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Technology vision for creative industries: a Delphi-study in Finland

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Abstract: The COVID-19 pandemic has hit hard on creative industries and at the same time revealed the industry's inability to take advantage of new technologies. This observation raises an urgent need to create a short- and mid-term technology vison for the industry to help creatives to identify new technology driven business opportunities and training needs. A traditional consensus driven Delphi-study consisting three rounds was conducted. Delphi-panel consisted nineteen creative industry and technology experts from Finland who represented seven thematic focus areas (e.g. arts and crafts and performing arts). As a result 31 different technologies were identified and prioritised from all seven viewpoints. Diffusion of innovation classification model by Rogers was utilized to evaluate the identified technologies adoption in 2 and 5 year timeframes. The level of agreement among experts is reported.

Keywords: technology vision, Delphi, creative i

1. Introduction

Creative industries has suffered significantly because of lockdown measures introduced across the world to tackle the spread of coronavirus. In past two years festivals, conferences and fairs have been cancelled or postponed. Cinemas, theaters and museums have stayed closed and television and movie productions has been suspended. As a result of these preventive measures, the opportunities for creatives to earn a living have deteriorated significantly in past two years and the situation remains still unclear due introduction of new coronavirus variants (Belitski et al. 2021).

At the same time, the corona crisis has also opened up significant new earning and business opportunities for industries and actors who have been able adjust their business operations according to new customer behaviour and needs (Donthu and Gustafsson, 2020). Among the beneficiaries have been those in particular, who have been able to transfer their operations to virtual environments by using various technological solutions. However, for many sectors including creative industry digitalization and adaption of new technologies has proved to be challenging. The digital transformation in creative industry

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is hindered by many challenges including e.g. immature technology, lack of capabilities and skills and cost-benefit issues (Roecker et al. 2017). In a creative sector, digital services have been developed to some extent during these exceptional times but they have been mainly grounded on solutions, which have been already existing before the crisis. Moreover, in most cases the emphasis has been mainly on being visible and retaining a contact with the public, rather than on actual revenue-generating activities.

The challenges of applying the technology affect the creative industries both in Finland (our case study country) and internationally. In Finland the Parliamentary Committee on the Future has drawn an attention to this and identified the development of digital services in the arts and culture sector as a key development measure (Heinonen, 2020). In all, the corona crisis has strongly emphasised the technology integration into everything megatrend and therefore highlights the need to reform operations accordingly (Dufva, 2020). The ability to apply new technological solutions has undoubtedly contributed to the recovery from the corona crisis for those who have sufficient skills and resources and will make them prepared for similar events also in the future.

Objectives of this study

Expert dominated Delphi technique (Linstone and Turoff, 1975) is utilized to define the technology vison for the creative industries while taking into account the characteristics of different creative industries. The study focuses on identifying the technologies in a short-term perspective (0-2 years), but is also taking into account technologies which can be exploited in the medium term (2-5 years). The emphasis on the short-term is expected to provide the most value for the creatives, since the majority of COVID-19 recovery funding as defined in NextGenerationEU recovery plan will support modernization (European Commission, 2021). The novel market ready and close to market ready technologies identified in a technology vision opens up possibilities to start innovating and ideating new technology-driven products, services and business models, which feasibility can be verified in real-life operating environments by utilizing rapid experiments in real-life environments.

2 Research design

Consensus seeking Delphi

A traditional consensus seeking Delphi process was utilized to define the technology vison for the creative industries in Finland (Linstone and Turoff, 1975). A Delphi process can be characterised as (1) an iterative and (2) structured group communication process, (3) among carefully selected (4) anonymous experts, who as a whole, deal with a complex problem until (5) consensus is reached (adapted from Linstone and Turoff, 2002, Keeney et al. 2006). By dictionary definition the term consensus is “a generally accepted opinion or decision among a group of people” (Cambridge Dictionary). However, there is no universally accepted decision rules to define when the consensus has been reached (World Health Organization, 2014). Many different approaches to define consensus have been used in Delphi studies (Heiko, 2012). In this study “certain level of agreement” approach was adopted. In prior Delphi studies agreement levels have been varied from simple majority (i.e. more than 50% of voters) to supermajority, which have been ranging from two thirds to even as high as 95% (Heiko, 2012). According to Vernon (2009) values of 70% are

commonly used as a threshold level for a consensus. Therefore in this study consensus is considered to be achieved when at least 70 percent of the Delphi panel members are selecting the top or bottom 2 measures in 5-Point importance/desirable Likert scale.

Definition and classification of creative industries

The creative industries (also sometimes referred as cultural industries) are difficult to define and many alternative classification systems have been proposed (Mangematin et al. 2014, DCMS 2001, UNTAD, 2008, Howkins, 2002, Hesmondhalgh, 2007). The following industries have been typically associated with creative industries: advertising, architecture, art, crafts, design, fashion, film, video, television, radio, literature, publishing, music, performing arts, visual and graphic art, video and computer games. Prior studies have shown that creative industry cannot be considered as a coherent sector, since client groups, firms legal status and business processes are varying greatly across the different sub-sectors (Chapain and Comunian, 2011). Therefore, defining a unified technology vision to cover all creative industries is not an applicable research strategy. Since the number of different industries is an extensive, it is also difficult to cover all creative industries in a single Delphi study.

To overcome this challenge cover as many industries as possible, core competence based classification schema proposed by Santonen et al. (2019) was adopted for categorization purposes. The classification model consist the following main core competences: (1) Management of creative work, (2) Visualization and graphical design, (3) Arts and crafts, (4) Writing and storytelling, (5) Performing arts, (6) Music and sound and (7) Solution and concept creation. Each core competence includes a set of skills and competences, which are typically associated with this category. To make sure that each Delphi-panel member would have the same understanding, the classification schema and included skill definitions were provided as background material for all panel members.

Diffusion of innovation

Diffusion of innovation classification model by Rogers (2003) was utilized to evaluate the identified technologies adoption in 2 and 5 year timeframes among the creatives. Roger's model includes the following five adoption categories and percentage shares for each category: (1) innovators representing 2.5 percent share of the sample population, (2) early adopters representing 13.5 percent, (3) early majority 34 percent, (4) late majority 34 percent and (5) laggards 16 percent. In addition, non-adopters was included as a sixth category. It expected that the technology adaption will differ between the defined creative competence areas and therefore it is possible that some of the technologies do not arouse interest in all core areas.

Selection of experts

One of the most important stages in Delphi-study is the selection of qualified experts. A multiple-step iterative approach proposed by Okoli and Pawlowski (2004) was utilized as follows to identify the experts. *First*, a Knowledge Resource Nomination Worksheet (KRNW) was constructed to define and ensure adequate coverage of expertise in relevant fields and to be able cover a number of different creative industries. *Second*, KRNW was populated with potential persons names based desktop research and personal contacts of the research team. Furthermore, creative industry trade organisations and associations

operating in Finland were also identified, since they play a significant role in a member advocacy. Trade organisations and associations were asked to nominate their representatives into panel as well as promote the possibility to participate among their members. *Third*, the identified experts were contacted by email or phone to investigate their willingness to join the Delphi-panel. Snowballing sampling was also utilized and experts were also as ask to nominate other relevant experts based on the given guidelines (Biernacki and Waldorf, 1981). *Fourth*, experts were requested to confirm their areas of expertise regarding (1) each seven specific creative industry sectors needs and (2) future technologies in those specific industry sectors in a five point bad to good Likert-scale. *Fifth*, the experts were ranked on the basis of their qualification and relevant experts meetings the defined criteria were invited to participate in the study. The process continued until the required number of panel members was achieved. In the Table 1, Delphi-panel members' profiles are classified based on industry and technology expertise.

Table 1. Number of Delphi-panel members based on their needs and technology expertise knowledge*

Creative industry core competences	*Expertise about the needs and technology[1]*	*Expertise only about the needs[2]*	*Expertise only about the need technology[3]*	*Experts sum[1,2,3]*	*Others*
1. Management of creative work (MGMT)	6	6	2	14	5
2. Visualization and graphical design (VISU)	6	3	2	11	8
3. Arts and crafts (A&C)	2	1	0	3	16
4. Writing and storytelling (TXT)	8	1	0	9	10
5. Performing arts (PERF)	9	4	0	13	6
6. Music and sound (MUSIC)	7	5	0	12	7
7. Solution and concept creation (SOLU)	8	3	0	11	8

[1,2,3] Including only the experts having very good or pretty good knowledge

The data collection process and response rate

A web-based eDelphi.org application was used for panel management and data collection, (Linturi et al. 2013). Before the first data collection round, the authors of this study conducted an extensive desktop research to define a preliminary technology list for the first data collection round (Mullen, 2003).

The first data collection round was conducted between 31st of May to 9th of June 2021. A mixed method approach was applied and qualitative and quantitative questions were asked as follows (Leech ja Onwuegbuzie 2009). Panel members were asked to adding new technologies, which meet technology readiness level (TRL) 4 to 9 as defined by European Commission (Buchner, 2019). The importance and desirability of the pre-defined technologies were ranked by using the following 5-Point importance/desirable Likert scale:

(1) Not important/desirable at all, (2) Not important/Not desirable, (3) Important/Desirable and (4) Extremely important/desirable. The fifth options included I don't know / No answer. For each technology option, the ranking was done for all seven core competence viewpoint. For each technology, there was also a possibility to give open comments. In all 19 panel members were sending their responses. Between the first and second round, inductive content analysis was conducted to consolidate the qualitative results (Elo and Kyngäs, 2008) and the level of consensus was measured as defined prior.

Second data collection round included similar response tasks as the round 1 and it took place between 16st of June to 23rd of June 2021. In addition, technology adaption among creatives was estimated with the help of diffusion of innovation theory (Rogers, 2003). Panel members were asked to pinpoint one of the Roger's groups, which they considered the best to described the situation in 2 and 5 years from now. The evaluation was done for all seven creative industry core competences. Furthermore, panel members were also asked to assess the technology impact of business potential and the number of jobs in creative industry, but due the space limitation, the results are omitted from this study. Afterwards, the responses were consolidated and shared to the panel members. In all 14 panel members were sending their responses.

The final third data collection round had significantly longer response time due summer holiday season and it was utilized between 28th of June to 16th of August due. The importance and desirability responses had reached sufficient maturity level during the round 2 and therefore, only technology adaption, impact on business potential and the number of jobs questions remained in third round. In all 15 panel members responded in round three. The number of responses varied between the three rounds (19, 14 and 15) but are in-line with similar studies (Mullen, 2003).

3 Results

Overall technology importance ranking

The overall technology importance ranking and the Kruskal-Wallis non-parametric ranking test comparison results between core competence areas is presented in Figure 1. The results in ALL columns includes the assessments of the all panel members who had expertise either on needs, technology or both of them at least in one of the core competence area. For each core competence areas, the results includes only those panel member who had expertise (i.e. need, technology or both) on the particular core competence area. Furthermore, the colour coding in the Figure 1 is indicating that at least 70 percent of the experts were agreeing either on the importance (green) or the non-importance (red) of the technology.

A Kruskal-Wallis test showed that in the case of 19 technologies (61 percent) the importance perceptions differed significantly (all ps < 0.05) between core competence areas. For those 19 technologies, the core competence areas were explaining the between 19 to 46 percent of the variability in the ranking scores. For the remaining 12 technologies, the importance perceptions did not differ, thus the importance of these technologies were considered to be similar between the core competence areas.

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Technology	ALL[1]	ALL[1]	ALL[1]	MGMT	VISU	A&C	TXT	PERF	MUSIC	SOLU
	Mean	Sig.	Effect size	Median						
1. Extended reality (XR)	3.56	**	30 %	4	4	3	3	4	3	4
2. Social media and cloud-based platforms for creative work and freelance services	3.54		4 %	4	4	4	3	3	3.5	4
3. Immersive exhibits and performances	3.52	**	35 %	3	4	2.5	3	4	4	4
4. Telepresence	3.50		16 %	3	4	2	3	4	4	4
5. Holograms	3.44	*	25 %	3	4	2	3	4	3	4
6. 360-degree video	3.40	*	19 %	3	4	3	4	4	3.5	4
7. Data driven creative innovations	3.37	**	34 %	4	3	2	4	3	3	4
8. Online and virtual learning platforms	3.35		4 %	3	3.5	3	3.5	3	3	3
9. Distributed (video) production	3.34		18 %	3	4	2	3	4	3	3
10. Livestreaming	3.31		19 %	3	4	3	3	4	4	3
11. Cloud-based collaboration platforms	3.30	*	22 %	4	3	2	3	3	3	4
12. Emotion tracking/sensing/recognition	3.29		14 %	3	4	2	3	4	3.5	4
13. Image GPT-3	3.29	*	26 %	3	4	2.5	4	3.5	3	4
14. Mobilephone based filming and editing	3.29		15 %	3	4	3	3	4	3.5	3.5
15. Crowdfunding	3.25		11 %	3	3	2	4	3	3	3.5
16. Cloud-based (project) management tools	3.24	*	28 %	4	3	3	3	3	3	3.5
17. Realtime hybrid media broadcasting	3.23	*	22 %	3	3.5	2.5	3	4	3	3
18. Next generation motion capture	3.22	**	39 %	2	4	2	3	4	3	4
19. Micropayment	3.20		9 %	3	3.5	3	4	4	4	3
20. Realtime captioning	3.19	*	28 %	3.5	2	3	4	3.5	3	4
21. Cloud-based GUI and UX applications	3.18	**	39 %	3	4	2.5	3	3	3	4
22. 3D scanning	3.06	**	40 %	3	4	2	2	4	2	4
23. Automated AI based metadata generation and management	3.05		22 %	3	3	3	3.5	3	3	3
24. Deepfake	3.00	**	31 %	2	4	2.5	2.5	4	3	3
25. Virtual LED studios	2.98	**	31 %	3	4	1	2.5	4	3	3.5
26. Speech recognition / voice controlling	2.88		12 %	3	2	3	3	3	2	3
27. 4DX movies	2.86	*	23 %	2	3	2	3	3	3	3
28. 3D print	2.85	**	47 %	2	4	3	2	3	2	4
29. Robot and AI art	2.84		23 %	2	4	2	3	3	2	4
30. Generative Pre-trained Transformer 3 (GPT-3)	2.68	*	21 %	3	2	1.5	4	3	2.5	3
31. AI based music technology	2.66	**	41 %	2	2.5	1	2	3	4	2.5

[1] Includes responses from all experts

* sig. 0.05 level, ** sig. 0.01 level

Expert agreement on the importance

Expert agreement on the non-importance

Figure 1. The overall technology importance ranking and the importance comparison between core competence areas

The level of agreement regarding technology importance

In the Table 2, the technology importance agreement levels between each core competence area are compared. In all 25 out of 31 of the technology assessments regarding "Arts and crafts" did not reach to agreement among the experts. However, due the low number of "Arts and crafts" experts (N=3), the result in this category in general should be considered more or less an exploratory study instead of robust technology importance listing.

On the contrary, the "visualization and graphical" experts were the most unanimous and 90 percent (28 out of 31) of the technology assessments reached to agreement. Also

agreement levels in the case "Writing and storytelling" (84 percent), "solution and concept creation" (81 percent), "performing arts" (77 percent) and "management of the creative work" (71 percent) can be considered high. Finally, also in the case of "Music and sound", most of the technology assessments (65 percent) reached also to agreement.

Table 2. Comparison of the technology importance agreement levels between core competence areas

Creative industry core competences	*Agreement on the importance*[1]	*Agreement on the non-importance*[2]	*Agreement SUM*[1,2]	*Non-agreement*
1. Management of creative work	19	3	19	9
2. Visualization and graphical design	27	1	28	3
3. Arts and crafts	2	4	6	25
4. Writing and storytelling	23	3	26	5
5. Performing arts	24	-	24	7
6. Music and sound	18	2	20	11
7. Solution and concept creation	25	-	25	6

Technology importance ranking between the core competence areas

The technology rankings heatmap is presented in the Figure 2. Respectively to Figure 1, the results in ALL columns includes the assessments of the all panel members whereas each core each core competence areas consisted only the experts within the particular area. The heatmap illustration visualizes the technology ranking order for each core competence area. As the Kruskal-Wallis tests above already revealed, the ranking order are significantly differing between the core competence areas. The three most important technologies for each core competence areas are:

Management of creative work: (1) Cloud-based (project) management tools, (2) Data driven creative innovations and (3) Social media and cloud-based platforms for creative work and freelance services. *Visualization and graphical design:* (1) Social media and cloud-based platforms for creative work and freelance services, (2) 360-degree video and (3) (a) Cloud-based (project) management tools, (b) Online and virtual learning platforms, (c) Livestreaming and (d) 3D print which all shared the same ranking. *Arts and crafts:* (1) Immersive exhibits and performances, (2) Extended reality (XR) and (3) Holograms. *Writing and storytelling*: (1) Realtime captioning, (2) Image GPT-3, and (3) (a) Micropayment, (b) Crowdfunding and (c) Data driven creative innovations which all shared the same ranking. *Performing arts:* (1) Immersive exhibits and performances, (2) Holograms and (3) (a) Extended reality (XR), (b) Realtime hybrid media broadcasting and (c) Next generation motion capture. *Music and sound:* (1) Telepresence, (2) Livestreaming, and (3) AI based music technology. *Solution and concept creation:* (1) 3D print, (2) Extended reality (XR) and (3) Cloud-based GUI and UX applications.

When comparing TOP3 technologies between each core competence area the following technologies can be found in more than one area: Extended reality (XR) in 3 different areas and (a) Cloud-based (project) management tools, (b) Holograms, (c) Immersive exhibits and performances, (d) Livestreaming and (e) Social media and cloud-based platforms for creative work and freelance services in 2 different areas.

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Technology	ALL	MGMT	VISU	A&C	TXT	PERF	MUSIC	SOLU
	MEAN	Rank						
1. Extended reality (XR)	3,56	7	9	2,5	9,5	4	15	2,5
2. Social media and cloud-based platforms for creative work and freelance services	3,54	3	1	12	9,5	15,5	7,5	9
3. Immersive exhibits and performances	3,52	13	14	1	17	1	4	8
4. Telepresence	3,50	9	24,5	12	12,5	6	1,5	14,5
5. Holograms	3,44	10	24,5	2,5	20	2	13	10
6. 360-degree video	3,40	15,5	2	4	22	9	17	5
7. Data driven creative innovations	3,37	1,5	24,5	25,5	4	27	14	4
8. Online and virtual learning platforms	3,35	7	4,5	15	7,5	20,5	12	21,5
9. Distributed (video) production	3,34	11	24,5	6	25	7	5	20
10. Livestreaming	3,31	18,5	4,5	19,5	17	8	1,5	26,5
11. Cloud-based collaboration platforms	3,30	4	24,5	25,5	15	25	10	6
12. Emotion tracking/sensing/recognition	3,29	18,5	24,5	15	12,5	10	7,5	18
13. Image GPT-3	3,29	15,5	14	5	2	17,5	24,0	14,5
14. Mobilephone based filming and editing	3,29	15,5	18,5	9,5	20	13,5	6	21,5
15. Crowdfunding	3,25	15,5	9	22	4	15,5	18,5	14,5
16. Cloud-based (project) management tools	3,24	1,5	4,5	27	12,5	26	22,0	14,5
17. Realtime hybrid media broadcasting	3,23	22	14	18	20	4	9	25
18. Next generation motion capture	3,22	27	24,5	7	23,5	4	20	11,5
19. Micropayment	3,20	20	9	19,5	4	19	11	24
20. Realtime captioning	3,19	5	18,5	30	1	17,5	21	11,5
21. Cloud-based GUI and UX applications	3,18	7	14	15	23,5	30	27	2,5
22. 3D scanning	3,06	21	9	8	29	12	30	7
23. Automated AI based metadata generation and management	3,05	12	9	23	7,5	29	26	17
24. Deepfake	3,00	29	14	9,5	27	11	16	30
25. Virtual LED studios	2,98	24	30,5	12	28	13,5	23	23
26. Speech recognition / voice controlling	2,88	23	18,5	28	12,5	22	25	26,5
27. 4DX movies	2,86	31	18,5	24	26	20,5	18,5	29,0
28. 3D print	2,85	26	4,5	17	30	28	31	1
29. Robot and AI art	2,84	28	24,5	21	17	23	29	19
30. Generative Pre-trained Transformer 3 (GPT-3)	2,68	25	29	31	6	31	28	28
31. AI based music technology	2,66	30	30,5	29	31	24	3	31

Figure 2. The technology importance ranking score and the importance comparison between core competence areas

Technology adaption in 2 and 5 years from now time frame

Figure 3 heatmap presents the technology adaption results in "2 year from now time frame" whereas Figure 4 presents technology adaption results in "5 year from now time frame". The results consist all expert opinions combined for different core competence areas. A Kruskal-Wallis test showed that in "2 years from now" adaption perceptions for 7 technologies (23 percent) differed significantly (all $ps < 0.05$) between core competence areas. The core competence areas were explaining the between 33 to 51 percent of the variability in these ranking scores. In the case of "5 year from now time frame", adaption

perceptions differed significantly (all *p*s < 0.05) for 8 technologies (26 percent) and core competence areas were explaining the between 33 to 51 percent of the variability in these ranking scores. For the remaining 24 technologies (2 year from now) and 23 technologies (5 year from now) technologies, the perceptions did not differ between the core competence areas. However, only in the case of "Robot and AI art" technology (2 years from now), the experts achieved consensus (i.e. 71 percent of the experts argued that adaption will be at

Technology	Kruskal-Wallis H		2 years from now					
	Effect size	Sig.	Non-adopters	Innovators	Early adopters	Early majority	Late majority	Laggards
1. Extended reality (XR)	24 %		5 %	34 %	37 %	12 %	10 %	2 %
2. Social media and cloud-based platforms for creative work and freelance services	17 %		0 %	10 %	15 %	59 %	17 %	0 %
3. Immersive exhibits and performances	20 %		10 %	37 %	29 %	17 %	7 %	0 %
4. Telepresence	25 %		7 %	20 %	41 %	27 %	2 %	2 %
5. Holograms	33 %	*	12 %	56 %	32 %	0 %	0 %	0 %
6. 360-degree video	30 %		5 %	24 %	37 %	29 %	5 %	0 %
7. Data driven creative innovations	30 %		7 %	46 %	27 %	17 %	2 %	0 %
8. Online and virtual learning platforms	20 %		0 %	10 %	5 %	46 %	32 %	7 %
9. Distributed (video) production	29 %		5 %	32 %	39 %	22 %	2 %	0 %
10. Livestreaming	26 %		5 %	17 %	17 %	37 %	24 %	0 %
11. Cloud-based collaboration platforms	36 %	*	0 %	17 %	27 %	39 %	17 %	0 %
12. Emotion tracking/sensing/recognition	18 %		15 %	63 %	20 %	2 %	0 %	0 %
13. Image GPT-3	35 %	*	17 %	46 %	29 %	5 %	2 %	0 %
14. Mobilephone based filming and editing	27 %		2 %	24 %	32 %	29 %	12 %	0 %
15. Crowdfunding	15 %		0 %	29 %	34 %	34 %	2 %	0 %
16. Cloud-based (project) management tools	27 %		0 %	17 %	17 %	39 %	27 %	0 %
17. Realtime hybrid media broadcasting	27 %		10 %	44 %	37 %	10 %	0 %	0 %
18. Next generation motion capture	34 %	*	20 %	46 %	29 %	5 %	0 %	0 %
19. Micropayment	9 %		7 %	44 %	37 %	12 %	0 %	0 %
20. Realtime captioning	22 %		7 %	46 %	41 %	5 %	0 %	0 %
21. Cloud-based GUI and UX applications	39 %	*	12 %	24 %	24 %	32 %	7 %	0 %
22. 3D scanning	19 %		12 %	29 %	32 %	22 %	5 %	0 %
23. Automated AI based metadata generation and management	15 %		7 %	37 %	32 %	20 %	5 %	0 %
24. Deepfake	51 %	**	12 %	46 %	37 %	5 %	0 %	0 %
25. Virtual LED studios	20 %		12 %	46 %	27 %	15 %	0 %	0 %
26. Speech recognition / voice controlling	15 %		10 %	29 %	49 %	12 %	0 %	0 %
27. 4DX movies	24 %		32 %	27 %	39 %	2 %	0 %	0 %
28. 3D print	36 %	*	10 %	20 %	32 %	37 %	2 %	0 %
29. Robot and AI art	16 %		2 %	71 %	27 %	0 %	0 %	0 %
30. Generative Pre-trained Transformer 3 (GPT-3)	8 %		12 %	51 %	32 %	2 %	2 %	0 %
31. AI based music technology	25 %		22 %	46 %	29 %	2 %	0 %	0 %

* sig.0.05 level, ** sig. 0.01 level

"Innovators" phase).

Figure 3. Technologies adoption in 2 year time frame

Technology	Kruskal-Wallis H		5 years from now					
	Effect size	Asymp. Sig.	Non-adopters	Innovators	Early adopters	Early majority	Late majority	Laggards
1. Extended reality (XR)	39 %	*	2 %	12 %	15 %	44 %	15 %	12 %
2. Social media and cloud-based platforms for creative work and freelance services	17 %		0 %	0 %	10 %	17 %	34 %	39 %
3. Immersive exhibits and performances	25 %		7 %	12 %	34 %	20 %	20 %	7 %
4. Telepresence	27 %		5 %	10 %	24 %	29 %	17 %	15 %
5. Holograms	38 %	*	7 %	20 %	56 %	12 %	5 %	0 %
6. 360-degree video	27 %		5 %	7 %	24 %	37 %	20 %	7 %
7. Data driven creative innovations	28 %		0 %	24 %	37 %	15 %	15 %	10 %
8. Online and virtual learning platforms	16 %		0 %	0 %	12 %	10 %	32 %	46 %
9. Distributed (video) production	31 %		5 %	17 %	24 %	29 %	20 %	5 %
10. Livestreaming	29 %		2 %	5 %	17 %	27 %	22 %	27 %
11. Cloud-based collaboration platforms	31 %		0 %	0 %	22 %	27 %	27 %	24 %
12. Emotion tracking/sensing/recognition	31 %		10 %	22 %	41 %	20 %	7 %	0 %
13. Image GPT-3	33 %	*	17 %	15 %	37 %	12 %	20 %	0 %
14. Mobilephone based filming and editing	23 %		2 %	5 %	32 %	24 %	15 %	22 %
15. Crowdfunding	8 %		0 %	7 %	32 %	32 %	15 %	15 %
16. Cloud-based (project) management tools	19 %		0 %	7 %	10 %	17 %	32 %	34 %
17. Realtime hybrid media broadcasting	36 %	*	7 %	17 %	37 %	24 %	12 %	2 %
18. Next generation motion capture	46 %	**	15 %	29 %	29 %	20 %	5 %	2 %
19. Micropayment	12 %		7 %	10 %	44 %	20 %	15 %	5 %
20. Realtime captioning	27 %		5 %	12 %	34 %	37 %	10 %	2 %
21. Cloud-based GUI and UX applications	38 %	*	7 %	12 %	22 %	20 %	24 %	15 %
22. 3D scanning	28 %		10 %	12 %	20 %	37 %	17 %	5 %
23. Automated AI based metadata generation and management	23 %		5 %	20 %	29 %	24 %	15 %	7 %
24. Deepfake	40 %	*	7 %	24 %	41 %	24 %	2 %	0 %
25. Virtual LED studios	31 %		10 %	7 %	41 %	24 %	15 %	2 %
26. Speech recognition / voice controlling	14 %		5 %	17 %	29 %	27 %	22 %	0 %
27. 4DX movies	20 %		22 %	22 %	27 %	24 %	5 %	0 %
28. 3D print	51 %	**	7 %	10 %	20 %	34 %	17 %	12 %
29. Robot and AI art	26 %		2 %	37 %	39 %	17 %	5 %	0 %
30. Generative Pre-trained Transformer 3 (GPT-3)	16 %		12 %	12 %	44 %	20 %	10 %	2 %
31. AI based music technology	30 %		15 %	24 %	39 %	20 %	2 %	0 %

* sig.0.05 level, ** sig. 0.01 level

Figure 4. Technologies adoption in 5 year time frame

When consensus was evaluated at the individual core competence level for 2 years (Table 3) and 5 years (Table 4) from now time frame, the level of consensus among the experts improved only slightly. The “Arts and crafts” experts were the most unanimous and were agreeing on 9 technologies (29 percent of all technologies) on 2 year time frame and 6 technologies (19 percent of all technologies) on 5 year time frame. As highlighted earlier, the number of “Arts and crafts” experts was only 3. Therefore, the agreement was more easy to achieve due small number of experts. “Management of creative work” experts were the second most unanimous and agreed on 6 technologies on 2 year time frame and 2 technologies on 5 year time frame.

Table 3. Identified technologies* that reached expert consensus in 2 years from now time frame

	MGMT	*VISU*	*A&C*	*TXT*	*PERF*	*MUSIC*	*SOLU*
Non-adopters							
Innovators	5, 12, 24, 29		1, 5, 6, 13, 14, 20, 23, 29, 30	29		24, 29	
Early adopters		5, 24, 27			6, 26		
Early majority	11, 15	28					
Late majority							11
Laggards							
Total (N)	*6*	*4*	*9*	*1*	*2*	*2*	*1*

* Id numbers are referring to Figure 3 technology list

Table 4. Identified technologies that reached expert consensus in 2 years from now time frame

	MGMT	*VISU*	*A&C*	*TXT*	*PERF*	*MUSIC*	*SOLU*
Non-adopters							
Innovators			3, 12, 17, 18, 24				
Early adopters	5		14	24			
Early majority		1, 24					
Late majority							
Laggards	8			2			
Total (N)	*2*	*2*	*6*	*2*			

* Id numbers are referring to Figure 4 technology list

4 Conclusion

The COVID-19 crisis highlighted the need to improve creative industry actors' ability to adopt new technological solutions. Expert dominated consensus seeking Delphi technique was utilized to define the technology vison for the creative industries. Focusing on short- to mid-term perspective (0-5 years) in all 31 different technologies were identified. The agreement levels regarding the technology importance were agreed in most core competence areas, excluding the "Arts and Craft", in which only 6 out of 31 technology assessment reached consensus. It became also clear that the technology importance ranking are differing between the seven core competence areas. Thus, it is apparent that each core competence area have different business and operational needs, in which only a certain type of technological solution are relevant. When looking at the most important technologies from each core competence area viewpoint, it is possible to find technologies, which were relevant in multiple competence areas. These technologies

included e.g. “Extended reality (XR)”, “Social media and cloud-based platforms for creative work and freelance services”, “Immersive exhibits and performances”, “360-degree video”, “Data driven creative innovations”, “Livestreaming”, “Cloud-based (project) management tools” and “Realtime captioning”. However, based on our technology adaption assessment results, the Delphi experts in most cases did not share the same vision regarding the adaption time frame. Thus, the future studies should focus especially on estimating the adaption time frame. To conclude, when comparing this study finding to a prior study by Abbasi et al. (2017) who proposed technology roadmap for the creative industries, many similar technologies can be found. Therefore, the creative industry practitioners should pay attentions to these identified technologies and start exploring what kind of the new business opportunities could be emerging by utilizing these technologies.

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