Multimed Tools Appl (2013) 66:33–57
DOI 10.1007/s11042-012-1143-8

Categorization of ambient media projects on their business models, innovativeness, and characteristics—evaluation of Nokia Ubimedia MindTrek Award Projects of 2010

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Published online: 17 June 2012

Abstract Ambient Media describe media environments, where the medium is embedded within the natural environment. They follow the anytime, anywhere, and anyhow principle for media access. The Nokia Ubimedia MindTreks Awards have been established a few years ago to explore the potential of ambient media. In this article we analyze the total project portfolio submitted to the 4th Nokia Ubimedia MindTrek Awards in 2010 according to their business value, innovativeness, and use of ambient media. The aim of this article is to gain insights into the general characteristics of ambient media, their properties, and business functions. The article rounds up in providing a substantial framework and guidelines for ambient media developers in their product designs.

Keywords Ambient media · Ubimedia · Ubiqutious media · Tangible user-interfaces · Characteristics of ubqituous media · MindTrek

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1 Introduction

The Nokia Ubimedia MindTrek Award took place the 4th time in 2010, and in total 20 projects have been submitted for the competition. In short, Nokia Ambient Mindtrek Competition is an annual international competition organized by MindTrek, Nokia, EMMi Lab/Tampere University of Technology (TUT), Tampere University of Applied Sciences (TAMK), the Tampere Region Centre of Expertise in Ubiquitous Computing and the Ambient Media Association (AMA). The main purpose of this event is to promote innovations in the field of ambient media as well as encourage digital media developers to invent creative ambient media ideas/concepts and also to develop new and innovative ambient media products & services. Each year, the Nokia Ubimedia Mindtrek Awards receive tens of finished ambient media products and developed product and service concepts from developing teams worldwide. Then, based on the evaluations of an internationally distinguished jury, 3 teams are selected for the Nokia Ubimedia MindTrek Awards sharing a prize of 7,000 euros.

The review process is guided by certain research questions, which this paper will analyze in depth:

- How is it possible to measure the innovation values of submissions to the competition?
- Can a framework for innovations be established in the field of ambient media?
- What attributes and variables can be used to evaluate the innovation characteristics?
- How can innovation capability be measured over time?
- Which long-term prediction can be made for innovations?
- How can innovations be matched with the market characteristics of ambient media?
- Which core business and commercialization logic underlays the project to create value for consumers?

This work shall sketch a first framework for measuring ambient media products on their innovativeness. However it is obvious, that this can only open a pathway for future studies in this area.

2 Background and related work

The ‘father’ of innovations, Joseph Schumpeter sees *innovations as a disruption which fosters the creation of knowledge* as a return-on-investment. Thus in his theory the benefit of innovation is the created knowledge which might—or might not—lead to capitalization of the invention (see [18–20]). Seth Godin’s viewpoint on innovations is rather similar and emphasizes the *importance of the process* of the development of innovations rather than the innovation as such [3]. Both have one thought in common—innovation is a matter of attempting to create new, rather than systematizing and quantifying the approach. The basic method applied within the scope of this study has been explored in [12], however, has been extended in many ways as e.g. a more quantitative analysis. For the exploration of ambient media in general, we refer to e.g. [13].

3 Research design & method

The research problem is very simply described, but the answer rather complex and difficult: How is it possible to measure the innovation value of entries submitted to a competition? However, this study is divided into 4 parts:

- *general portfolio analysis:* measuring the general project features
- *business model & commercialization analysis:* analysis of the project business models and commercialization strategies based on the comments of project submitters during submission;
- *analysis of significance for ambient media:* compilation of features, characteristics, and functionalities contributing to ambient media environment;
- *innovation analysis:* analysis of projects on their innovativeness and novelty based on quantitative and qualitative methods.

3.1 General portfolio analysis

The general portfolio analysis attempts to gain insights in project parameters such as application categories, team backgrounds, service and application areas, and core technologies. The evaluation of these variables is based on either data available through project submitters or evaluation by the article authors.

3.2 Business model & commercialization strategy

The evaluation of the projects business model and commercialization strategy primarily relied on the self-evaluation of the submitters. However as the jury members also had to evaluate the entries on their business, artistic, and social impact also this value was weighted with the self-evaluation. For the self-evaluation, the following main categories have been considered:

- *no business model or commercialization strategy*: projects did not show any intend for commercialization, or had weak or no business models developed;
- *sales to businesses*: the primary business model or commercialization strategy targets businesses either through the sales of services/applications, devices/materials, or to improve the operation of a business. A specific category within sales to businesses was the sale of devices/material to manufacturers which was compiled to a separate category to the specific of specific industries as e.g. textile industry;
- *sales to consumers*: the primary business model or commercialization strategy focuses on the end-consumer either through sales of service/applications or devices/materials. Sales to consumers included also the provision of a free, non-profit service, as well as the offering of a service eco-system;
- *advertising, sales, and marketing*: the primary business model was related to advertising, sales, and marketing, thus allowing interactive engagement with advertisements, passive advertising, and proactive advertising systems.

3.3 Characteristics of ambient media

Due to the novelty of ambient media, the classification of ambient media projects is rather tricky. However, a very obvious classification based on a simple categorization of projects in the field of ubiquitous computation [8] is a good starting point for the development of a classification method for ambient media. Within the scope of this work, we try to extend the idea towards ambient media environments (see Table 1).

Principles can be understood as “a comprehensive and fundamental law, doctrine or assumption” [14], in which framework of ambient media flourishes and exist. Basically these principles for ambient media [10] are *manifestation*—defining the fundamentals how ambient

Table 1 Levels of 'intelligence' for ambient media

am-devices	devices, gadgets, and hardware
am-environment	smart environments and spaces enabled by hardware and software
am-media	rendering/interaction of/with objects in time/space in the environment
am-communication	communication between objects and people
am-experience	experience and consumer

media are rendered in time & space within the natural human environment; *intelligence*—defining the laws for indicating the 'smartness' of ambient media objects; *morphing*—defining the laws for how ambient media in the physical world connects, interacts, and communicates with the virtual digital overly; and *experience*—a framework for aesthetics, level of user engagement, immersion, and usability. As ambient media are a rather ungraspable concept, we define quantitative measures for each of the principles of ambient media and are assigning these to the various ubiquitous projects in a later section of the article.

3.3.1 Level of intelligence

The level of intelligence for ubiquitous services has been discussed in [6], whose work was based on [15]. For the purpose of ambient media, the taxonomy of the level of intelligence has been extended, and adapted to the specific needs in ambient media environments. The basic idea is based on the commonly known knowledge hierarchy (see [22, 23]) and has been discussed in relation to Peirce's logic in [11]. See Table 2 for a more detailed description and the criteria adopted from the references stated above.

3.3.2 Level of manifestation

The level of manifestation gives information about how the digital overlay is rendered throughout the physical world. In other words, manifestation describes how ambient media turn digital information into a human perceptible representation. The wide variety of ubiquitous technologies enables many new possibilities for creating human perceptible

Table 2 Levels of 'intelligence' for ambient media

Value	Level	Classification	Description
5	High	am-wisdom	services understanding principles of consciousness and interpreted understanding
4		am-understanding	services understanding 'why' on the basis of learning, inference, and proposing or triggering actions by inferring knowledge to create new knowledge
3		am-knowledge	services understanding 'how' patterns about the environment, including consumer, objects, and situations reacting in behalf of the consumer
2		am-information	services understanding relationships upon user request and reacting on explicit/implicit interactions requiring consumer interpretation (who/when/where/what?)
1	Low	am-data and communication	services based on raw data and symbols relating to simple data models, formats, transactional services, information exchange without any related meaning

system elements—digital objects may manifest as analogue signals, digital signals, or sounds. Thus manifestation deals with representation of the digital overlay in the physical world and how digital data can be embodied within physical objects.

A first approach to describe fidelity, how "a system's display components [are described] and how the data from the world is encoded into patters, pictures, words, or sounds". The theory is based on ideas from Semiotics, dealing with "signs, sign systems (such as natural languages) and their meanings" [17]. Similar to music, ambient media follow a certain semiotics [21], and the representation of digital objects in the physical world can be expressed through a sign composed of the triple *signifier*, *signified*, and *meaning* [16]. *Signified* represents the cause, object, or phenomenon as representation of the sign, as e.g. the route to the next shopping center in a location based service; a *signifier* is the representation of the cause, object, or phenomenon as e.g. voice indicating to turn right at the next crossing to come to the destination; and a *meaning* is assigned by the system user who is interpreting the signifier, as e.g. conscious decision to turn right at the next crossing to travel to the shopping center.

In ambient media, signs can be manifold and also arranged spatio-temporal throughout the natural environment. To build a qualitative scheme for measuring and describing ambient media from the semiotics point of view, a categorization for signs is required. As described in [17], we distinguish between signs that are *symbolic, iconic,* or *indexical.* Signs that are symbolic are without reference and meaning, therefore arbitrary as e.g. a red warning signal; on the other hand, iconic signs have a reference to something else, resemble a purpose, or have structural similarity as e.g. a dedicated fire alert warning signal; and an indexical sign represent a higher level structure and has a spatio-temporal arrangement, causality, or proximity with other objects, as e.g. a visual language (see also [21]). Table 3 the classification of the level of manifestation for ambient media utilized within the scope of this article.

3.3.3 Level of morphing

Where the level of manifestation indicates how specific projects are rendered throughout the natural environment, especially how the digital overlay is mapped to the physical world—the level of morphing focuses on how the digital world is linked to the physical world. This includes especially I/O modalities that can be seen as interface. Especially the notion of Tangible User Interfaces (TUIs) [5] describes how physical objects can be manipulated to interact with the digital world. To classify and measure the level of morphing, we adopted a method from [7], which defines the type of link between physical and digital objects in terms of coherence. This addresses "whether the physical and the digital artifact are seen as one

Table 3 Levels of 'manifestation' for ambient media

Value	Level	Classification	Description
3	high	am-index	ambient media rendering spatial-temporal arrangements of signs representing causalities, higher level meaning, or proximity with other objects (e.g. music, meanings, semantic)
2		am-icon	iconic ambient media objects representing structural similarity for a specific purpose (e.g. metaphors, visuals, audio signals, drawings)
1	low	am-symbol	ambient media based on symbolic signs represent symbols without reference or higher level interpretation (e.g. letters, numbers, abstract symbols)

Table 4 Levels of 'morphing' for ambient media (after [7])

Value	Level	Classification	Description
5	high	illusion	illusion of same object by direct representations or presentations of digital objects based on physical properties of physical objects as e.g. artistic installations projecting images of humans passing by, …
4		proxy	proxy projection by coherent proxy interfaces as direct association or replica of digital objects enabling direct manipulation as e.g. artificial paper, architectural models, …
3		identifier	interfaces acting as references, bookmarks or indexes for obtaining digital artifacts as e.g. tokens, barcodes, stickers, …
2		specialized tool	specialized tools and objects with a specialized function temporarily connected to different digital objects as e.g. daily objects, mirrors, light systems, …
1	low	general purpose tool	weak level of coherence operating as general input devices as e.g. keyboard, mouse, PC, …

common object that exists in both the physical and the digital domain or whether they are seen as separate but temporarily interlinked objects". See Table 4 for a further classification.

3.3.4 Level of experience

To define a level of experience is by far more complex and involves many criteria, such as aesthetics, emotional binding, and higher level of constructs for defining reflection and knowledge. Within the scope of this article, the level of experience is defined as "continuous engagement with the world through acts of sense making at many levels […] constituting that we can never be outside of experience, and active in that is an engagement of a concerned, feeling, self-acting with an through materials and tools" [24]. We categorized therefore the level of experience according to [24], and they are depicted in Table 5.

Table 5 Levels of 'experience' for ambient media (after [24])

Value	Level	Classification	Description
5	high	appropriative	actual sense making of experiences, especially the creation of wisdom for similar encounters in the past and in the future and self-creation of experiences, e.g. artistic installations
4		recounting	social recounting and communication of encounters with others allowing the creation of additional knowledge around the encounter as well as exchange of experiences, e.g. social media
3		reflective	involving judgments, reflections, conclusions, and sense making of a particular situation as inner thoughtful process e.g. control systems
2		interpretation	interpretation of the narration and structure of the encounter, it's agents, objects, and possibilities related to our feelings and emotions
1	low	anticipation and connecting	prejudiced encounter of a particular situation eventually linked to that giving sense to the actual situation without actual reflection e.g. simple data transmission services

3.3.5 Level of collaboration

Not solely inter-human collaboration, but also inter-object collaboration, and computer mediated collaboration are a principle of ambient media. On general level, collaboration can be divided into the number of entities that are involved in the collaboration (e.g. one-to-one, one-to-many, and many-to-many). However, or ambient media it's also required to address the time-scale of the collaboration (e.g. short-term, long-term, goal driven) and weather the goals are single goals within a certain context or collective goals within many contexts. A good approach is to address collaboration from agent based programming. Within the context of this article, we extended the idea for collaboration from [2] towards ambient system designs and classified projects accordingly and are depicted in Table 6.

3.4 Project innovation study

The evaluation of the value of an innovation is an extremely difficult and trick task, and this study was based on the available data material either coming from competitors, jury members, or self-evaluation of projects. The main challenge was the development of correct variables that should be independent, eventually be weighted, and describe the outcome in abstract matter. For the valuation we divided the variables in three groups: 1) *added value for consumers/business:* analysis of the business models & commercialization strategies submitted by the projects, and the jury evaluation evaluated through the business/social/artistic value of the project; 2) *impact and contributing knowledge of ambient media environments:* evaluated based on the variables stated in the previous section; 3) *novelty, disruption, and innovation value:* analysis of the degree of novelty, innovation form, innovation phase, and the subjective evaluation of jury members. Several variables and their valuation are listed in Table 7. For the final calculation several values have been summed up in each category, and normalized. Each category had the same weight on the total sum.

Table 6 Levels of 'collaboration' for ambient media (after [2])

Value	Level	Classification	Description
1	high	collective collaborative	full collective collaborative strategies with collective long-term goals and relationship either with one-to-one, one-to-many, and many-to-many traits e.g. social networks, …
2		flexible collaborative	flexible cooperation strategies either emphasizing sub-sets of goals or collective goals to allow a long term one-to-one, one-to-many, or many-to-many cooperation on a long term basis e.g. service eco-systems
3		to-many collaborative	short term context defined goals paired with self-interest strategies supported by one-to-many and many-to-many collaboration for short term goals within a certain context e.g. informational messaging service
4		one-to-one collaborative	self-interest based collaboration for a short-term goal with to achieve a clear subset of goals within a certain context with a predominant one-to-one collaboration form as e.g. user identification at cash machines, single database queries, …
5	low	no collaboration	single entities or objects providing no collaboration on several levels – either inter-objects, between users, nor between object and user

Table 7 Total variables applied within the scope of this study

Variable	Measurement and criteria	Values
Novelty, Impact and Disruption (max. score 20)		
innovation phase	project submission form and subjective assessment	1 existing solution
		2 imitation
		3 concept
		4 invention
		5 innovation
degree of novelty	project submission form and subjective assessment	1 existing solution
		2 imitation
		3 incremental improvements
		4 radical
innovation form	project submission form and subjective assessment	1 existing solution
		2 product innovation
		2 market innovation
		2 process innovation
		2 structural innovation
		3 social innovation
subjective innovation value	jury members	1 low innovation value
		2 medium innovation value
		3 high innovation value
level of experience	subjective evaluation based on entries	1 anticipation and connecting
		2 interpretation
		3 reflective
		4 recounting
		5 appropriative
Contribution to the Knowledge of Ambient Media (max. score 18)		
levels of intelligence	subjective evaluation based on entries	1 data and communication
		2 information
		3 knowledge
		4 understanding
		5 wisdom
level of manifestation	subjective evaluation based on entries	1 symbol
		2 icon
		3 index
level of morphing	subjective evaluation based on entries	1 general purpose tool
		2 specialized tool
		3 identifier
		4 proxy
		5 illusion
level of collaboration	subjective evaluation based on entries	1 no collaboration
		2 one-to-one collaborative
		3 to-many collaborative
		4 flexible collaborative
		5 collective collaborative

Table 7 (continued)

Variable	Measurement and criteria	Values
Capitalization and Value for Customers/Businesses/Artistic (max. score 21)		
producer background	project submission form and subjective evaluation	1 individual
		2 working group
		3 university & research laboratory
		4 SME
		5 cooperation
business models & commercialization strategy	jury members	1 low
		2 medium
		3 high
subjective value	jury members	1 low
		2 medium
		3 high
commercialization strategy	project submission form and subjective evaluation	1 no business model
		2 free, non-profit service for consumers
		3 advertising, sales, and marketing
		4 sales to consumers/businesses
		5 provision of a service eco-system
project phase	project submission form and subjective evaluation	1 concept
		2 artistic installation
		3 prototype
		4 in commercialization
		5 ready product & commercialized

4 Analysis of the project portfolio

In the year 2010 the Nokia Ubimedia MindTrek Award with the theme "how ubiquitous computing affects intelligent media environments, and what the future of location-and context aware media services might look like", attracted a total of 20 entries. The largest number of submissions came from Europe (17), and the second largest number of submissions from Asia (3). The top three submitting countries where Finland as organizing country (6), Germany (3), and The Netherlands (2). Note, that the country of submission origin is only marginally related to the international development of ambient media, as it indicates to which countries the competition has been marketed to. Figure 1a illustrates the country of submission origin.

The background of contest teams is rather versatile, from self-organized workgroups, research institutions, individuals, universities, SMEs, and universities (see Fig. 1b). The major contributions are coming from the scientific and research community (11), and a very significant number (5) from SMEs and startup-companies. The individual or workgroup contributions relate to the service category "Media & Art", which fits to the modality of working in these kinds of environments as well as to the project types.

The service and application areas of submissions range rather widely (see Fig. 2a and b). Most entries (50 %) relate to technology development and sharing information & communication. However, it is important to note, that entries related to sharing information &

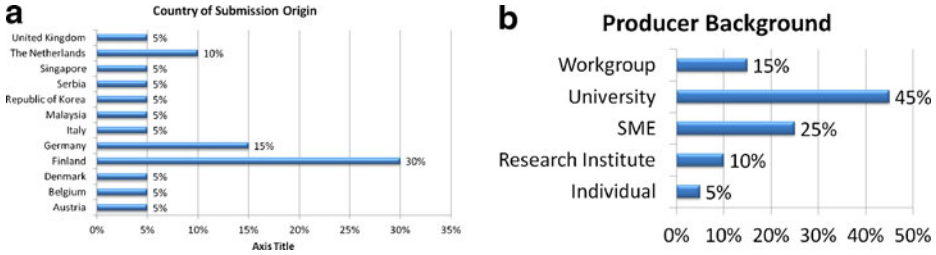


Fig. 1 **a** and **b**. Countries of Submission Origin and Producer Background

communication not solely contributed to traditional communication and information sharing methods. This application area also included innovative projects (15 %, 3 projects) that enables new forms of communication and information sharing as e.g. perceptive activity and sensitive touch (e.g. PeR); implicit forms of communication, where people act as virtual carrier of devices that seamlessly exchange information with devices and other people (e.g. Siren); or forms of communication where textiles act as information displays (e.g. AmbiKraf). It is also important to note, that many service and application areas have as target to apply advanced technology to improve the quality of our daily life, payment modalities, provide cost efficiency, and home decoration and construction. Viewing the entries from this point of view, we can state, that 30 % of the project would fit under this category (namely myGreenSpace, Floweather, EnergyLife, Luxpass, WEtransport. PeR).

Further classifying the submission according the main object of submissions, we note, that the highest amount of submissions were related to rendering technologies that deal with how the digital world renders in the real physical world (40 %, 8 projects). Besides the artistic installations and interactive (5 %, 1 projects), and passive (15 %, 3 projects) displays, new objects for rendering as e.g. on textiles (AmbiKraf and PeR); and rendering information in an analogue form via daily objects (e.g. Floweather); and sensing urban displays (myGreenSpace) have been submitted. Especially rendering on fabrics seems to provide interesting new possibilities for communication and information display. Also the utilization of daily objects (e.g. flowers) for information visualization as e.g. is shown by the project Floweather that displays the actual state of a current world condition is a rather interesting possibility. Both submission types fit well to the notion of ambient media, where daily objects become part of a smart space. A special importance is displays capable of sensing their environment (myGreenSpace) and having the capability to adapt the content of the screen seamlessly and unobtrusively.

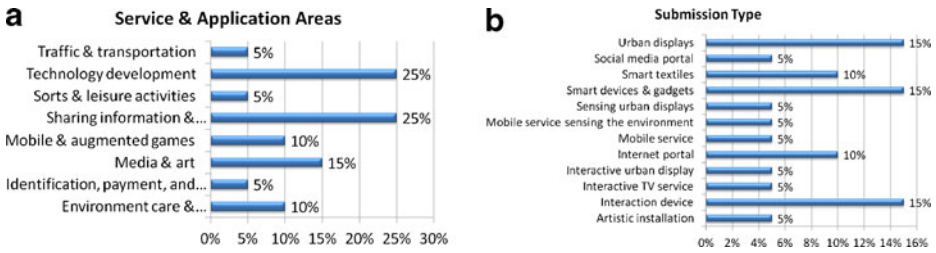


Fig. 2 **a** and **b**. Service & Application Areas and Submission Types of Entries

On the other hand, considering the actual contents and applications of submitted products and service concepts, we can generally categorize into 5 main groups concerning the primary consumer value:

- *Everyday life*: the main target of entries in this category is to apply advanced technology to improve our quality of life and cost efficiency in the traditional scenarios, like home decoration/construction (myGreenSpace, PeR, AmbiKraf and Floweather), TV channel (Joe) and energy efficiency (EnergyLife).
- *Technology development*: in this category, the corresponding entry work emphasizes on developing enabling technology for the future versatile applications of ambient media, like display (Ambient Video Installation, EPKapula, EPSystem Aleksandra Vasovic and ElementalProjections) and mobile applications (Luxpass and VirtualTouch).
- *Sharing information:* the central theme of this category is to develop technology platforms, based on web and/or mobile technology, to share information in an efficient and easy-to-use way (Siren, www.hoax.it, MMU Notify and WEtransport).
- *Game*: play is of course still the main target for the game developers. When combining with ambient media, the submitted game entries provide some interesting new ideas on how to interact and interface with human behaviors and surrounding environments (iBall and Around the world).
- *Social networking*: not just for sharing information, the application of ambient media on social networking proposed by the entry Twinners provides a real-time platform for people from geographically distant locations to virtually "sit" and enjoy time together.

As shown in Fig. 3b, in the competition 2010, considering the "context media" theme, the most popular application areas are everyday life, technology development and shared information. Notice that, the above applications are actually implemented based different types of platforms. Among the entries, 15 teams choose digital devices, e.g. computer, mobile phone, TV and projectors, to carry their innovation, while 5 teams try to integrate

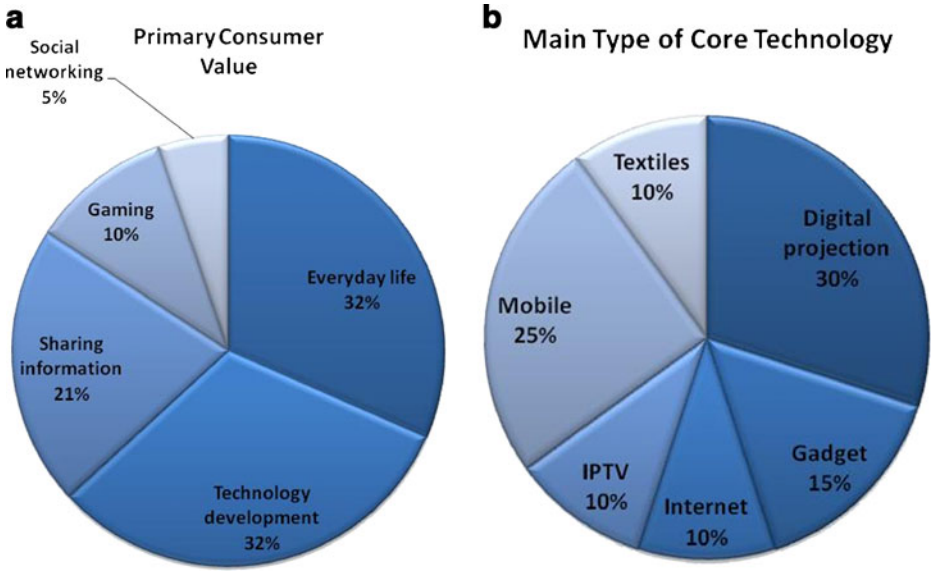


Fig. 3 **a** and **b**. Primary consumer value and main type of core technology

their products and service with everyday life object, such as wall, rug, ball, and textile. It is seen that the digital equipment is still the major developing preference for the current ambient media developers. Yet with the fast-growing development of technology and awareness in the ambient media area, we would expect to observe more and more innovations that are embedded with living environment without emphasizing the use of digital devices in near future.

Thus the main type of core technology related to digital projection (30 %) followed by mobile technology (25 %) as main platform for deploying services. New platform types and new forms of everyday objects relate to the development of technology in form of new gadgets (15 %), and utilizing textiles (10 %). Solely 20 % of the projects relied on traditional platforms as e.g. IPTV or Internet portals.

5 Business model & commercialization

Ambient media are relatively new, and solely 'hype' services promise to generate profit, as e.g. location based services in combination with advertising (e.g. Google Maps [4]). Significant amounts of submitted projects (55 %) were developed at research laboratories. The natural conclusion is that most of the projects are in prototype stage (50 %), without any ideas for project commercialization or clearly defined business models. In previous analysis of competition entries it has been stated [9], that most projects have are exploring opportunities, rather than proposing concrete profit models, having a secured base of clients, commercialization strategies, or business models. The competition in the year 2010 showed a similar trend, but a slight improvement in the projects that are already commercialized, or show a commercialization intention (20 %). A compilation of the results can be found in Fig. 4.

In line with the results of the study of the 2008 year's entries [9] is that the proposed business models are rather vaguely formulated and require additional market research and exploration of business opportunities. The most popular target for the developed products was the provision of services for the consumer (40 %). Thus, the proposed business model or commercialization strategy targeted the end-consumer sales. Business models or

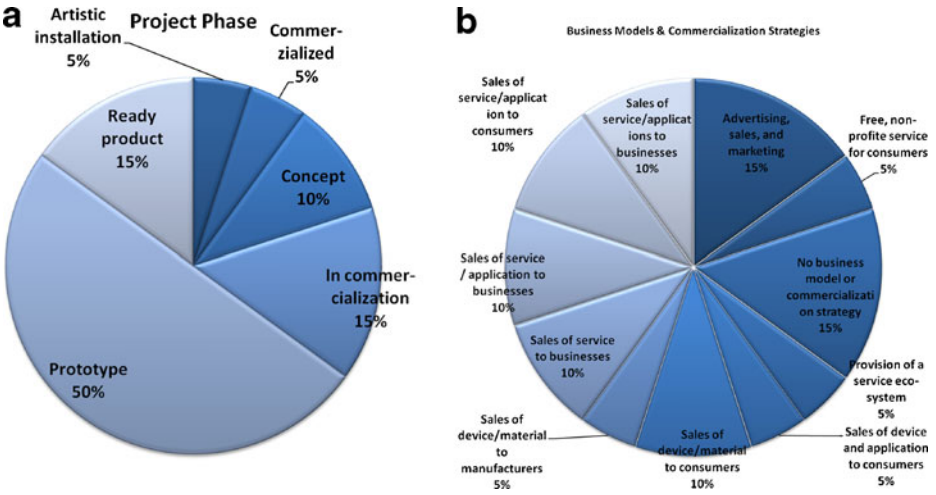


Fig. 4 **a** and **b**. Project Phase and Business Models & Commercialization Strategies

commercialization strategies related to the sales of service, devices, applications, or hardware. Nevertheless, the idea of providing service eco-systems, where the device is bundled with content services seemed to be an interesting idea to further develop the business concept (myGreenSpace). A marginal amount of projects developed services that were delivered to the consumer for free from non-profit organizations. Applications and services related to leisure, art, entertainment, and gaming seem to be predominant and might lead to other very potential business models for ambient media.

Potential profit models range from the sales of gadgets (e.g. Floweather), selling of applications in application stores (e.g. iBall), or mobile applications (e.g. Around the World). Also professional application areas as e.g. military camouflaging (e.g. AmbiKraf) are envisioned. Projects emerging from traditional media industries as e.g. TV and video showed the best proposals for business models. They rely on the convergence between the profit logic of traditional media and the newly emerging media (e.g. JOE, and Twinners). They address the trends in broadcasting of increased competition and the emergence of new forms of TV such as social TV and Internet distribution and attempt to challenge this development by the development of either new form of content or service platforms. It is important to note, that very less projects were non-commercial and provided free access of the content to the consumer.

The second largest share of products is targeted for sales to businesses (35 %) with different purposes. Projects related to smart textiles show fundamental new business models as e.g. the creation of new value-chains by creating added value through the integration of high-tech players and traditional textile industry (e.g. PeR and AmbiKraf). Nevertheless, also other applications seem to have impact on the value creation. Entergy saving applications attempt to integrate energy producers, network operators, and building companies aiming at reduced energy consumption (e.g. EnergyLife). The investigation of these possibilities and the impact on traditional textile industry seems to be a rather interesting starting point for future investigations. Sales of fully developed platforms to businesses across various sectors are another stated potential business model. Enabling service provider with the possibility to send notification to consumers via a mobile messaging service (e.g. Notify-me) or social interactive TV platforms (e.g. Twinners) are examples for this possibility. Also the sales of content formats (e.g. JOE, Twinners) provide new possibilities for content developers of ambient technologies. Other stated business potentials relate to the direct sales of devices or hardware to manufacturers (especially for smart textile related projects), or the improvement of the core business through additional services (e.g. EPKapula, EPSystem).

Fifteen percent of projects are aimed for advertising, sales and marketing purposes. Advertising either on smart textiles, in shopping windows enriched with advanced consumer interaction possibilities, or through urban displays seems still one of the main business concepts for many applications. New interaction techniques with urban displays enable new innovative techniques for enhancing public screen experience (e.g. VirtualTouch) and promise to lead to higher level of engagements with the product or brand.

While analyzing the various business models of the different submitted projects, a few other observations have been made. One feature that was obvious was the *easy adaptability* of the primary function of the technical solutions to other application scenarios. Examples are Luxpass, which can extend its functionality from password authentication to the sales of entrance tickets for events; the functionality of Siren, a concept where people act information broker via a mobile device, can be extended towards many various concepts where social interaction and information exchange is the essential key; Floweather can be connected to any sensory input such as e.g. domestic sensors or other states of the environment.

However, many applications emphasized *cheap production costs* for the system. However this observation cannot be generalized, as many projects seem to have high production costs

Fig. 5 **a**–**e**. Evaluation of project entries to their levels of intelligence, morphing, manifestation, experience, and collaboration

involved. Also not generalized can be the fact, that products are easy to be integrated into existing solutions, or that projects are improvements of operations of business, where new technology leverages existing technology to improve the service (e.g. EPKapula, EPSystem).

Considering the developing stage of products, Fig. 4a shows that most entries have surpassed the conceptualizing stage and built corresponding prototype for attending the year's 2010 competition. This certainly shows the growing understanding and developing power in the ambient media area. Most entry teams not only propose concepts but also are eager to further develop those concepts into tangible forms.

In addition to the innovativeness and quality of products, business or profit model is also the key for sustainable success of ambient media. In general, the submissions show some thoughts on the possible business model. Selling ambient media products and service to private sector (companies) seems to be a good choice rather than selling to public sector and individual customer. It is also interesting to notice that, according to Fig. 4b, targeting for private sector or individual customer, "soft" products, such as application and service, are more common than "hard" product, such as device and material, among all the entries.

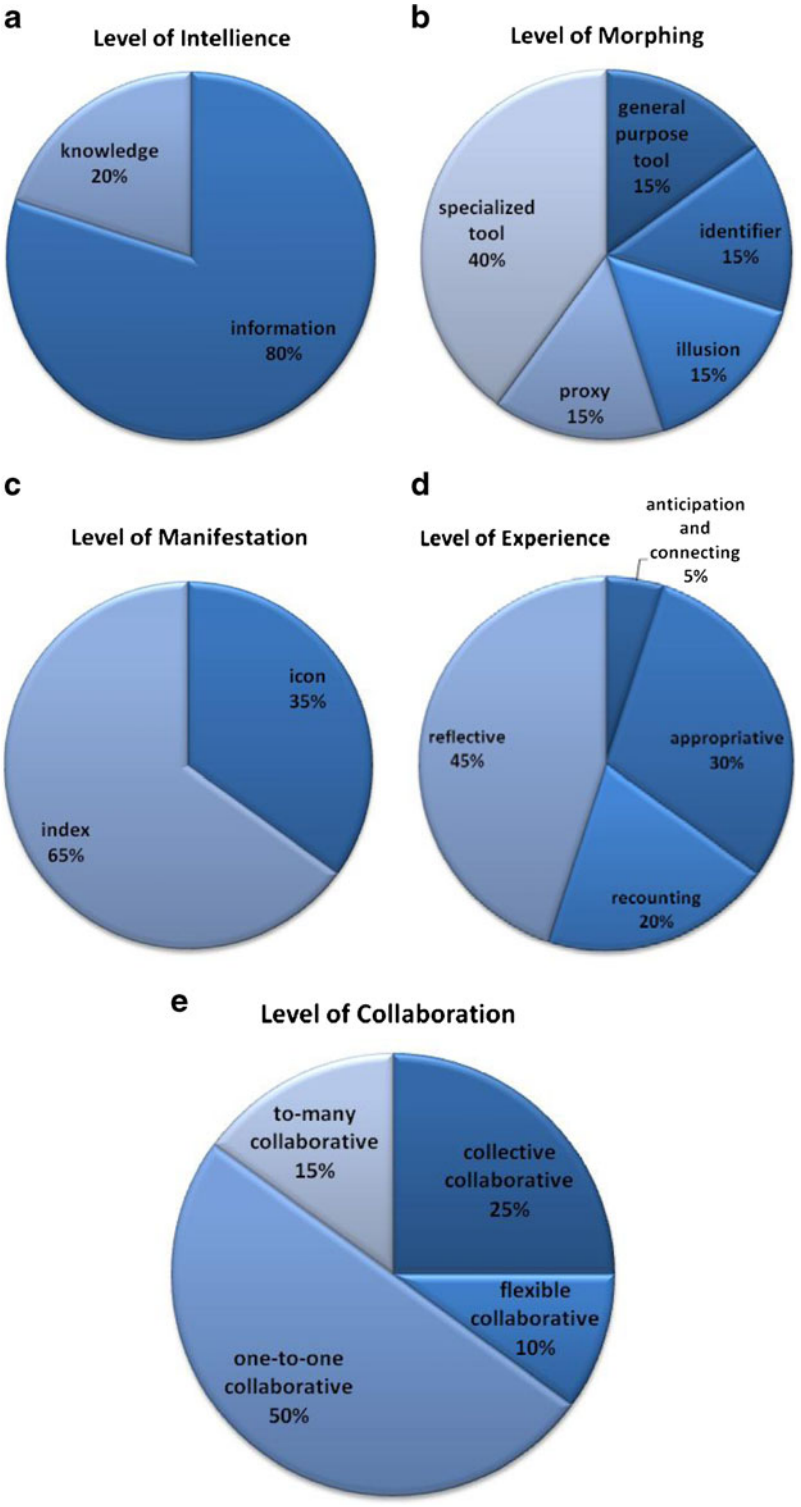
6 Impact on ambient media environments

The impact on ambient media environments has been measured according to the criteria mentioned above. Figure 5 compiles the impact of the various projects on ambient media environments. Various projects have been categorized according the framework in previous sections based on a subjective evaluation by the study authors.

6.1 Levels of intelligence

Considering the level of 'intelligence', as expected, there have been no project submitted that are dealing with the processing of wisdom or with understanding. Surprisingly several project entries did not deal with basic data and communication processing based on raw data or simple transactional services. This clearly shows, that the field of ambient media developed far beyond simple data driven services dealing with the advance of basic network and communication technologies, transactional services, and simple information exchange based services. An advance of previous competition entries is the emergence of knowledge processing application (20 %, 4 projects), that enable application to react proactively and in the behalf of the consumer. Most of the products (80 %, 16 projects) were still centered on information processing, where services require consumer interpretation and explicit/implicit interactions.

The premiere project dealing with ambient media on a knowledge basis is Siren. Siren allows the seamless distribution of documents and information between objects, humans, and environments without human intervention. Interaction takes place implicitly, thus the service understands the situation and allows information exchange based on physical encounters and viral transmissions. The service especially emphasizes that the carrier of information in form of humans, digital objects, or locations become hotspots for information which is exchanged between different entities on an automated basis. The other projects dealing with the processing of knowledge, namely PeR, ElementalProjections, and AmbiK-raf were partially on the borderline to fulfill the criteria of knowledge processing systems. The feature contributing to the knowledge processing capabilities of PeR is especially the


a
Level of Intellience
knowledge 20%
information 80%
b
Level of Morphing
general purpose tool 15%
identifier 15%
illusion 15%
proxy 15%
specialized tool 40%
c
Level of Manifestation
icon 35%
index 65%
d
Level of Experience
anticipation and connecting 5%
appropriative 30%
recounting 20%
reflective 45%
e
Level of Collaboration
collective collaborative 25%
flexible collaborative 10%
one-to-one collaborative 50%
to-many collaborative 15%

feature of making indirect interaction happen. The system allows analyzing perceptive activity of its environment, as e.g. connected entities in the environment or learning new situations by perceiving either activities or itself.

The specific feature of ElementalProjectsions is its capability for self-diagnosis, which turns the project into a system with self-healing capabilities with a minimal intervention of consumer. However, the border between information and knowledge processing systems is rather blurry. As e.g. smart textiles can turn textiles into objects understanding the environment (AmbiKraf), rather solely acting as display objects for information. The latter is typical for information processing systems, requiring consumer interpretation as e.g. myGreenSpace.

6.2 Levels of morphing

Illusion as a level of morphing is typical for artistic installations (e.g. Aleksandra Vasovic), video installations (as e.g. Ambient Video Installation), or advanced display devices (e.g. myGreenSpace). These projects illustrate how a projection of an object can be made by direct representations of an illusion based on physical properties such as generating visuals based on user-driven input and algorithm based manipulation. Artistic projects definitely fall in the similar category, as e.g. the visitor of a gallery becomes part of the illusion (e.g. Aleksandra Vasovic). myGreenSpace allows the visualization of a living space, thus make the projected image to a representation of the illusion of another space.

The level of morphing, where everyday objects act as proxies or replica of digital objects, has been demonstrated by iBall. In the application iBall, a ball equipped with sensors becomes a physical proxy to the digital world. The physical ball acts as replica of the physical world and allows further manipulation. Another example for proxy objects is the project PeR, where a rug becomes a proxy for physical and touch based interactions with the digital world. Around the World deals with digital packages that are bound to physical location and can be carried around on physical objects. Mobiles as physical objects in a wider sense act as manipulators for digital packages that can be carried.

Projects dealing with the concept of identifiers are Luxpass, where a mobile phone becomes a reference for PIN codes or passwords for secure transmission between mobiles and other devices. In Floweather, where an object visualizes any variables in the digital world as e.g. pollution—the physical object acts as interface for the index of the e.g. pollution level. A more problematic project to be categorized was Siren. However, viewing Siren as device that contains references to digital artifacts, or bookmark to other digital objects, can be view the carrier device as identifier for digital objects.

Projects dealing with the simplest level of morphing, where objects are either specialized or general purpose tools, have been easily identified. General purpose tools, such as e.g. the projects Joe, Hoax, or Twinners simply are based on general input devices such as mouse, keyboard, or PCs. Several of these projects are based on standard web-platforms that are based on commonly known input devices. Specialized tools, where other objects rather than general purpose tools become interaction devices are nicely shown in projects such as e.g. Wetransport, VirtualTouch, MMU, EPSystem, EPKapula, AmbiKraf, ElementalProjections, and EnergyLife. The features of these projects are e.g. public screens becoming input devices, mobile phones, audio based inputs, textiles, etc.

6.3 Levels of manifestation

Most of the projects deal with an index type of manifestation (65 %, 13 projects) and media objects represent a higher level structure and had semantic meaning. This is especially the

case for more artistic oriented installations (e.g. Aleksandra Vasovic), convoying a higher level of semantic and meanings by their art work conveying higher level meanings. The remaining projects (35 %, 7 projects) rendered media objects for specific purposes. A good example for iconic representation is the project EngergyLife, where a 3 dimensional carousel is utilized to visualize energy consumption on a mobile phone. In general, several submitted projects grew in complexity and utilized advanced methods for rendering media objects in the ubiquitous space. This is a good indicator that ubiquitous computation developed rather quickly, and involves increased complexity in user interfaces.

6.4 Levels of experience

Most of the submitted projects deal with reflective experience, thus consumer experience related to control systems a-like characteristics. Thus, the user has to reflect and to make sense from the displayed information. Typical examples are projects dealing with the control of ambient systems, as e.g. EPSystem or EPKapula. Appropriate experience, where the usage of the system leads to wisdom or sense making was dominant in quite a few projects. One example for this type of experience is EngergyLife, where the system leads to a consumer experience dealing with the reflection about energy consumption in a consumer home. One project can be clearly identified as anticipation and connecting experience. A situation where the consumer has to identify himself with the help of a tool can be classified as a particular situation requiring no actual reflection by the consumer while utilizing this service. A few of the projects demonstrate recounting of experience, by involving social communication and encounters. Example projects are e.g. iBall, Winners, Siren, or PeR. These encounters are either mediated (e.g. PeR), or direct (e.g. iBall or Siren).

6.5 Level of collaboration

Most projects (50 %, 10 projects) deal with a one-to-one collaboration, where collaboration is solely established on a temporary basis. In Luxpass the collaboration is solely for the time requiring the identification of a user; in PeR, the collaboration is between a human and a perceptive device; or in Floweather the collaboration is between an object and a human. A good example for to-many collaboration is the project MMU, where collaboration takes place in the context of exchanging informational messages notifying students from a centralized server for a short term goal. A good example for flexible collaboration is Siren, which allows several kinds of collaboration possibilities (one-to-one, one-to-many, many-to-many)) based on a long term basis. The system also allows the realization of different cooperation strategies based on goals of the total users utilizing the system, or the realization of goals for a certain time-point. Hoax representing a social network for the exchange of hoaxes on the Internet, can be seen as collective collaborative project, where the social network is in control of long-term goals enabling man various cooperation strategies, and traits.

7 Innovation evaluation of projects

The innovation value of projects has been depicted in Fig. 6 and was categorized according the classification stated in the method section of this paper. The categorization has been made according the previously mentioned criteria and was based on a subjective evaluation of the authors of this study.

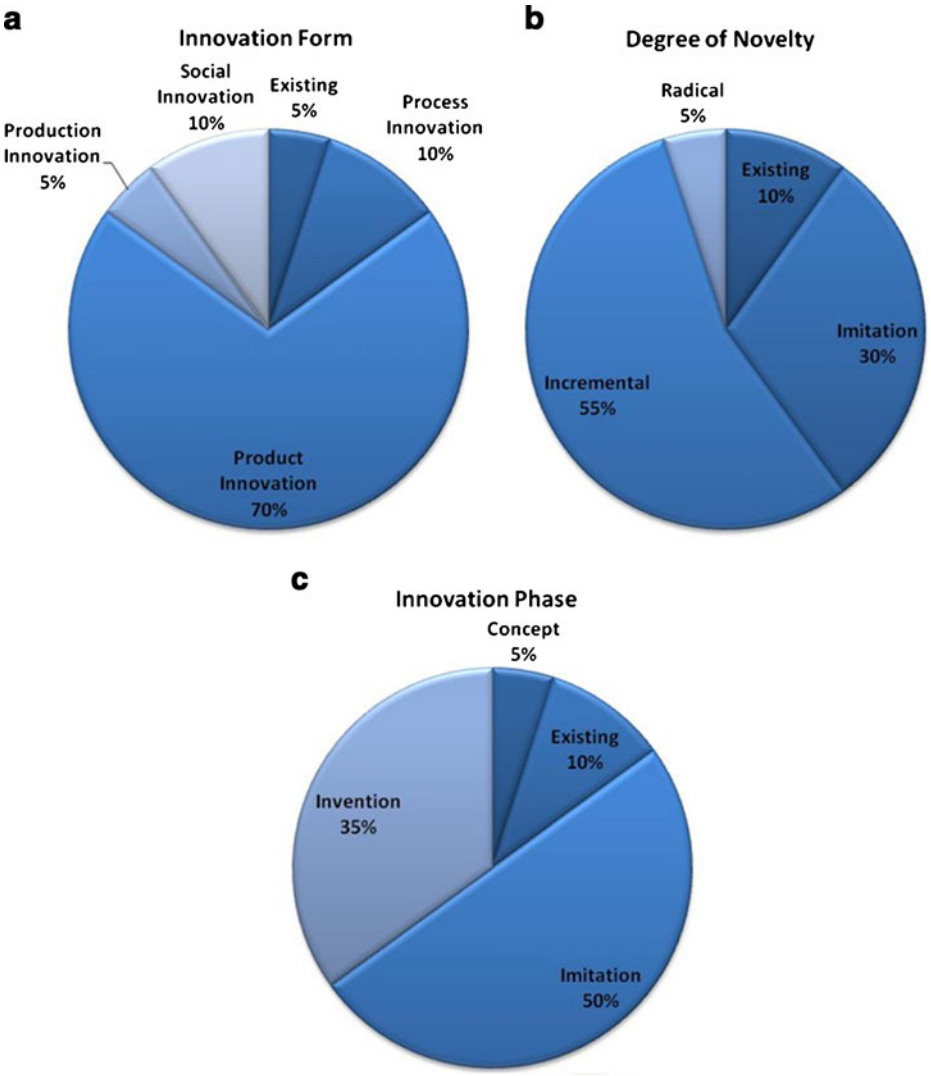


Fig. 6 **a**,**b**, and **c**. Evaluation of project entries to their levels of intelligence, morphing, manifestation, experience, and collaboration

The detailed subjective innovation value has been compiled in Table 8. It reflects the jury evaluation of the first round of evaluation. For each criterion, the jury evaluation values have been averaged. Solely the first jury round has been considered, as the total set of projects was included in this evaluation round.

8 Conclusions

The most significant results from the innovation study are depicted in Fig. 6, where several projects have been ranked. Interestingly several final nominees made it to the top-5

Table 8 Expert Evaluation of Each Single Project

Project	Business/Artistic/ Social Value	Innovation Value	Subjective Value
Hoax	1.5	1	1
Aleksandra Vasovic	1	1	1
Joe	2	1	2
MMU Notify-Me	1	1.25	1
Ambient Video Installation	2	1.33	1
EPKapula	2	1.33	1.33
ElementalProjections	2	1.5	1.5
Floweather	2.25	1.5	2
PeR	2.66	1.66	2.33
Twinners	2.75	1.75	2
EnergyLife	2.25	1.75	2.5
EPSystem	2.66	2	1.66
Siren	2.33	2	1.66
iBall	2	2	2.5
Around the World	1.5	2	1.5
VirtualTouch	1.5	2	1.25
myGreenSpace	2.75	2.25	2.75
WEtransport	2.25	2.25	2.25
Luxpass	2.66	2.33	1.66
AmbiKraf	1.5	2.5	1.5

innovative projects that have been examined by this study. However, neither of these two projects did not get nominated nor a special mention made it to the top 5 of the final evaluation. This is due to the fact, that they rank rather highly business aspects (Twinners is a commercialized solution), or highly in the contribution to ambient media in our classification model (Around the World). Interestingly none of the special mentions selected in the final competition made it into the top 5 of the final evaluation. However, as the selection of special mentions is mostly based on specific features or characteristics of the submitted project, this is not rather surprising. Another interesting assessment is the fact that an artistic installation (Aleksandra Vasovic) is in the top-5 of the projects contributing to the knowledge of ambient media, but rather poorly performs in criteria related to capitalization and value, or novelty. However, artistic installations are always tricky to evaluate on these variables and require personal experience of the installation as such, which cannot be provided to the jury members within the scope of this competition.

On general level, this study can be solely seen as one attempt to evaluate the innovativeness of products submitted to a competition. It is very tricky to formulate a general scheme that allows the quantification of innovations, and the calculation of a concrete innovation value. However, where this study definitely contributes, is in the provision of a general taxonomy and an evaluation scheme for ambient media products. But it also shows that a general evaluation based on the criteria mentioned in this study has its correctness, comparing the products that have been nominated by the competition, and the final results of the innovation study. Therefore it can be definitely seen as a framework for measuring novelty or innovation of ambient media. The framework can provide directions and insights for

Table 9 Total evaluation of project entries

Project	Project Phase	Commercialization strategy	Subjective value	Business/artistic/ social value	Producer background	SUM capitalization and value for customer/ business/art	Innovation form	Degree of novelty	Innovation phase	Subjective innovation value
Aleksandra Vasovic	2	1	1	1	1	6	3	2	2	1
Ambient video installation	3	1	1	2	4	11	2	2	2	1
Hoax	5	2	1	1.5	2	11.5	2	1	4	1
MMU notify me	5	4	1	1	3	14	1	1	1	1.3
WEtransport	3	1	2.3	2.3	3	11.5	3	3	2	2.3
Joe	1	4	2	2	2	11	2	3	2	1
Siren	1	3	1.7	2.3	3	10.99	2	3	3	2
ElementalProjections	5	3	1.5	2	4	**15.5**	2	2	1	1.5
VirtualTouch	3	3	1.3	1.5	3	11.75	2	3	4	2
EPKapula	3	4	1.3	2	4	14.33	2	3	2	1.3
Floweather	4	4	2	2.3	3	15.25	2	2	2	1.5
EnergyLife[a]	4	4	2.5	2.3	3	**15.75**	2	2	2	1.8
EPSystem	3	4	1.7	2.7	4	**15.32**	2	3	2	2
iBall[a]	3	4	2.5	2	3	14.5	2	2	4	2
Luxpass	3	4	1.7	2.7	2	13.32	2	3	4	2.3
Around the world	4	4	1.5	1.5	3	14	2	3	4	2
AmbiKraf[a]	3	4	1.5	1.5	3	13	2	4	4	2.5
PeR[a]	3	4	2.3	2.7	3	14.99	2	3	4	1.7
Twinners	5	4	2	2.8	4	**17.75**	2	3	2	1.8
myGreenSpace[a]	3	5	2.8	2.8	3	**16.5**	2	3	2	2.3

SUM novently, impact, and disruption	Level of intelligence	Level of manifestation	Level of morphing	Level of experience	Level of collaboration	SUM contribution to the knowledge of ambient media	Total normalized SUM
8	2	3	5	5	2	**17**	0.78
8	2	3	5	5	2	**17**	1.03
8	2	3	1	5	5	16	1.13

Table 9 (continued)

SUM novently, impact, and disruption	Level of intelligence	Level of manifestation	Level of morphing	Level of experience	Level of collaboration	SUM contribution to the knowledge of ambient media	Total normalized SUM
4.25	2	2	2	3	3	12	1.13
4.25	2	2	2	3	3	12	1.18
8	2	3	1	5	2	13	1.20
10	3	3	3	4	4	**17**	1.25
6.5	3	3	2	3	2	13	1.33
11	2	3	2	3	2	12	1.35
8.33	2	3	2	3	3	13	1.40
7.5	2	2	3	3	2	12	1.41
7.75	3	2	2	5	3	15	1.45
9	2	3	2	3	2	12	1.49
10	2	2	4	4	5	**17**	1.50
11.33	2	2	3	1	2	10	1.50
11	2	3	4	3	5	**17**	**1.52**
12.5	2	2	2	3	2	11	**1.54**
10.66	3	3	4	4	2	16	**1.56**
8.75	2	3	1	4	5	15	**1.61**
9.25	2	3	5	5	4	**19**	**1.62**

[a] winners or special mention of the competition

Values in bold shows the most important results of the evaluation

project developers to characterize and give certain ambient features to their products rather than simply starting on working on an idea. It shall help developers to think their projects through, and especially for rather poorly experienced developers it helps to get insights. This might lead to reduced failure rates while developing projects. However, it supports also developers to clarify and refine their doings already from the beginning. Inherently it is possible that they will succeed on a better level.

The study gave also many insights into measurements and variables that can be applied in future competition submissions and what the innovation characteristics are. What this study does not allow is to give insights about the long-term prediction of specific services—the field is rather too new to allow these kinds of predictions. But the study definitely gives strong insights into potential business and commercialization strategies that underlay current ambient media projects, and which projects might have value for the consumer (Table 9).

Acknowledgments The 'credits' for this paper are definitely for several hard working teams that contributed to the competition. Only with their insights they provide new contributions to the field of ambient media. Several projects, as well as the competition can be found on [1].

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