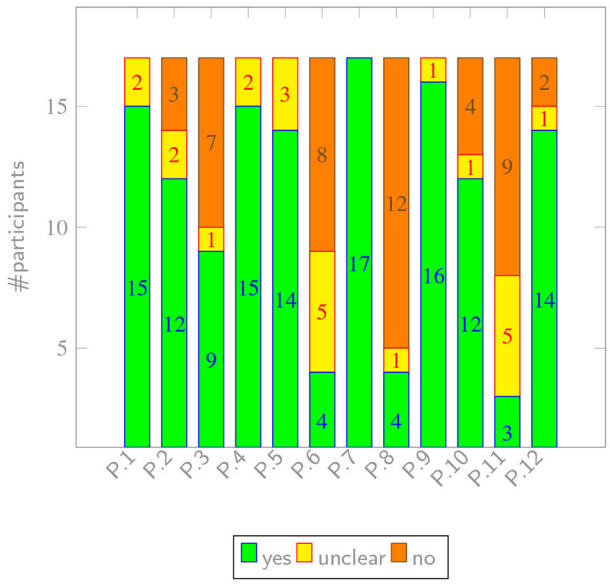

FIGURE 6
Musicians' reported adherence to agile principles in their daily practices.

(P.1) *Our highest priority to satisfy the customer through early and continuous delivery of valuable software.*

According to the results of our interviews, the vast majority of the respondents (15 out of 17, about 88%) provided a positive reply to this question, while 2 did not provide a clear answer. Overall almost all of the participants mentioned customer approval and good quality of the final product as desirable outcomes of their work. Most of the musicians though did not prioritize their tasks apart from having a standard to do list.

It emerged that another process that musicians do to please their customers involves the release of demo versions of their music. This process is comparable with the process of prototyping in software development.

In general, we found out that to produce a valuable result, musicians adopted enthusiastic moods because such attitudes, we found out, boosted their creativity and lead to better results.

(P.2) *Welcome changing requirements, even late in development process. Agile process harnesses changes for the customer's competitive advantage.*

Most of the respondents followed this principle as they reported to be fully committed to accommodate customers' requests (12 subjects, amounting to about 70%). Two respondents did no produce clear answers, while 3 were against such a practice. It is worth mentioning that we found out that it is a relatively common practice among musicians to include a certain number of free changes for the customer in any the contract they sign.

(P.3) *Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.*

We found that musicians tend to think that this practice is rather problematic, even if it appears to be a consequence of 5. Delivery music in chunks is quite complicated; however, it is still possible to release demo versions or snippets. This process helps gathering early feedback, which can be instrumental (it was noted) to achieve customers' satisfaction.

Specifically, 9 participants (about 53% of the sample we interviewed) confirmed that they practice partial releases during work. Nevertheless, 7 individuals (about 41% of the sample) claimed to just release the final product. 1 person preferred not to respond to this question.

(P.4) *Business people and developers must work together daily throughout the project.*

Overall, musicians do consider a good and effective relationship with their customers a top priority. Specifically, 15 respondents (about 88%) were clearly positive about this point while 2 (about 12%) remained agnostic. We note that no one expressed negative feeling about this idea.

It is also worth noting that almost all the participants we interviewed explicitly mentioned detailed discussions with customers as one of their preferred strategies for communication.

In particular, 9 musicians clearly reported willingness to find common ground with their customers, as they think that this practice usually leads to the production of a quality product and to better business relationships. To achieve this, several musicians reported to teach their customers the fundamentals of music composition.

On a side note, to check the quality of their work most of the musicians we interviewed (12, equivalent to 70%) directly involve customers, 4 of them (about one quarter of the sample we interviewed) reported to use focus groups.

(P.5) *Build projects around motivated individuals. Give them the environment and support they need, and trust to get the job done.*

Not much to say here. The vast majority of the musicians we interviewed (14 out of 17 subjects, amounting to approximately 82% of the total) clearly stated that they think it is beneficial to work with motivated people. 3 remained dubious.

Several participants also mentioned the presence of demotivated people around them. Such people are usually immediately dismissed from their role.

(P.6) *The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.*

We found out that this principle is quite controversial for musicians. Only 4 subjects regularly have face to face conversations with their customers. 8 subjects (47%, almost half of the total) preferred various forms of online communications (such as video calls, messages, and file transfers through messengers). 5 did not clearly answer this question and remained uncertain about the best method of communication.

(P.7) *Working software is the primary measure of progress.*

All the musicians we interviewed (100%) agreed that pleasing their customer is the general measure for good progress. This can be done in different ways, of course. For example, with external reviewers (such as friends or families) or by dealing directly with the customer. In any case, we must note that there was a constant emphasis in claiming that the success of a project is based on customers' acceptance.

The majority of the interviewees (11, more than 64%) said they did not use any tool for tracking their work.

(P.8) *Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.*

The vast majority of the interviewees (12, amounting to approximately 70% of the total) claimed to work till exhaustion (meaning they only stop when they feel pain in their arms or need to eat or to sleep). We found a few exceptions, of course. Such people followed a regular working schedule.

(P.9) *Continuous attention to technical excellence and good design enhances agility*

Practically all the interviewees (16 out of 17) considered technical excellence and good design, in the sense of a suitable organization of work, as a top priority. Interestingly, in the context of game audio the idea of agile composition is quite well known [4].

(P.10) *Simplicity - the art of maximizing the amount of work not done - is essential*

While only one musician made an explicit mention of the desire to simplify the overall production of her music, 12 of them (amounting to 71% of the total) created their work in steps minimizing tasks and focusing on the key customers' desires.

Moreover, 10 musicians (58%) said to avoid tasks prioritization in the organization of their work because in composition there is almost always a well-defined, pretty clear sequencing of actions.

(P.11) *The best architectures, requirements, and designs emerge from self-organizing teams*

In general, we note that all the musicians we interviewed in our survey believed that preparing their work beforehand would lead to more productivity and less stress. However, only 3 of them tried self-organizing teams, while 9 (amounting to 53% of the total) structured their work in a different way. We note that 5 subjects did not produce a clear answer to this question.

(P.12) *At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly*

According to our survey the majority of musicians reflect on how to become better in their work – in our case 14 out of 17, (amounting to 82% of the total). They typically do so by using audience reviews, experts blogs, or by consulting more experienced colleagues.

It is worth mentioning in this context, that when dealing with criticism, musicians tend to focus mostly on comments coming from

4 See for instance https://www.videogamemusicacademy.com/agile-composer-project-management-game-audio/ Accessed on April 2022.

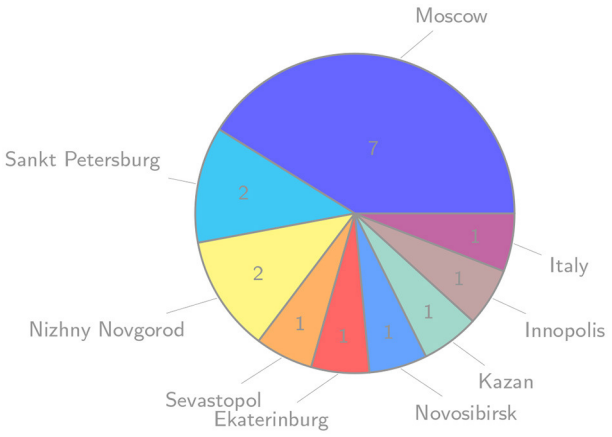

FIGURE 7
Locations of the interviewees.

those that they consider more experiences than themselves.

To sum up, we note that 9 of the 12 agile principles find some sort of application in the daily practices of most musicians. This corroborates our original intuition concerning these two fields, which -despite being apparently very distant- do share interesting and profitable connections. This in turn suggests the possibility for further research in the field, signaling the possible development of a new strand of research at the interface between software engineering and music production.

6. Limitations and shortcomings

There are a few critical issues in our approach. One of the biggest limitations concerns the selection of the interviewees. The questionnaire used for the interview was administered to mostly Russian speaking individuals, people largely based in Moscow, Kazan, and a few other cities (Figure 7). The sample included a few people from other countries (such as Italy). However, such numbers are small and it was not possible to recruit further people with different backgrounds.

Another potential limitation concerns the sample size (17 individuals). The sample cannot be taken as valuable for a serious statistical analysis (Russo et al., 2015). This means that we could not derive statistically significant results from this research study; however, we were able to derive hypotheses (about the applicability of agile methodologies to musical production) that could be investigated in future research. As a matter of fact, in the near future, we plan to use PLS-SEM (Partial Least Squares - Structural Equation Modeling) to larger sample sizes and thus obtain measured constructs of better statistical significance (Missiroli et al., 2017; Russo et al., 2018a; Ciancarini et al., 2019; Russo and Stol, 2019, 2021; Cucolaş and Russo, 2023).

The interview questions were formulated by the researchers involved in this experiment and no prior analysis tools were used to derive meaningful metrics. We acknowledge this as a potentially significant methodological issue; however, we note that questions administered to our sample were scientifically sound and also very reasonable.

A skeptical reader may also object about the data collection process. As stated above, we organized one to one (semi-structured and structured) interviews sessions, which were then recorded and placed on a private online repository. There are indeed potential limitations affecting both SSIs and SIs (Barriball and While, 1994; Whiting, 2008; Doody and Noonan, 2013; Galletta, 2013).

For example, SSIs are normally time consuming and may be affected by a series of biases, including the following.

- Respondent bias, when the respondent deliberately answers the questions presented incorrectly.
- Researcher bias, when researchers, intentionally or unintentionally, guide the respondent's answer.
- Reactivity, when the interviewer's physical presence affects the respondents' answers.

Following (Robson, 2002) we adopted a number of techniques to minimize the occurrence of such biases. These techniques involve:

1. prolonged involvement,
2. member checking,
3. peer debriefing,
4. audit trail,
5. observer triangulation.

We achieved *Prolonged Involvement* by cultivating a relaxed atmosphere, which was conducive to dialogue and discussion. We made sure to return our findings to the interviewees. This was done to increase accuracy, objectivity, and resonance and ultimately contributed to achieve *Member Checking*). To abide to the requirement of *Peer Debriefing* we sent a cover letter describing the study, its research questions, as well as its aims and overall rationale to the interviewees ahead of the meeting. To comply with *Audit Trial*, we made available to our interviewees our research protocol. We ensured full anonymity for the participants involved in our study. We achieved *Observer Triangulation*, by having three researchers supervising each interview (Runeson and Höst, 2009; Connaway and Powell, 2010; Ciancarini et al., 2021a,b; Farina et al., 2022),

There are, of course, also potential issues with SI. For SIs the questions typically need development, review, and extensive testing. Also, in SIs the pre-planned set of questions is at risk of being revealed, which can help applicants game the system. To avoid these issues, we collaboratively cross-checked the questions administered to our sample and paid particular attention not to reveal any of them to the participants ahead of the interview sessions. SIs performed with these technical precautions can be highly beneficial. As noted by Daniel et al. (2006) structure interviews can:

- increased reliability - as questions are standardized;
- decreased variability among interviewees; and
- Increased results' validity by objectifying them.

7. Conclusion

In this paper we investigated empirically the relations between Agile principles and the daily practice of professional musicians. 73 invitations to participate in the study were sent; however, only 17 professional musicians agreed to take part in our empirical study.

Based on the results of our study we can hypothesize that standard software development life cycle models (such as Waterfall, Spiral, V-model) are not adequate models to describe the daily practices of musical composers. This is because their work requires a lot of flexibility, which such models intrinsically lack. We can also note that 9 out of 12 Agile Principles are consciously or unconsciously followed by the musicians we interviewed. These results, even though obtained on a relatively small statistical sample are interesting as they suggest possible profitable connections between the daily practices of software engineers and those of musical composers. In addition, they also illustrate and point out the reach and potentially significant impact of agile methodologies and principles in other domains.

Further research on this topic will be oriented toward a detailed investigation of the analogies between the composition processes underlying musical production and software development. In doing so, we will also try to better understand the behavioral dispositions characterizing these professions while drawing further meaningful comparisons between them.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcomp.2023.1181041/full#supplementary-material

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