


Drivers and barriers for design and designers in interdisciplinary product development - a literature-based conceptual model

Bernd Stoehr , Christian Koldewey and Roman Dumitrescu

Heinz Nixdorf Institute, Paderborn University, Germany

 bernd.stoehr@hni.uni-paderborn.de

Abstract

Design is associated with many benefits for businesses, ranging from successful products and brands to greater economic success. However, companies still have difficulties in unlocking the potential of design. This publication develops a literature-based conceptual model that outlines necessary organizational factors and their interrelation to create an environment for design and designers to thrive. At the same time, it explains why companies are having difficulties in leveraging the benefits of design. Further research directions are derived to strengthen the role of design and designers.

Keywords: collaborative design, user-centred design, design management, product design, human-centred design

1. Introduction

Since Apple's founding, the design of its products has been a key differentiator. However, by the mid-1990s, Apple's products were losing uniqueness. „Sales were lagging, and shares had plummeted”. In 1997, the comeback of Steve Jobs brought design back to the heart of the company and played a major role in the company's turnaround (Ravasi and Lojacono, 2005). This is just one of the most impressive and prominent examples of the importance of design to business success. Beyond Apple, design plays an important role in industries ranging from furniture to consumer electronics and even industrial goods (Gemsera and Leenders, 2001; Russo et al., 2009). The business opportunities associated with outstanding design are extremely rich and powerful. Design can significantly contribute to the creation of successful products and brands (Goffin and Micheli, 2010). Gemsera and Leenders (2001) also showed that design-driven companies generate higher sales growth and achieve greater market success (Gemsera and Leenders, 2001). However, although the benefits of design seem compelling, previous research has shown that companies still face challenges in realizing the benefits of design. Several challenges for design and designers have been identified in the literature. For example, a lack of integration of designers in the development process, or a low priority of design activities compared to engineering aspects as well as cost and time (Inal et al., 2020; Ardito et al., 2014).

Most studies in the literature focus on individual challenges, drivers, or barriers and neglect the relationship between them, leaving the phenomenon as a whole, for example in terms of cause and effects, insufficiently understood. This finding is supported by the argument of Blessing and Chakrabarti (2009) in their Design Research Methodology that a "network of influencing factors" is necessary to fully comprehend an existing situation (Blessing and Chakrabarti, 2009). This serves to conceptualize an existing situation in sufficient detail by identifying the factors that need to be addressed and forms the basis for the development of effective support in order to improve the current situation (Blessing and Chakrabarti, 2009). Furthermore, this is also in line with existing literature in the subject area, which

suggests further research into factors and their interrelationships (Zaina et al., 2023; van Kuijk et al., 2019; Kashfi et al., 2017). Against this background, we formulate the following research question: "What are the organizational drivers/barriers in interdisciplinary product development that promote/hinder the unfolding of the potential associated with design and designers and how are they interrelated?" To address this question, we synthesize the individual aspects of the known literature into a conceptual model. This literature-based conceptual model explains which organizational factors must be in place and how they need to interrelate to provide the necessary environment for design and designers to unfold. At the same time, it explains why companies are having difficulties in leveraging the benefits of design. Since today's products are created in interdisciplinary collaboration between design, engineering, marketing, and other disciplines, we develop this model with a focus on the organizational context of interdisciplinary product development.

2. Related work

Due to conceptual ambiguities, a valid understanding of design and designers throughout this paper is needed. In the context of design, various overlapping terms and professions such as industrial design(er), UX/UI design(er), and usability design(er) are used and interpreted in different ways. Because of our focus on interdisciplinary product development, we will use these terms and related ones synonymously and consistently use the terms design and designer throughout this publication. Non-designers are considered to be, for example, engineers or managers. The existing literature identified various organizational drivers and barriers for design and designers in interdisciplinary product development. According to research by van Kuijk (2010), there is a lack of knowledge about design in organizations (van Kuijk, 2010). However, the literature also reports on the importance of knowledge about design to integrate design and ensure design is given the appropriate status in the organization (Micheli et al., 2018). There are also divergent views between managers and designers on what constitutes "good" design (Micheli et al., 2012). It is reported that design and designers are not sufficiently integrated into the process (Inal et al., 2020; Zhang et al., 2011). Only 20% of all designers surveyed in a study by Inal et al. (2020) felt sufficiently involved in the interdisciplinary product development process (Inal et al., 2020). However, early and continuous integration is crucial for product design quality (Kashfi et al., 2017). More generally, design is not sufficiently prioritized in the interdisciplinary development process. This is reflected by the fact that time and financial resources are not sufficiently available (Silveira et al., 2021). At the same time prioritization is an essential factor for achieving high product design quality (van Kuijk et al., 2019). The significance of design is not sufficiently acknowledged at the management level (Boivie et al., 2006). However, management support is crucial to prioritize design activities (Kashfi et al., 2017; van Kuijk et al., 2019). Research suggests that designers face the challenge of being stereotyped as artists, with their contribution not considered as added value (Kaygan, 2014). Additionally, differences in language between designers and managers, or engineers, further complicate collaboration (Laursen, 2017).

The literature highlights numerous barriers and drivers for design and designers in the organizational context of interdisciplinary product development. However, apart from the research of van Kuijk et al. (2019), there is a lack of understanding in the published literature as to how these factors interrelate to create an organizational environment for design and designers to unfold their associated potential.

3. Research design

Developing the conceptual model is divided into four main steps - identifying and selecting literature, extracting factors and causalities, thematic analysis, and conceptual modeling. The initial stage involves collecting and selecting suitable literature. We followed an exploratory approach, based on our previous study outcomes. Firstly, we searched the Scopus database to identify potentially relevant literature. Aligned with our defined understanding of design and designers' we used keywords like "industrial design", "usability", "user experience", and "human factors". Additionally, we used keywords such as "challenges," "barrier," or "driver," and synonyms to find relevant literature. Furthermore, we considered particular relevant journals - Design Issues, Journal of Product Innovation, Journal of User Experience, Human Factors, International Journal of Design, International Journal of Human-Computer Studies, CoDesign, and Journal of Design Research for our literature search. Further criteria for selection

were the overall quality of the publication, the number of citations, and the year of publication (more recent publications were preferred). The main criteria were the focus on interdisciplinary aspects in design, e.g. collaboration with other roles. We selected relevant literature based on the paper title and, if promising, based on the full publication. Title-based forward and backward searches supplemented the set of relevant publications. This process resulted in a final set of relevant publications, which we used as a basis for further work. In the second step, factors, drivers, and barriers for design and designers were extracted from these publications. Since our research aimed at developing a conceptual model, we also extracted causalities from the literature. By causality, we mean the relationship between cause and effect of the identified factors. We extracted both explicitly examined causalities and those that are implicitly mentioned and, therefore, rather assumed. We define explicit causalities as "proven" by dedicated research. Often, causalities are only mentioned in the text of publications. For instance, Goffin and Micheli (2010) note that "[...] managers playing down the role of design, or design being excluded from the decision-making process, because as one designer in the group put it, the CEO has no idea what design is." (Goffin and Micheli, 2010). From this passage, we extracted the implicit causality that a lack of knowledge about design among managers influences the integration of design, and the corresponding direction of the effect. Moreover, we determine more precisely that (in this case) a lack of knowledge negatively influences design integration. The next step was to synthesize the various factors and causalities into key factors (drivers or barriers) and causalities. We used Braun and Clarke's (2006) approach by creating initial codes, searching and reviewing themes, and identifying and naming themes (Braun and Clarke, 2006). Those factors and causalities were the basis for designing the conceptual model, which is a graphical representation of the key factors. In summary, we analyzed a total of 35 relevant publications. From these, ~500 factor- and causality-related text passages were extracted and consolidated into 6 factors and related causalities, which were visualized as a conceptual model. This model is the outcome of this publication and will be presented in the following chapter.

4. Conceptual model

The literature-based conceptual model is shown in Figure 1. This literature-based conceptual model explains which organizational factors need to be in place and how they must interrelate to provide the necessary environment for design and designers to unfold. At the same time, it explains why companies are having difficulties in leveraging the benefits of design.

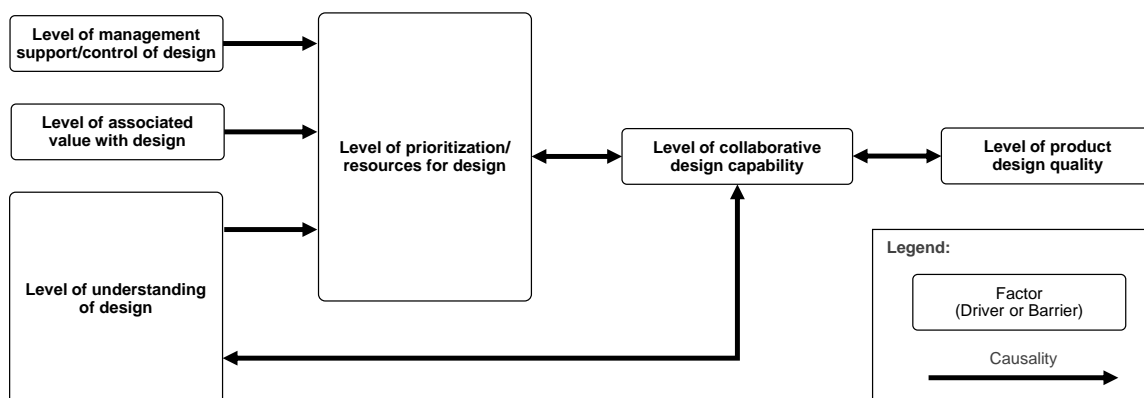


Figure 1. Literature-based conceptual model

The consolidated factors are shown as rectangles, and the causalities between the factors are shown as arrows. For a better understanding, the model is briefly described in the following, before the factors and the causalities are discussed in more detail in the subsequent sub-chapters. For example, suppose non-designers in the organization have a comprehensive understanding of design (Level of understanding of design). In that case, this will positively influence prioritization and allocation of resources for design (Level of prioritization/resources for design). A higher priority of design activities and suitable resources in turn will positively affect the unfolding of design capabilities (Level of collaborative design capability) which directly impacts the quality of the product design (Level of product design quality). The quality of the product design (Level of product design quality) and its

technical mutability also influence the unfolding of existing organizational design capabilities (Level of collaborative design capability). The level of understanding of design also has another effect. For example, a lack of understanding of non-designers about design influences the use of language, whereby differences in the use of language used by non-designers and designers influence communication and collaboration (Level of collaborative design capability) and therefore also have an impact on product design quality (Level of product design quality).

Table 1 shows the factors identified, including a brief characterization and the number of references found in the literature. A list of full references is in Appendix A. These factors, be they barriers or drivers, are characterized based on the literature in more detail in the following sub-chapters. Additionally, the causalities known from the literature are described, whereby only one specific example is given for readability reasons. The "Level of product design quality" factor is mainly a result of the other factors and is therefore not considered in more detail.

Table 1. Overview of literature-based factors

| Factor | Characterization | No. of References |
|---|--|-------------------|
| Level of prioritization/resources for design | Extent to which design activities are prioritized and supported with necessary resources. | 25 |
| Level of associated value with design | Extent to which design is associated with value for the organization and the customer. | 17 |
| Level of understanding of design | Extent to which non-designers understand the concept and the value of design. | 13 |
| Level of collaborative design capability | Extent to which the interdisciplinary development team collaborates and has the necessary capabilities to design products. | 12 |
| Level of management support/control of design | Extent to which design activities are supported and controlled by management. | 9 |
| Level of product design quality | Product design quality and its technical mutability. | 3 |

4.1. Level of understanding of design

4.1.1. Characterization

The factor of non-designers' understanding of design is often mentioned in the literature. In most cases, a lack of understanding is reported. [Inal et al. \(2020\)](#) surveyed 400 UX experts, showing that 40% of top managers are "not familiar" or "probably not familiar" with the concept of UX. Among developers and marketers, the estimate is around 25% ([Inal et al., 2020](#)). In the same survey, around 40 of the UX professionals interviewed stated that a lack of understanding and knowledge about UX in the organization is perceived as a challenge ([Inal et al., 2020](#)). More specifically, a lack of awareness at the management level is reported ([Boivie et al., 2006](#)). Other sources suggest that designers and managers differ in their understanding of design ([Goffin and Micheli, 2010](#)). In general, the concept of design is perceived as "fuzzy", with false "preconceptions" and "misunderstandings" ([Boivie et al., 2006](#)). According to [Kaygan \(2014\)](#), design is often understood as simply "make things look good" ([Kaygan, 2014](#)). There is also evidence in the literature that the value or contribution of design is not recognized in organizations. According to [Kaygan \(2014\)](#), there is a general perception among engineers that designers "draw well" and have "some creative ideas", but do not have a "real job" and do not make a "real contribution" ([Kaygan, 2014](#)).

4.1.2. Causalities

The "Level of understanding of design" factor affects the "Level of prioritization/resources for design". Table 2 shows an exemplary causality taken from the literature. According to [Micheli et al. \(2018\)](#), organizations in which design is a high priority also have a comprehensive understanding of design. We interpret this as an increasing understanding of design leads to a higher priority for design. This positive effect is indicated by "+ / +" in the effect column (a higher level of understanding leads to higher priority). The exemplary causality is implicitly mentioned in the extracted text passage, so it is labeled

in Table 2 as implicit. However, most sources in the literature mention the case where a lack of design understanding negatively influences the prioritization of design activities and the allocation of resources (Goffin and Micheli, 2010; Kashfi et al., 2017; Boivie et al., 2006; Wale-Kolade and Nielsen, 2016; Micheli et al., 2018; Kashfi et al., 2019; Nielsen et al., 2023). The "Level of understanding of design" also influences the "Level of collaborative design capability" (Goffin and Micheli, 2010; Kashfi et al., 2017; Micheli et al., 2012; Nielsen et al., 2023). For example, a lack of understanding of design leads to e.g. language differences and misunderstandings between designers and non-designers, which in turn makes communication and collaboration more difficult (Kashfi et al., 2017).

Table 2. Exemplary causality for factor "Level of understanding of design"

| Causality | | Exemplary quote | Effect | Type | Source |
|----------------------------------|--|--|--------|----------|-----------------------|
| Level of understanding of design | Level of priority/resources for design | "Where design [...] was the dominant perspective, [...] design was widely understood in the organization." | + / + | Implicit | Micheli et al. (2018) |

4.2. Level of prioritization/resources for design

4.2.1. Characterization

Prioritization of design activities and allocation of resources is a widely discussed factor in the literature, with reports mostly of insufficient prioritization. According to a study conducted by Inal et al. (2020) over 30% of the surveyed UX professionals saw a low priority of UX issues as a primary challenge within their organizations (Inal et al., 2020). Managers often disregard the importance of design, or even omit it from decision-making processes (Goffin and Micheli, 2010). Although design is recognized as essential, there is no genuine commitment to its implementation (Wale-Kolade, 2015). Other sources suggest different interpretations of the appropriate prioritization of design. Design is mostly seen as something "on the side" (Kashfi et al., 2017). There is only a limited amount of time available (Silveira et al., 2021). In addition to a lack of time, a lack of financial resources is also reported (Inal et al., 2020). Furthermore, certain sources indicate a shortage of "professionals designated to work with UX" or "qualified UX professionals" within the development team (Silveira et al., 2021; Inal et al., 2020).

4.2.2. Causalities

The factor "Level of prioritization/resources for design" affects the "Level of collaborative design capability" (Nielsen et al., 2023; van Kuijk et al., 2019). The implicitly mentioned reference is that "Pushing for faster results and for implementing untested designs negatively impacted UX competence development which in turn led to accepting poorer quality design" (Nielsen et al., 2023). Van Kuijk et al. (2019) have explicitly investigated this causality, as shown in Table 3.

Table 3. Exemplary causality for factor "Level of prioritization/resources for design"

| Causality | | Exemplary quote | Effect | Type | Source |
|--|--|--|--------|----------|-------------------------|
| Level of prioritization/resources for design | Level of collaborative design capability | "Resource allocation exerts influence [...] the UCD capability of a team or organization." (UCD: User-Centered Design) | + / + | Explicit | Van Kuijk et al. (2019) |

4.3. Level of associated value with design

4.3.1. Characterization

The factor of the value associated with design is often mentioned in the literature. The associated value with design is often mentioned as a driver. For companies, design contributes to developing successful products, generating value for the business, creating a competitive advantage, or creating value for customers (Silveira et al., 2021). Design is seen as a "differentiator" (Kashfi et al., 2017). For marketing departments, design is one of the "selling points" for products and advertisements (Kashfi et al., 2019).

However, it is also reported that there is a "lack of consensus on the value of UX" (Kashfi et al., 2017). Customers do not always recognize the added value of design, with particular reference being made to the lack of measurability of the added value of design and the return on investment (Kashfi et al., 2017). While costs are very much "tangible", the benefits are "quite intangible" and "not easy to quantify reliably" (Rajanen and Iivari, 2007). Concerning the role of designers, designers have to "justify" their role and have to spend much of their time on "missionary activities" (Boivie et al., 2006).

4.3.2. Causalities

The "Level of associated value with design" factor affects the "Level of prioritization/resources for design". It is often mentioned in the literature that the value associated with design, whether for the organization or the customer, is a driver for prioritizing design (Kashfi et al., 2017; Silveira et al., 2021; Bygstad et al., 2008; Choma et al., 2022; Ji and Yun, 2006; Kashfi et al., 2019). An example of a causality identified in the literature for this positive effect is shown in Table 4 (Choma et al., 2022). But some sources also point out that a lack of associated value with design, for example for the customer, can also have a barrier effect (Kashfi et al., 2017; Valencia et al., 2013; Venturi et al., 2006; Nielsen et al., 2023). Additionally, a lack of measurability of the associated value with design negatively influences the prioritization and provision of resources (Rajanen and Iivari, 2007).

Table 4. Exemplary causality for factor "Level of associated value with design"

| Causality | | Exemplary quote | Effect | Type | Source |
|---------------------------------------|--|--|--------|----------|---------------------|
| Level of associated value with design | Level of prioritization/resources for design | "Of all factors that encourage startups to adopt UX practices within this dimension, value for the business and competitive advantages were the factors most selected by respondents." | + / + | Implicit | Choma et al. (2022) |

4.4. Level of management support/control of design

4.4.1. Characterization

The factor of management support and control of design is often mentioned in the literature. Both the positive effect of management support and a lack of support are reported. "Support from the project manager is very important [...] and from management in general" (Boivie et al., 2006). Management is also assigned the role of easing developers' doubts about the importance of design (Gulliksen et al., 2004). The literature also reports a lack of management support. In a survey by Inal et al. (2020) around 25% of designers stated a lack of management support in the organization (Inal et al., 2020). There is also a lack of usability goals and incentives for good design (Venturi et al., 2006). Management should incorporate design into the business strategy and mission and support it. Furthermore, design goals should be set, and appropriate incentives should be provided (Venturi et al., 2006).

4.4.2. Causalities

The factor "Level of management support/control of design" affects the "Level of prioritization/resources for design". The literature often mentions that management support is key in prioritizing design activities and providing resources. Table 5 shows an example from the literature.

Table 5. Exemplary causality for factor "Level of management support/control of design"

| Causality | | Exemplary quote | Effect | Type | Source |
|---|--|---|--------|----------|-----------------------|
| Level of management support/control of design | Level of prioritization/resources for design | "Commitment from the management was often cited among the most important factors for a successful adoption of UCD." (UCD: User-Centered Design) | + / + | Implicit | Venturi et al. (2006) |

In most cases, the causality is described such that sufficient management support has a positive effect on the prioritization of design activities (van Kuijk et al., 2019; Boivie et al., 2006; Ji and Yun, 2006;

Kashfi et al., 2017; Venturi et al., 2006). However, too much management involvement can also have a negative effect (Micheli et al., 2018). One reference also states that a lack of management support negatively influences the prioritization of design (Kashfi et al., 2017).

4.5. Level of collaborative design capability

4.5.1. Characterization

The factor of collaborative design capability is often mentioned in the literature. As the publication focuses on the organizational environment of design and designers in the context of interdisciplinary product development, rather than on the knowledge and capabilities required for the design process itself (e.g., selection of design methods), we focus on the collaborative aspect of this factor. Design requires regular communication and collaboration between designers and non-designers (Kashfi et al., 2017). In the literature, communication and collaboration are often seen as barriers. Silveira et al. (2021) report a "communication and collaboration gap" (Silveira et al., 2021). Collaboration is challenging due to different responsibilities and motivations (Kashfi et al., 2017). In a survey by Inal et al. (2020), almost 30% of the designers surveyed stated that they see communication problems with developers (Inal et al., 2020). It is a challenge for designers to communicate to engineers regarding aspects that go beyond the functional and technical aspects, such as the emotional aspects of the product (Laursen, 2017). In addition, non-designers reported a lack of trust in their design capabilities, which further complicates collaboration (Nielsen et al., 2023; Ananjeva et al., 2020; Kashfi et al., 2017; Wale-Kolade, 2015). Because of siloed teams, designers are unaware that their tasks overlap with other roles, which makes collaboration even more difficult (Nielsen et al., 2023).

4.5.2. Causalities

The "Level collaborative design capability" factor affects the "Level of understanding of design". Kashfi et al. (2017) assume that a closer collaboration between designers and non-designers leads to an increase in understanding of design among non-designers (Kashfi et al., 2017). The "Level of collaborative design capability" also affects the "Level of prioritization/resources for design". According to some identified sources, the causality is described with the effect that a lack of collaboration, or language barriers hinder the prioritization of design (Silveira et al., 2021; Laursen, 2017; Nielsen et al., 2023). Table 6 shows an example of an implicit causality identified from the literature for this negative effect of a lack of collaboration (Nielsen et al., 2023). Chilana et al. (2010) mention in this context that designers' lack of domain knowledge can also negatively influence prioritization (Chilana et al., 2010). Van Kuijk et al. (2019) explicitly investigated the causalities and concluded that appropriate design capabilities also positively affect product design quality (van Kuijk et al., 2019).

Table 6. Exemplary causality for factor "Level of collaborative design capability"

| Causality | | Exemplary quote | Effect | Type | Source |
|--|--|--|--------|----------|-----------------------|
| Level of collaborative design capability | Level of prioritization/resources for design | "[...] where UX was compartmentalized, and consequently the [...] responsible for UX were not provided with adequate resources [...] which led to de-prioritisation of UX [...]" | - / - | Implicit | Nielsen et al. (2023) |

5. Discussion

This paper makes three key contributions. First, the conceptual model derived from the literature confirms the core structure and factors of the case-study-based framework by van Kuijk et al. (2019) which depicts the drivers and their relationships for usability and user-centered design in product design practice. Our research provides a signification contribution and extents this framework in the sense that the understanding of design (among e.g., managers and engineers) and the associated value of design are key factors for prioritizing design activities and collaboration in design. In our understanding, these aspects cannot be found in this form in the framework developed by van Kuijk et al. (2019). Second, our research shows that the overall understanding of the phenomenon is still vague. Especially most of

the causalities between the different factors are only implicitly mentioned in the text and have not been investigated in detail. Therefore, we see the need to focus further research on cause-effect relationships for example by performing experimental studies to examine the underlying mechanisms more in detail. Third, it seems particularly worthwhile to focus further research on the non-designers' understanding of design. This factor seems to have an impact on priority setting as well as interdisciplinary collaboration. However, the literature remains unclear in characterizing the necessary understanding of design in detail. Very different and high-level aspects can be found ranging from a lack of formal knowledge about design to a reduced understanding of the term, to a lack of knowledge about the added value of design. Further case studies or experimental research could provide answers to the raised questions. Those research directions should be supplemented by a systematic literature review on the drivers and barriers for design and designers in interdisciplinary product development. This will enrich the presented conceptual model, provide an even more comprehensive understanding of the investigated phenomenon, and enable the development of more refined approaches for support.

6. Conclusion

Design is associated with many benefits for businesses, ranging from successful products and brands to greater economic success. However, companies still have difficulties in unlocking the potential of design. The literature identified various organizational factors that inhibit or facilitate design and designers. This publication built on this preliminary work and developed a literature-based conceptual model in a structured four-step process with a focus on interdisciplinary product development. The literature-based conceptual model explains which organizational factors must be in place and how they need to interrelate to provide the necessary environment for design and designers to unfold. At the same time, it explains why companies are having difficulties in leveraging the benefits of design. Based on the deeper understanding gained through the conceptual model, further research directions were derived to strengthen the role of design and designers in the context of interdisciplinary product development and to enable organizations to leverage the associated potentials of design.

References

- Ananjeva, A., Persson, J.S. and Bruun, A. (2020), "Integrating UX work with agile development through user stories: An action research study in a small software company", *Journal of Systems and Software*, Vol. 170. <https://doi.org/10.1016/j.jss.2020.110785>
- Ardito, C., Buono, P., Caivano, D., Costabile, M.F. and Lanzilotti, R. (2014), "Investigating and promoting UX practice in industry: An experimental study", *International Journal of Human-Computer Studies*, Vol. 72 No. 6, pp. 542–551. <https://doi.org/10.1016/j.ijhcs.2013.10.004>
- Bak, J.O., Nguyen, K., Risgaard, P. and Stage, J. (2008), "Obstacles to usability evaluation in practice: A survey of software development organizations", *Proceedings of the 5th Nordic conference on Human-computer interaction: building bridges*, pp. 23–32. <https://doi.org/10.1145/1463160.1463164>
- Blessing, L.T. and Chakrabarti, A. (2009), *DRM, a Design Research Methodology*, Springer London. <https://doi.org/10.1007/978-1-84882-587-1>
- Boivie, I., Åborg, C., Persson, J. and Löfberg, M. (2003), "Why usability gets lost or usability in in-house software development", *Interacting with Computers*, Vol. 15 No. 4, pp. 623–639. [https://doi.org/10.1016/s0953-5438\(03\)00055-9](https://doi.org/10.1016/s0953-5438(03)00055-9)
- Boivie, I., Gulliksen, J. and Göransson, B. (2006), "The lonesome cowboy: A study of the usability designer role in systems development", *Interacting with Computers*, Vol. 18 No. 4, pp. 601–634. <https://doi.org/10.1016/j.intcom.2005.10.003>
- Bornoe, N. and Stage, J. (2014), "Usability Engineering in the Wild: How Do Practitioners Integrate Usability Engineering in Software Development?", *Human-Centered Software Engineering, Lecture Notes in Computer Science*, Vol. 8742, Springer Berlin Heidelberg, pp. 199–216. https://doi.org/10.1007/978-3-662-44811-3_12
- Braun, V. and Clarke, V. (2006), "Using thematic analysis in psychology", *Qualitative Research in Psychology*, Vol. 3 No. 2, pp. 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Bygstad, B., Ghinea, G. and Brevik, E. (2008), "Software development methods and usability: Perspectives from a survey in the software industry in Norway", *Interacting with Computers*, Vol. 20 No. 3, pp. 375–385. <https://doi.org/10.1016/j.intcom.2007.12.001>

- Chilana, P.K., Wobbrock, J.O. and Ko, A.J. (2010), “Understanding usability practices in complex domains”, *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 2337–2346. <https://doi.org/10.1145/1753326.1753678>
- Choma, J., Guerra, E.M., Alvaro, A., Pereira, R. and Zaina, L. (2022), “Influences of UX factors in the Agile UX context of software startups”, *Information and Software Technology*, Vol. 152. <https://doi.org/10.1016/j.infsof.2022.107041>
- Gemsera, G. and Leenders, M. (2001), “How integrating industrial design in the product development process impacts on company performance”, *Journal of Product Innovation Management*, Vol. 18 No. 1, pp. 28–38. <https://doi.org/10.1111/1540-5885.1810028>
- Goffin, K. and Micheli, P. (2010), “Maximizing the Value of Industrial Design in New Product Development”, *Research-Technology Management*, Vol. 53 No. 5, pp. 29–37. <https://doi.org/10.1080/08956308.2010.11657648>
- Gulliksen, J., Boivie, I., Persson, J., Hektor, A. and Herulf, L. (2004), “Making a difference – a survey of the usability profession in Sweden”, *Proceedings of the third Nordic conference on Human-computer interaction*, pp. 207–215. <https://doi.org/10.1145/1028014.1028046>
- Hoegh, R.T. (2008), “Case study: integrating usability activities in a software development process”, *Behaviour & Information Technology*, Vol. 27 No. 4, pp. 301–306. <https://doi.org/10.1080/01449290701766325>
- Hokkanen, L., Xu, Y. and Väänänen, K. (2016), “Focusing on user experience and business models in startups: investigation of two-dimensional value creation”, *Proceedings of the 20th International Academic Mindtrek Conference*, pp. 59–67. <https://doi.org/10.1145/2994310.2994371>
- Inal, Y., Clemmensen, T., Rajanen, D., Iivari, N., Rizvanoglu, K. and Sivaji, A. (2020), “Positive developments but challenges still ahead: a survey study on UX professionals' work practices”, *Journal of Usability Studies*, Vol. 15 No. 4, pp. 210–246.
- Ji, Y.G. and Yun, M.H. (2006), “Enhancing the Minority Discipline in the IT Industry: A Survey of Usability and User-Centered Design Practice”, *International Journal of Human-Computer Interaction*, Vol. 20 No. 2, pp. 117–134. https://doi.org/10.1207/s15327590ijhc2002_3
- Kashfi, P., Feldt, R. and Nilsson, A. (2019), “Integrating UX principles and practices into software development organizations: A case study of influencing events”, *Journal of Systems and Software*, Vol. 154, pp. 37–58. <https://doi.org/10.1016/j.jss.2019.03.066>
- Kashfi, P., Nilsson, A. and Feldt, R. (2017), “Integrating User eXperience practices into software development processes: implications of the UX characteristics”, *PeerJ Computer Science*, Vol. 3. <https://doi.org/10.7717/peerj-cs.130>
- Kaygan, P. (2014), “‘Arty’ versus ‘Real’ Work: Gendered Relations between Industrial Designers and Engineers in Interdisciplinary Work Settings”, *The Design Journal*, Vol. 17 No. 1, pp. 73–90. <https://doi.org/10.2752/175630614x13787503069990>
- Laursen, E.S. (2017), *Exploring the Collaboration Between Industrial Designers and Engineering Designers in a Handover Situation: sharing the product concept's underpinning logic*, Aalborg University Press.
- Micheli, P., Jaina, J., Goffin, K., Lemke, F. and Verganti, R. (2012), “Perceptions of Industrial Design: The “Means” and the “Ends””, *Journal of Product Innovation Management*, Vol. 29 No. 5, pp. 687–704. <https://doi.org/10.1111/j.1540-5885.2012.00937.x>
- Micheli, P., Perks, H. and Beverland, M.B. (2018), “Elevating Design in the Organization”, *Journal of Product Innovation Management*, Vol. 35 No. 4, pp. 629–651. <https://doi.org/10.1111/jpim.12434>
- Nielsen, S., Ordoñez, R., Skov, M.B. and Jochum, E. (2023), “Strategies for strengthening UX competencies and cultivating corporate UX in a large organisation developing robots”, *Behaviour & Information Technology*, pp. 1–29. <https://doi.org/10.1080/0144929x.2023.2227284>
- Ovad, T. and Larsen, L.B. (2015), “The Prevalence of UX Design in Agile Development Processes in Industry”, in *2015 Agile Conference*, pp. 40–49. <https://doi.org/10.1109/agile.2015.13>
- Rajanen, M. and Iivari, N. (2007), “Usability Cost-Benefit Analysis: How Usability Became a Curse Word?”, *Lecture Notes in Computer Science*, Vol. 4663, Springer Berlin Heidelberg, pp. 511–524. https://doi.org/10.1007/978-3-540-74800-7_47
- Ravasi, D. and Lojacono, G. (2005), “Managing design and designers for strategic renewal”, *Long Range Planning*, Vol. 38 No. 1, pp. 51–77. <https://doi.org/10.1016/j.lrp.2004.11.010>
- Russo, P., Gleich, R., Möller, G. and Herrmann, C. (2009), *Strategisches Industriegüterdesign*, Springer Berlin Heidelberg. <https://dx.doi.org/10.1007/978-3-642-00116-1>
- Silveira, S.A.M., Choma, J., Pereira, R., Guerra, E.M. and Zaina, L.A.M. (2021), “UX Work in Software Start-Ups: Challenges from the Current State of Practice”, *Lecture Notes in Business Information Processing*, Vol. 419, Springer International Publishing, Cham, pp. 19–35. https://doi.org/10.1007/978-3-030-78098-2_2
- Szabó, B. and Hercegfí, K. (2023), “User-centered approaches in software development processes: Qualitative research into the practice of Hungarian companies”, *Journal of Software: Evolution and Process*, Vol. 35 No. 2. <https://doi.org/10.1002/smr.2501>

- Valencia, A., Person, O. and Snelders, D. (2013), “An in-depth case study on the role of industrial design in a business-to-business company”, *Journal of Engineering and Technology Management*, Vol. 30 No. 4, pp. 363–383. <https://doi.org/10.1016/j.jengtecman.2013.08.002>
- van Kuijk, J., Daalhuizen, J. and Christiaans, H. (2019), “Drivers of usability in product design practice: Induction of a framework through a case study of three product development projects”, *Design Studies*, Vol. 60, pp. 139–179. <https://doi.org/10.1016/j.destud.2018.06.002>
- van Kuijk, J.I. (2010), *Managing product usability: How companies deal with usability in the development of electronic consumer products*, Delft University of Technology.
- Venturi, G., Troost, J. and Jokela, T. (2006), “People, Organizations, and Processes: An Inquiry into the Adoption of User-Centered Design in Industry”, *International Journal of Human-Computer Interaction*, Vol. 21 No. 2, pp. 219–238. https://doi.org/10.1207/s15327590ijhc2102_6
- Vredenburg, K., Mao, J.-Y., Smith, P.W. and Carey, T. (2002), “A survey of user-centered design practice”, *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 471–478. <https://doi.org/10.1145/503376.503460>
- Wale-Kolade, A. and Nielsen, P.A. (2016), “Apathy Towards the Integration of Usability Work: A Case of System Justification”, *Interacting with Computers*, Vol. 28 No. 4, pp. 437–450. <https://doi.org/10.1093/iwc/iwv016>
- Wale-Kolade, A.Y. (2015), “Integrating usability work into a large inter-organisational agile development project: Tactics developed by usability designers”, *Journal of Systems and Software*, Vol. 100, pp. 54–66.
- Zaina, L., Choma, J., Saad, J., Barroca, L., Sharp, H., Machado, L. and Souza, C.R.B. de (2023), “What do software startups need from UX work?”, *Empirical software engineering*, Vol. 28 No. 3, p. 80. <https://doi.org/10.1007/s10664-023-10322-x>
- Zhang, D., Hu, P. and Kotabe, M. (2011), “Marketing-Industrial Design Integration in New Product Development: The Case of China”, *Journal of Product Innovation Management*, Vol. 28 No. 3, pp. 360–373. <https://doi.org/10.1111/j.1540-5885.2011.00803.x>

Appendix A: List of full references for conceptual model factors

| Factor | References |
|---|--|
| Level of prioritization/ resources for design | (Goffin and Micheli, 2010; Boivie et al., 2006; Inal et al., 2020; Ardito et al., 2014; Boivie et al., 2003; Silveira et al., 2021; Hokkanen et al., 2016; Choma et al., 2022; Ji and Yun, 2006; Bak et al., 2008; Vredenburg et al., 2002; Hoegh, 2008; Venturi et al., 2006; Szabó and Hercegfi, 2023; Nielsen et al., 2023; Kashfi et al., 2017; Wale-Kolade and Nielsen, 2016; Valencia et al., 2013; Ovad and Larsen, 2015; Ananjeva et al., 2020; Bornoe and Stage, 2014; Bygstad et al., 2008; van Kuijk et al., 2019; Wale-Kolade, 2015; Gulliksen et al., 2004) |
| Level of associated value with design | (Goffin and Micheli, 2010; Boivie et al., 2006; Kashfi et al., 2017; Wale-Kolade and Nielsen, 2016; Choma et al., 2022; Kashfi et al., 2019; Hoegh, 2008; Valencia et al., 2013; Venturi et al., 2006; Szabó and Hercegfi, 2023; Nielsen et al., 2023; Bygstad et al., 2008; Rajanen and Iivari, 2007; Silveira et al., 2021; Ji and Yun, 2006; Bak et al., 2008; Micheli et al., 2018) |
| Level of understanding of design | (Goffin and Micheli, 2010; Kashfi et al., 2017; Boivie et al., 2006; Micheli et al., 2012; Inal et al., 2020; Boivie et al., 2003; Ovad and Larsen, 2015; Szabó and Hercegfi, 2023; Nielsen et al., 2023; Micheli et al., 2018; Gulliksen et al., 2004; Kashfi et al., 2019; van Kuijk et al., 2019) |
| Level of collaborative design capability | (Goffin and Micheli, 2010; Micheli et al., 2012; Kashfi et al., 2017; Laursen, 2017; van Kuijk et al., 2019; Choma et al., 2022; Chilana et al., 2010; Silveira et al., 2021; Micheli et al., 2018; Inal et al., 2020; Nielsen et al., 2023; Ananjeva et al., 2020) |
| Level of management support/control of design | (Boivie et al., 2006; Inal et al., 2020; Gulliksen et al., 2004; Venturi et al., 2006; Szabó and Hercegfi, 2023; Nielsen et al., 2023; Ji and Yun, 2006; Micheli et al., 2018; van Kuijk et al., 2019) |
| Level of product design quality | (van Kuijk et al., 2019; Nielsen et al., 2023; Szabó and Hercegfi, 2023) |