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Innovating in Times of Crisis

Welcome to the September issue of the Technology Innovation Management Review. We invite your comments on the articles in this issue as well as suggestions for future article topics and issue themes.

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Overview

The Technology Innovation Management Review (TIM Review) provides insights about the issues and emerging trends relevant to launching and growing technology businesses. The TIM Review focuses on the theories, strategies, and tools that help small and large technology companies succeed.

Our readers are looking for practical ideas they can apply within their own organizations. The TIM Review brings together diverse viewpoints — from academics, entrepreneurs, companies of all sizes, the public sector, the community sector, and others — to bridge the gap between theory and practice. In particular, we focus on the topics of technology and global entrepreneurship in small and large companies.

We welcome input from readers into upcoming themes. Please visit timreview.ca to suggest themes and nominate authors and guest editors.

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About TIM

The TIM Review has international contributors and readers, and it is published in association with the Technology Innovation Management program (TIM; timprogram.ca), an international graduate program at Carleton University in Ottawa, Canada.

Editorial: Innovating in Times of Crisis

Stoyan Tanev, Editor-in-Chief and Gregory Sandstrom, Managing Editor

Welcome to the September issue of the *Technology Innovation Management Review*. This month features the first two of several papers in upcoming issues from the 31st ISPIM Innovation Conference, which had the theme "Innovating in Times of Crisis", and was held virtually on June 7-8th, 2020. Our ongoing cooperation with the International Society for Professional Innovation Management offers the opportunity for the Editorial Board to select highly relevant articles in particular research domains and invite submissions that undergo the usual double blinded peer review process resulting in the selection of high quality contributions of interest to our readers. Three other papers add further contributions based on current research focusing on the strategic aspects of business intelligence, smarter cities, and the social acceptance of cleaner energy.

Tiago Filipe Pereira da Silva and **João Paulo Coelho Marques** start the issue with "*Human-Centered Design for Collaborative Innovation in Knowledge-based Economies*". They describe case study research they did on a university-industry collaboration based on a course project associated with Stanford University's ME310 Design Innovation program. The case focuses on the Porto Design Factory at the Polytechnic Institute of Porto, and IKEA Industry joining forces to tackle a problem using project-based learning. The students involved made use of human-centred design principles in new product development through direct exposure to a specific industrial environment and the knowledge facilities associated with their course of study. The innovative project resulted in the development of the LÄNK Technology, along with nine other prototypes, coming out of this combination of approaches used in an applied classroom-industry setting. Their aim was to lead to "stimulating co-creation, and solving companies' problems by involving students and professionals in a mutual learning process" (pg. 13).

Next, **Priscilla Kan John, Emmaline Lear, Patrick L'Espoir Decosta, Shirley Gregor, Stephen Dann,** and **Ruonan Sun** present *"Designing a Visual Tool for Teaching and Learning Front-End Innovation (FEI)"*. As part of their research, the authors designed and developed a guided visual tool that they call the "project client map" (PCM), which is "intended to assist students in their class projects solving real-world problems with industry clients" (pg. 16). The case study for the paper involves the artefact development and evaluation of the PCM in a classroom setting, as the researchers begin to develop their new visual tool. The authors present it as a way for "teaching Master-level students how to solve unstructured real-world industry challenges through their project work", and as "a visual mapping tool for problem formulation and identification as part of tackling FEI" (pg. 24). This route to addressing problematization follows that of evidence-based teaching and learning, along with using both "design thinking" and "design science research" methods.

After that, **Yassine Talaoui, Marko Kohtamäki,** and **Risto Rajala** are found *"Seeking 'Strategy' in Business Intelligence Literature: Theorizing BI as part of strategy research"*. They conducted an in depth literature review and identified a gap regarding how BI and competitive intelligence work together with respect to strategic thinking. They discovered previously unlinked literature that connects BI with strategy research and practice. Their paper offers a re-conceptualization of BI as a strategic artifact according to four clusters: BI as a system, BI as a planned process, BI as a product, and BI as a decisional paradigm. The aim of the authors is "to encourage a change in perspective for researchers to adopt a more comprehensive view of BI aimed at facilitating real time decision making and strategic learning" (pg. 35).

Haven Allahar continues with, *"What are the Challenges of Building a Smart City?"* After providing a brief background of the "smart city" concept, including its various attributes and distinguishing features, the author looks at smart city initiatives, including the importance of having an ICT plan as part of a smart city's characteristics. For a use case with which the author is closely familiar, he focuses on the Port of Spain's efforts to become a "smart city", or at least to become "smarter". The paper shows the difficulties and barriers to smart city planning, outlining both the ideals to strive for in smart city development, as well as the easy ways to fall short with confusing, unrealistic, or over-estimated smartification dreams. The paper concludes that "there is no single route to becoming a smart city" (pg. 38). Nevertheless, "there are critical steps that can be adopted as part of a building process for achieving that objective" (Ibid). The paper provides multiple insights from the literature recommended for smarter city development, including policy proposals, thus containing implications for both city builders and researchers.

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The edition concludes with **Mika Westerlund**'s *"Social Acceptance of Wind Energy in Urban Landscapes"*, noting the Canadian government's recent call for a green, inclusive "restart" of the economy in its post-COVID-19 recovery plan. Exploring the scenarios of the possibility for an accelerated transition to renewable energy systems, this article raises social awareness issues related to clean energy and sustainability planning for cities. The author focuses on wind energy, based on data collected from residents of the city of Helsinki, Finland. The paper outlines various factors affecting the social acceptance of wind energy and distinguishes three groups in terms of level of acceptance: Protagonists, Centrists, and Antagonists. The findings include that "gender demographics matter for wind energy acceptance" (pg. 57), where the survey results revealed that, "in the Finnish urban context, women come out as more supportive of wind energy than men" (Ibid). The research likewise upholds the established understanding that, for example, of wind turbine visibility to inhabited city space, "distance matters in wind energy acceptance" (Ibid). The key challenge with wind energy appears to be engagement and willingness to participate in decision-making processes, thus taking ownership of the energy challenge.

The TIM Review currently has Calls for Papers on the website for Upcoming Themes with special editions on "*Digital Innovations in the Bioeconomy*" (Feb. 2021) and "*Aligning Multiple Stakeholder Value Propositions*" (March 2021). For future issues, we invite general submissions of articles on technology entrepreneurship, innovation management, and other topics relevant to launching and scaling technology companies, and for solving practical problems in emerging domains. Please contact us with potential article ideas and submissions, or proposals for future special issues.

Stoyan Tanev, Editor-in-Chief
Gregory Sandstrom, Managing Editor

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Human-Centered Design for Collaborative Innovation in Knowledge-based Economies

Tiago Filipe Pereira da Silva and João Paulo Coelho Marques

> *"We climbed Maslow's hierarchy a little bit and we are now focused more and more on human-centered design which involves designing behaviors and personalities into products."*
>
> David Kelley
> IDEO Founder and Professor
> Stanford University

This research explores a university-industry collaboration based on the case study of an innovation project based on Stanford University's ME310 Design Innovation program. The Porto Design Factory and IKEA Industry joined forces to tackle a problem using what has come to be called a human-centered design approach. The case study provides an understanding of outcomes that reveal the potential of using a human-centered design approach to solve technical problems while enhancing customer experience. It also identifies the benefits that each institution gained by collaborating. The outcomes show that companies benefit from building interfaces with external partners, and that universities are relevant players in the innovation ecosystem, satisfying their third mission of being entrepreneurial institutions.

Introduction

Innovation has been understood as a driver for businesses seeking long-term successful performance (Tushman & O'Reilly, 2002). Both industry leaders and academics have contributed to understanding innovation, which has led to today's vision of the concept as a process that allows organizations to adapt to new situations and capitalize on their knowledge (Lundvall & Nielsen, 2007). In the context of a knowledge-based economy (Lundvall & Johnsson, 1994), creating, acquiring, and transforming knowledge are critical capabilities for companies to thrive and be competitive. It is therefore crucial that interfaces with the external environment are created (Kline & Rosenberg, 1986) for companies to develop relationships with suppliers, partners, and clients as all of them may constitute a source of innovative insights.

Companies are not the only players in the innovation ecosystem. Both public and private organizations have a say, including the state, not-for-profit institutions, and universities (Lundvall, 1992). The latter have been important actors in the innovation landscape by embracing their third mission of being proactively entrepreneurial in searching for value creation opportunities (Etzkowitz, 2001). Universities, as a primary source of knowledge generation and transfer, are relevant allies for companies to jointly do research and co-develop new products and services. For this purpose, several techniques have been developed to provide a structure for innovation. One of them, is called "human-centered design" (HCD), which promotes the engagement with users, clients, and stakeholders, thereby enabling the generation and utilisation of knowledge to enhance human lives (Kelley, 2002; Giacomin, 2014).

This research explores a university-industry collaboration between the Porto Design Factory based ~~a~~t the Polytechnic Institute of Porto (PDF), and the IKEA Industry, which was created to co-develop a project for the ME310, a "Product and Service Innovation" post-graduate course. The main goal of the paper is to explore the collaborative project's development as driven by the problem-solving HCD approach, through the use of a case study.

The article is divided into six sections. After the Introduction, the second section focuses on reviewing the relevant literature to provide theoretical background for this work, followed by explaining the research methodology. The fourth section presents the HCD case, and the fifth shows the results and adds discussion. Finally, the study concludes that the HCD approach can be relevant to guide and actively engage stakeholders when used as an innovation project management tool.

Literature Review

Innovation and Knowledge Production

Innovation has been an important topic over the years, with considerable economic, social, political, and technological impact. The economist Joseph Schumpeter (1934) was a key figure in revealing the importance that innovation has in economic growth, and how it transforms knowledge into new products.

External sources of innovation have been considered important inputs for company innovation processes (von Hippel, 1988; Antonelli & Fassio, 2015). Therefore, a need exists for organizations to have "doors" or interfaces whereby they can collect external information to make it economically useful (Caraça et al., 2009).

Universities have played a key role in national and regional economies and in recent years have been increasing their contribution to social development. The transformation of university cultures and missions has paralleled the global trend of economic development, where R&D's once central role in the whole process has now become a secondary focus. This has given way to today's vision of both extensive and open cross-organization collaboration. The so-called "entrepreneurial university" (Etzkowitz, 2001) is now seen as a relevant stakeholder capable of generating and transforming knowledge into innovative outputs, which can leverage industry capabilities in collaborative partnerships.

Innovation Techniques focusing on Co-Creation

Systematic and successful innovation is only possible if a process is in place to align a company's culture with its extended stakeholders in a way that can affect the outcomes of the process. Several techniques and processes have been developed to provide a structure for engaging in innovation. One example is the stage-gate model (Cooper & Kleinschimdt, 1986), which clarifies the steps between an initial idea and the eventual product launch, and furthers elaborates on post-market monitoring, thus giving a linear view of innovation based on stages of development followed by decision points called "gates". Another approach is based on Lages' (2016) "value creation wheel", which aims to generate value through problem solving in five flexible phases: discover, create, validate, capture, and consolidate value. This approach encourages an innovation team to embrace a certain problem and try to understand it in the initial phase, then to feed that information into the subsequent phases of the process.

The customer development approach (Blank & Dorf, 2012) focuses on the importance of knowing and understanding customers to facilitate the innovation dissemination process. Through the four phases of customer discovery, customer validation, customer creation and company building, innovators and entrepreneurs can adopt a structured process to ensure the distinctiveness of their value proposition to customers and other relevant stakeholders (Bailetti et al., 2020). The lean startup (Ries, 2011) approach is heavily based on the software industry, but has also been considered for extended areas of new product development. It advocates a build-measure-learn feedback loop iterative process, which relies on user feedback to make incremental adjustments and improvements to the solution being built. The above approaches and techniques all imply an increasing concern with lean and agile processes for innovation, with a strong focus on customer and user feedback to improve the new product development process.

Emphasis on the customer is based on the premise that new product development often fails, not for the lack of advanced technology or technical skills, but rather because of a failure to understand users' needs (von Hippel, 2007). The HCD approach has been one of the most followed and adopted approaches by a range of organizations (Schmiedgen et al., 2015). Approaches such as "design thinking" are based on human-centered principles to fully engage with and become immersed in the user environment (Liedtka, 2018).

Human-Centered Design

HCD is a conceptual framework that seeks to holistically understand humans for the purpose of meeting their needs, desires, and aspirations (Uebernickel et al., 2019). According to Giacomin (2014), it aims to stimulate the people involved in a problem to seek solutions by using techniques to communicate, interact, and empathize.

The HCD approach, through insights collected from

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observation and interaction with potential users or customers, provides important opportunities to target unexplored markets or improve existing products. This means that the outputs of such an approach can lead to both incremental and disruptive innovation. To achieve this, HCD has tools to deeply analyze user research. Several techniques have been created to facilitate the detection of user meanings, desires, and needs, either by verbal or non-verbal means. Some examples are ethnographic interviews (Spradley, 1979), questionnaires, role playing and focus groups (Stewart et al., 2007), participant observation (Spradley, 1980), identifying personas, experiencing prototypes, the customer journey, day-in-the-life analysis, and scenario planning.

IDEO (2015), one of the most relevant players driving the HCD approach, defines it as a three-phased process of inspiration, ideation, and implementation. This process leads the project team to deeply understand a problem by immersion into the context of the study, then to think divergently about multiple possibilities to solve the problem and lastly, to bring the result to those that will benefit from it. Constant throughout for the project makes use of both divergent and convergent thinking, as well as prototyping, the later which allows assumptions to be continuously tested and validated. The goal of the overall process is to achieve a balance between human desirability, business viability, and technological feasibility, in order to ensure successful solutions (IDEO, 2015).

The innovation paradigm's shift to a human-centered approach may have a unifying role within organizations because rather than each company department working individually on its own goals and objectives, HCD can potentially unite all business dimensions with the same goal. The HCD process relies heavily on gathering different perspectives and promoting multidisciplinary work to enrich the outcomes. It encourages innovation teams to constantly validate their assumptions and continuously improve their understanding of the people involved in and affected by the problem to be solved by "getting beneath the surface" (Brown, 2008).

Thus, the innovation paradigm's shift to a human-centered approach may open an opportunity to fill the gap in knowledge about HCD, which has raised questions about how collaborative projects driven by the HCD problem-solving process can be used in real case studies.

Research Methodology

To fill this gap, our investigation for this paper analyzed a collaborative university-industry project using the HCD process. The specific objectives were 1) to gain an understanding of the benefits of HCD in the context of university-industry collaboration, 2) to explore the outcomes of the project, and 3) to discover the relevance of HCD for achieving those outcomes.

The project was promoted by IKEA Industry Portugal, PDF, and Warsaw University of Technology (WUT) for their ME310 Product and Service Innovation post-graduate course.

Many data sources were considered in order to develop this case study, including student documentation, photos, reports, and five interviews. Semi-structured interviews and informal conversations were the main methods used to collect insights from the participants involved in various phases of the project. The interviewees included the IKEA Industry Portugal head of innovation, and their corporate liaison responsible for periodically establishing contact with the team of students, the PDF's director, and two Portuguese members of the student team.

From the IKEA Industry head of innovation and the corporate liaison, we collected information about the company's current innovation process, and how the ME310 course and HCD changed it. The information also included other aspects related to the project, such as company expectations, challenges, and difficulties felt, along with outcome relevance.

The interview with the PDF's director provided insights toward understanding the university's point of view regarding collaboration, like benefits and difficulties, value proposition both to the company and students, as well as the importance of taking an HCD approach for educating future professionals. The student interviews provided the overview of their first-person experience in embracing a challenge and solving it using HCD, and the intricacies and relevance of HCD in acquiring competencies for future work.

The interviews were conducted during the last quarter of 2019 and took 40 minutes per person on average, with the researcher making an audio recording and writing notes to allow further content analysis.

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Case Study: ME310 Project

Case Context
The case studied was a joint project between IKEA Industry and Porto Design Factory (Polytechnic Institute of Porto) developed in the academic year 2017/18.

IKEA Industry is the industrial branch of the globally known Swedish brand IKEA, which has been a pioneer in the furniture industry. IKEA has presented innovative solutions, a well-performing business model, and delivers an interesting customer experience. Its strategy is to position itself as a strong, international, and open company.

In 2014, the industry group defined its guidelines, "IKEA Group Manufacturing Strategy Now: 2020", which highlighted the importance for the company of establishing active relationships with suppliers, industrial networks, and the academic world. The goal was to extend the company's manufacturing competence, along with embracing diversity and new knowledge. Heading the work in the project presented was IKEA Industry Portugal, with its team located in northern Portugal.

PDF is a transversal unit of the Polytechnic Institute of Porto, which is positioned as a global platform based on interdisciplinary work, applied research, and industrial collaboration. Over the years, many students have attended its educational courses, with a strong emphasis on problem-solving methodologies, such as HCD and design thinking, as well as collaborations with industrial partners. One of these programs is ME310, which was originated at Stanford University (Carleton, 2019).

ME310 is a year-long course in which students work in international and interdisciplinary teams to solve real-world problems provided by industry sponsors. Each team addresses a given problem statement and at the end of the course journey, students are responsible for having designed and built a functioning prototype. Students are challenged to question, embrace ambiguity, and learn by doing, as the course uses a project-based learning methodology (Carleton, 2019).

The journey is composed of several milestones, which are based on an iterative prototyping process (Figure 1) that is driven by the HCD approach. Students are expected to use practical tools and techniques from the design thinking toolkit (Uebernickel et al., 2019).

The macro-cycle visual represents the different phases of the ME310 program during its first three quarters. It shows the various prototypes and concept adaptations from the beginning of the project until the final proof of concept. Each iteration of the prototype should be the result of research and user testing, as an effective way to make constant improvements.

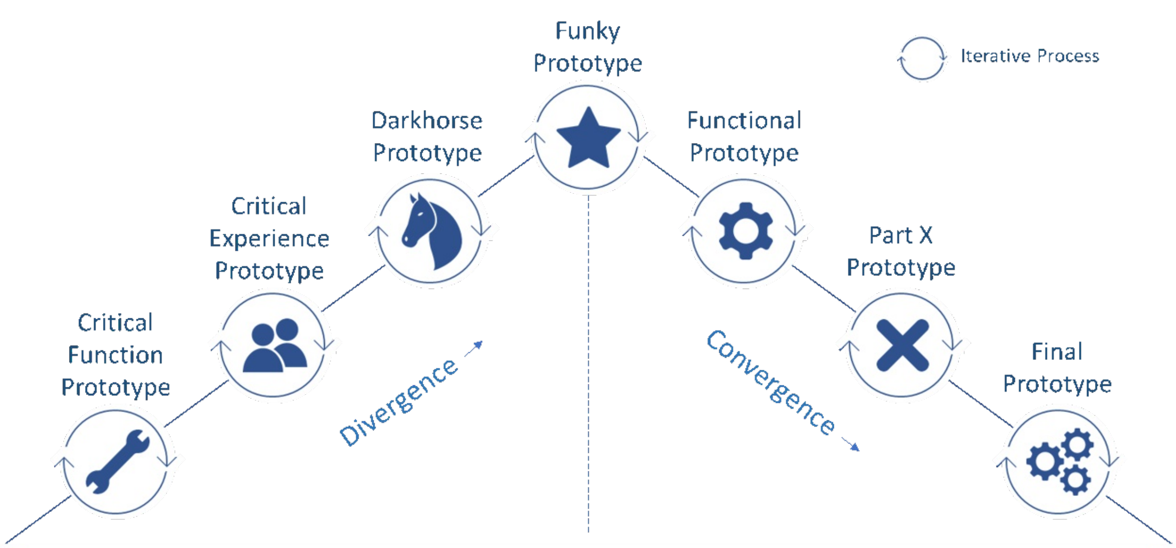

Figure 1. ME310 Macro-cycle. Adapted from Uebernickel et al. (2019).

The iterative process is ensured by the micro-cycle or the Stanford design innovation process mentioned both by Uebernickel and colleagues (2019), and by Wiesche and colleagues (2018). This process is composed of five different steps that have similarities with other design thinking models: 1) (re)define the problem, 2) Find needs and benchmark, 3) brainstorm, 4) prototype, and 5) test.

That was the five-step process behind the project's progress in which the team constantly collected information about the problem and the stakeholders involved, thereby turning those insights into product iterations. The project management followed each of the steps and the sequential prototyping deliveries of the macro-cycle.

Project Outcomes

In the 2017/18 edition of the course, IKEA Industry joined as a corporate partner for the third year in a row, challenging a team of six students, three from PDF and three from Warsaw University of Technology, with different backgrounds from engineering, physics, design and biotech. Here is the briefing students had to work on and solve: "Eliminate drilling from the mass manufacturing of wood furniture".

IKEA Industry Portugal provided a workforce to observe the project and to get involved in it more closely in an extended way through its innovation team with the help of a corporate liaison.

The project started with the student team working on redefining the problem, exploring each word of the briefing individually and conducting research to understand the impact of the drilling process at issue. To holistically understand the problem the team needed broader knowledge of the factory, manufacturing process, materials, worker flow, and working conditions. This included research on the internet and in specialized publications to gain a broad vision of the design context. An initial drawing of the stakeholders' map provided an understanding of which people and organizations were involved in the complex industrial arrangement and who could influence or be influenced by the given problem.

After gaining a broad understanding of the context, both the Portuguese and Polish students were able to visit an IKEA Industry factory. Doing field research allowed the students not only to observe the manufacturing process to better understand the business, but also to connect with workers on the ground and speak with managers to gather various perspectives of the problem through conducting interviews.

A first glimpse at the project provided a clearer understanding of the real impact a solution to the given challenge could have. IKEA's business model relies on reducing the costs of production to enable lower prices and thus increase demand. This is the rationale behind having a close-to-perfect assembly line, with efficient timing, as a way to offer customers better deals. Complementing the information from the other sources, weekly meetings with a corporate liaison from the technical department's equipment team provided students with insightful revelations regarding the factory's production line and machinery.

To summarize the findings and reorient the project towards its human factors and impact, the team chose the tool Persona, which describes archetypes of users, giving them a name, a visual representation, and typically also quotes, as described by Wiesche and colleagues (2018). It allowed the students to collect information on the initially established needs, ambitions, and desires of the stakeholders. The three identified stakeholders had different roles in the project: the factory worker on the ground, factory manager, and customer.

After "getting out of the building", as the teaching team encouraged the student team to do, it was time to create a prototype. By the end of the quarter, the team had to design and build two prototypes: a critical function prototype (CFP), and a critical experience prototype (CEP). It was necessary to be hands-on and to start exploring concepts more than only thinking about final solutions. The prototypes were designed with exploration and divergence in mind, and to test assumptions regarding the problem faced. They were meant to be developed relatively crudely and rapidly, with a minimum allocation of resources possible.

The winter quarter was a key part of the whole project, when divergence reached its peak and important decisions were made to narrow choices and select the final proof of concept corresponding to the initial challenge. Research on primary and secondary sources was conducted throughout the project. The student team needed to constantly go back and forth between them in the research process because new knowledge brought with it new perspectives. At this stage, it was necessary to explore the problem more deeply and to slowly start envisioning the project's future. The team collected findings from the visits and external contributions, and then started to work on framing its new understanding of the context.

By targeting the housing issues in big cities, the team assumed that furniture needs to be multifunctional and serve many different purposes, and that it should be adapted to small spaces, occupying less room or being storable when not used. It should thus be capable of being assembled and dismantled repeatedly, providing the same quality from the first to the last use.

The first deliverable of the quarter was a dark horse prototype. Reaching the peak of divergent thinking, the dark horse was an opportunity to test farfetched concepts, which were the ones least likely to be successful.

The team decided to explore two different concepts: furniture made of living materials and origami furniture. The "living furniture" relied on fast growing plants that would be shaped into a bench or table and could be turned into garden furniture. Such furniture offers a sustainable and environmentally friendly solution for people's homes, while not needing any special skills or tools for assembly. The origami furniture was thought to respond to a need for versatile furniture that could have different applications, offering customization options through modularity, and the ability to be stored easily when not used.

The team tested the initial prototypes that were carried out with nine users, who engaged the prototypes, assembling and dismantling them while the team recorded the event on video, noted how long the engagement lasted, watched user behavior, and collected various observations. At the end of the test, some questions were asked regarding what the user felt during the experience and their general opinion about the furniture concept.

The convergent phase of the project had begun with a funky prototype. To reorient every member of the team, the students decided to redefine the persona for whom they were building the solution. An earlier question remained open: was the solution for the factory worker on the ground, the manager, or the final customer? However, it was now clear that the target should be the end customer because the vision of making everyday life better is for customers who also create the product demand. Understanding the pain points and needs of the persons involved, the team then defined origami furniture as the main concept to explore in future prototypes.

The spring quarter constituted the sprint towards building the final proof-of-concept, which was ultimately to be delivered to the company. One of the students during this time said, "At that point we were entering a phase of the project when things started to become extremely technical". The student team was able to contact several external specialists for finetuning the prototype, adapting it to the current manufacturing process and materials, and generating a potential business model to channel the product.

By exploring the "origami furniture" concept further, the team was able to understand how this would be beneficial for a range of different IKEA products, such as cabinets and other square-shaped pieces, where the solution, named LÄNK Technology (Figure 2), could be applied. The students developed a way to avoid traditional furniture junctions that rely on matching joints, screws, and other materials, by embedding a flexible fiber inside the furniture that would connect all pieces during assembly and disassembly.

The final concept was submitted to for user validation conducted with 20 randomly picked people, some who were familiar with IKEA furniture assembly and some who were not. The aim was to test the experience of assembling a LÄNK cube and an EKET cube, which are easy-assemble solutions already existing in IKEA's product catalogue. The test consisted of measuring the time taken to assemble and dismantle the cubes, and involved collecting qualitative data from the answers to predefined questions. Users found the solution intuitive and the prototype cube easy to manipulate. Bearing in mind the limitations of only working with a prototype, it was possible to infer that the technology was potentially interesting as an easy-assemble solution without the use of tools.

In the final documentation delivered to the company, the students conducted an extensive exploration of the differences between the production techniques used by IKEA Industry (BoS —board on style, and BoF —board on frame) and the ones needed for LÄNK technology. Together with a corporate liaison specialized in the factory's equipment and assembly process, the team tried to present a process requiring the minimum

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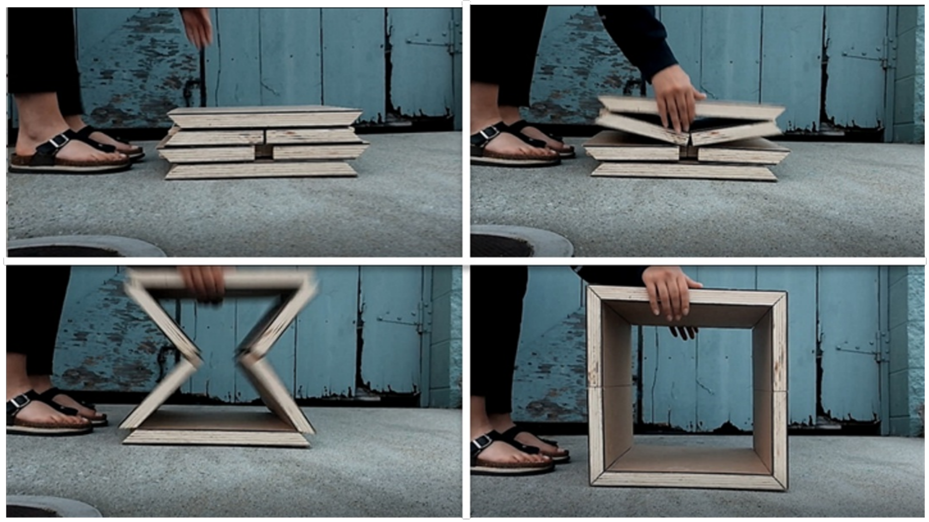

Figure 2. Assembling the cube with LÄNK Technology. Source: Project documentation.

changes possible to the current assembly line in order to increase the chances of implementation.

Both the student team and company representatives were aware that the proof of concept had some limitations and a lot of room for improvement. However, as stated by the head of the Innovation Department at IKEA Industry Portugal, the goal was to bring to the table new insights, radical approaches to product innovation, and challenging views of IKEA's business, manufacturing process, and products as a way to enrich internal knowledge and capabilities.

What had begun as an industrial challenge using university-industry collaboration, thus led to a solution that could potentially disrupt how consumers interact with their furniture. This was made possible by constantly engaging with multiple stakeholders, building empathy, finding customer pains and needs, and iteratively improving the concept.

Results and Discussion

Benefits of University-Industry Collaboration

The ME310 program allows a university to fulfil its primary mission: to teach. With today's competitiveness in higher education, universities must search for value propositions to attract students. Since universities teach and train students to gain competitive skills and experiences for the job market, practical exposure to the problems industry faces, along with immersion in industrial environments constitute a learning opportunity (Santoro and Gopalakrishnan, 2000). Throughout the project we studied, not only were the students able to face a technical problem at IKEA Industry, but they could also deeply explore it by making several visits to the Portuguese facilities. To enrich their experience, the team also visited IKEA Industry Poland, the factories of Portuguese competitors, and even those of other industries, as a way to engage stakeholders. The knowledge they accrued was supplemented with employee interviews, which brought greater understanding of the problem and learning experience. As corroborated by Mora-Valentin (2000), the value proposition of experiential learning at university is enhanced by partnering with relevant and well-known companies that might be appealing for students to work with in their future careers.

The ME310 program also provides a privileged learning environment for all individuals involved in the project. Under the auspices of university teaching (Santoro & Gopalakrishnan, 2000), it is a way of exposing students to industrial environments, knowledge and facilities of corporate partners, which can also lead to employment opportunities for university graduates (Lee & Win, 2004), as well as (Santoro & Betts, 2002). From a company's perspective, the course may also be a way of discovering talent and creating a relationship with potential future employees (Ankrah et al., 2013). This indeed happened in this case of our study, as one of the students was hired by IKEA Industry at the end of the ME310 project.

While the project was running, several workers from IKEA Industry were able to follow the student team's progress and to directly benefit from it. Professional training is thus a valuable outcome of such partnerships (Santoro & Chakrabarti, 1999), which can directly impact the people who are in contact with both the team and the innovation process. As the corporate liaison stated, "I started including prototyping early in my upcoming projects because I saw how the team did it and the importance of immediate validation. That had few costs for us and allowed me to test first before reaching suppliers of that service."

The participation of a company in the ME310 program also provides an opportunity to gain international exposure and for networking with other universities and companies. For example, PDF is presently involved in two different international networks: DFGN (Design Factory Global Network), and SUGAR. This way it collaborates with several companies that come together for community events, projects, and public presentations. According to George and colleagues (2002), this may give a boost for initiating other inter-organizational projects that may generate relevant impacts on a company's future.

Project Outcomes

The knowledge created and collected during the project was materialized in prototypes. This is commonly a major outcome of collaborative projects between universities and industry, as suggested by Santoro and Gopalakrishnan (2000). The ME310 project generated more than ten prototypes, some with several different iterations, and each with its own specific validation tests. This constitutes a relevant deliverable for IKEA Industry as a first step for future developments. In the words of the corporate liaison, "the outcomes of the project were delivered to the PDC in Poland, where they collect innovative concepts to further explore when needed". All of the documentation that supported the prototypes may also be viewed as a source of inspiration and knowledge concerning possible R&D paths, as well as technical information for replicating the prototypes.

The final proof of concept or of any concept explored during the project can potentially lead to business opportunities for the company to introduce new products or solutions to the market. According to Siegel and colleagues (2003), one motivation for industry to collaborate with universities is to seek to commercialize its technologies for financial gains. LÄNK Technology, as the most recognizable outcome of the project, has become suitable for application in various products that aim to eliminate drilling, thereby enhancing the manufacturing process. This could imply some impact on the company's performance if adopted in the future.

Industry partners tend to see university-industry collaboration as a potential opportunity to gain financial benefits through sales enhancement, or for developing new products that can benefit from serendipitous outcomes (George et al., 2002). This was strongly emphasized by the corporate liaison in our study, who stated that IKEA Industry wanted new insights and perspectives about their business, processes, and products. He noted, "We have a lot of internal knowledge because we've been doing this for ten years now. We understand our process and know our equipment, but we lack a fresh new vision which we knew we could get from ME310". The expectations of the company, however, were not entirely focused on financial benefits from the final proof of concept, but rather there was also a possibility of commercializing university-based technology, which happens in some cases (Siegel et al., 2003).

Role of Human-Centered Design

According to Kivleniece and Quelin (2012), in university-industry collaborations it is common for companies to look for solutions to technical problems. Nevertheless, although the project in our study started with the deeply-rooted technical problem of "eliminating drilling from wood furniture mass manufacturing", the final proof of concept had a stronger focus on the final customer and their needs. This speaks to the HCD approach, which aims to solve everyday problems and puts human desires at the center of the process (Kelly, 2002). For IKEA, to "create a better everyday life for the many", means that "the many" must be taken into consideration in every decision the company makes, including decisions about innovation and new product development.

The team of students we studied was able to extract the most relevant information from the factory and manufacturing process, and to translate that into leveraging a solution that would fit the user's needs. This process was enhanced by the tools and mindset of HCD by creating connections and empathy with the user (Giacomin, 2014; Liedtka, 2018). By understanding the need for a seamless assembly experience with no tools or guides, and by providing the potential for the furniture to be assembled and dismantled several times, not only were the individual user's problems addressed, but an answer to global demographic trends was also given. Hauffe (1998) showed that this is a relevant part of the design and innovation process, which must take into consideration society and its constant growth and development.

The tools of design thinking that put into practice a humanising and user-centered approach are understood as drivers for organizational culture, they may be a trigger for experiential learning, collaboration, risk taking, and learning (Elsbach and Stigliani, 2018). As the corporate liaison said, the project we studied had a relevant impact on his work process as he started to integrate prototyping in IKEA Industry's projects. This allowed IKEA to validate assumptions early, and subcontract services later in the projects.

The HCD process and its tools, which bridged the gap between the design research team and the users, were extremely relevant for the project's outcomes. The importance of continuously searching for validated assumptions and "getting beneath the surface" (Brown, 2008), introduces a new type of product development, since human-centeredness aims to empower human beings and enhance our lives through well-designed technological interfaces (Krippendorff, 2004).

The HCD technique also helped promote deep and diverse relations between IKEA Industry workers, students, engineers, material suppliers, and business specialists, including diversity in points of view, opinions, and knowledge that led to richer outcomes. The fact that the students had various backgrounds, cultures, and skills to interact with the inputs from several different mentors provided a multidisciplinary environment that enriched the project with input and feedback. This follows the vision of Sherwood and colleagues (2004), who state that companies seek variety in research expertise and inputs through university-industry collaboration.

Prototyping is the way through which creative problem-solving happens, which is a core activity of the HCD approach. Prior to this, an ideation process must occur based on previous findings concerning the particular problem to be faced. Divergence and convergence of innovative thinking provide a suitable environment to expand the possibilities for solving a given problem. Inspirational and divergent thinking employed in, for example, the dark horse prototype (Bushnell et al., 2013), offer strategies to enhance and empower the creativity of students. This allowed the problem in our study to be explored outside the usual boundaries.

Conclusion

This paper described how a collaborative project driven by a HCD technique can be used to solve technical problems with a strong focus on the user experience. HCD was used as a tool, within a ME310 project, as a form of relevant guidance to actively engage with innovation project management. It also promoted a collaborative approach to the innovation process by gathering various points-of-view and including an extended project team to enrich its outcomes.

Co-creation in the project led to greater engagement by different stakeholders, each of whom contributed their skills, knowledge and experience. The practical side of the technique was that it deeply embraced divergent and creative thinking, along with convergent and analytical reasoning, which increased the outcome's value.

The project made a relevant contribution to IKEA Industry's innovation portfolio by integrating more knowledge in their database that will feed future new product development efforts and inspire new outcomes. We believe that other customer-focused firms can thus benefit from using the HCD process by allowing the integration of users' insights into their value proposition.

The practical implications of this study for management can be viewed from the perspective of encouraging collaboration between universities and industry, in the sense of stimulating co-creation, and solving companies' problems by involving students and professionals in a mutual learning process.

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Designing a Visual Tool for Teaching and Learning Front-End Innovation

Priscilla Kan John, Emmaline Lear, Patrick L'Espoir Decosta, Shirley Gregor, Stephen Dann, and Ruonan Sun

> *The formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill.*
>
> Albert Einstein (1938)

This paper presents work on the design and development of a guided visual tool, the project client map (PCM), which is intended to assist students in their class projects solving real-world problems with industry clients. We use a design science research approach to contribute to existing knowledge through the design of an artefact (the PCM) that has a clear educational and learning goal, and that provides utility. Circumscribing a problem is an essential step to seed the ideation process in front-end innovation. While this step can employ existing tools that focus separately on the organisational, environmental, and human contexts of the problem under scrutiny, there is no formalised roadmap for how to integrate these tools. The PCM addresses this gap. We present a first version of the PCM in this paper, which will be refined in further work.

Introduction

Innovation is important to the economic prosperity of nations, with governments worldwide developing policies to boost innovation for their countries (OECD, 2019). Creativity and the exploration of ideas are key components of innovation, which are encouraged within organisations, for example, Google (Adams, 2016) to enhance competitiveness. To produce benefits, creativity and ideation need to be directed at solving relevantly-framed problems. This endeavour involves developing a solid understanding of the problem of interest in order for the ideation process to arrive at a value proposition that yields benefits for users when implemented. Identifying what problem to solve is therefore an essential step, which should to be done iteratively alongside the process of ideation. Failing to clearly grasp the problem to be solved can result in developing services or products that are not useful to target users.

A 2016 McKinsey poll reported that 94% of global executives were dissatisfied with their organisation's innovation performance, attributing the main issue to unsuccessfully identifying the problem that customers needed solving (Christensen et al., 2016). A problem-based approach to teaching university courses has been questioned as graduates are seen as inadequately prepared for identifying user needs in an ever changing world (Flores et al., 2010). To address this issue, we propose a guided visual tool to teach and support the process of problem formulation in order to seed the ideation process. This tool can be used iteratively with ideation to gradually focus on framing the problem under scrutiny in order to arrive at a valuable solution. We named this tool the "project client map" (PCM). The PCM takes a "design science research" (DSR) approach and draws from evidence-based practice (EBP) to provide a series of questions to support problem understanding and ideation. Our work was undertaken as part of an integrated learning component in classroom activities, where postgraduate students were tasked to help industry partners, the project clients, solve their real-world challenges.

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Background to Study

Idea development or ideation is an integral part of the innovation process. It is often considered to consist of three parts: (1) front-end of innovation (FEI), (2) new product development, and (3) commercialisation (or implementation) (Koen et al., 2014). FEI, also known as the "fuzzy front-end of innovation", has been described as "the earliest stage of an idea's development and comprises the entire time spent on the idea as well as activities focusing on strengthening it, prior to a first official discussion of the idea" (Reid & de Brentani, 2004, as cited in Brem & Voigt, 2009). FEI therefore comprises identifing a focal problem to be solved and ideating around it. FEI is notoriously hard to tackle because there is so much uncertainty involved in the process (Moenaert et al., 1995; Verworn et al., 2008). Moreover, creativity, acknowledged as a complex and difficult to manage process, plays an important role in the idea generation part of front-end innovation (Goldenberg et al., 1999). Sawyer (2012) described creativity using an eight-stage model consisting of: problem finding, acquiring knowledge, gathering related information, incubation, idea generation, idea combination, idea selection, and idea externalization. This description reinforces the importance of problem understanding for ideation.

A number of FEI models have been proposed (Koen et al., 2002, Gregor & Hevner, 2015). Koen et al.'s new concept development (NCD) model, recognises five activity elements of FEI: opportunity identification, opportunity analysis, idea generation, idea selection, and concept definition. Koen et al. (2014) used the NCD in a later study and noted a difference in processes undertaken for radical innovation compared with incremental innovation. Another model by Gregor and Hevner (2015), presents a finer-grained picture of processes involved in FEI using the lens of a knowledge innovation matrix (KIM), as they introduced it in 2014. In the KIM, innovation processes are classified into four quadrants across two dimensions: the knowledge (solution) maturity dimension and the application domain (problem) maturity dimension. The knowledge maturity dimension refers to the capture of knowledge in innovation processes, such as new ideas, insights, and technological know-how. The application domain maturity dimension refers to the identification of problems requiring solutions as revealed in new opportunities, markets, and needs. Chadha et al. (2015) identified eleven commonly used innovation techniques classified across the KIM quadrants. The authors recognised that the techniques could often be placed in more than one quadrant at different points in a project. This work suggests that regardless of the type of innovation we are considering, a fit between problem formulation and solution development is key, and often the two co-emerge in an iterative process (Maedche et al., 2019). This idea is congruent with the work of Von Hippel and Von Krogh (2016), who argue that a market need (the industry challenge in our case) and its solution are often discovered together, and developed as a "need-solution pair". In sum, formulating a problem appropriately (that is, defining a problem space) is an essential step for delivering innovation, which is recognised as being far from a simple matter.

Many analytic tools and frameworks (some of which are presented in the next section) exist to support the problem formulation and ideation phases of innovation. However, to the best of our knowledge, the extant literature does not contain a formalised roadmap on how to use them together as a way to help in the process of problem identification for FEI. Existing tools tend to be used in isolation and students often find it confusing to choose which tool to use and at what point in a project. This issue led us to develop the PCM to assist in problem formulation for FEI by providing a roadmap that integrates the relevant existing innovation tools.

Conceptual Background

The new visual PCM tool for facilitating the front-end innovation builds on and integrates ideas and theories drawn from a number of underlying areas. These areas include: visual representation in problem solving, visual tools in innovation, design science research, design thinking, and evidence-based management. An overview is provided below for each of these areas of thought.

Visual representation in problem solving

Visual representations such as diagrams, modelling tools, pictures, equations, and graphs provide forms of external representation that have been found to facilitate internal representations for people engaged in problem solving processes. An internal representation, or mental model, helps the problem solver store components of a problem space in their mind (Solaz-Portolés & Lopez 2007). Scaife and Rogers (1996) discuss important considerations for the effective design of external visual representations, relating to: (1) explicitness and visibility, (2) cognitive tracing and interactivity, (3) ease of production, (4) combining external representations, and (5) distributed graphical

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representations, as in idea sketching.

We took these guidelines into account while developing the PCM tool. In particular, the PCM builds on prior knowledge regarding users, which allows users to make use of it interactively, including a group innovation mode, where text can be integrated into the diagram. The visual format allows for simultaneous representations of a large number of dimensions in a compact form, as a useful way to show interconnections and patterns (Langley, 1999).

An overview of research on how internal representations (mental models) are constructed during problem solving was provided by Solaz-Portolés and Lopez (2007). These authors showed how using multiple external representations when problem solving can be beneficial for students of innovation and also influence innovation performance.

Visual representation tools in innovation

Organisations use multiple analytic tools and techniques when trying to innovate (Chadha et al., 2015), many of which take either a human-centred or a strategic management perspective. Human-centred tools, for example, IDEO and Mozilla, provide guidance and insight into understanding the challenges facing potential users for which the designers are seeking a solution. Strategic management tools, like CIMA (2007), help in grasping internal and external factors affecting an organisation's success. Both can provide great insights to spark innovation. The PCM combines both a human-centred and strategic management perspective to help develop insights into formulating the actual problem that needs solving. Moreover, it points to three existing visual analysis tools to delve deeper (see Figure 1): two human-centred tools, namely the value proposition canvas (VPC) (Osterwalder et al., 2015) and the empathy map canvas (EMC) (Gray, 2017), and one strategic management tool, which is a strengths, weaknesses, opportunities, and threats (SWOT) analysis (see Phadermrod et al., 2019).

Design Science Research (DSR)

DSR is an approach that focuses on trying to develop a "scientific" process for designing, as argued for by Simon (1968) in his seminal work Sciences of the Artificial. It emphasizes the building and application of a designed artefact in order to develop knowledge and understanding of a problem domain and its solutions (Hevner et al., 2004). We consider here a DSR process with six steps, as described in Peffers et al. (2008), which can be undertaken iteratively. These steps are described in the following section, as they informed our own process of developing the PCM.

We were interested in how to help students and practitioners develop skills in problem formulation. This made DSR a relevant approach to develop the PCM as an artefact with a clear utility (to guide students in learning how to succinctly formulate a problem to be solved) and a clear goal (to teach students how to tackle complex problems at the FEI stage). DSR is also particularly relevant for students studying information technology and computer science, as it embodies the methods used in computer science (Dodig-Crnkovic, 2002). However, it should be noted that DSR can differ from innovation, as DSR has a goal of contributing to a relevant disciplinary body of knowledge, as well as constructing an artifact with utility, whereas innovation is about applying ideas to create value. The criteria in DSR may not always apply in cases of innovation (see Hevner & Gregor, 2020). In addition, DSR has been criticized by some as paying too little attention to the complexities of problem formulation in the DSR process (see Maedche et al., 2019). For this reason, we found it helpful to consider the design thinking approach in addition to DSR.

Design Thinking (DT)

DT is a paradigm drawn from the design community that has been adopted to solve problems in many professions, including engineering and computing (see Brooks, 2010; Plattner et al., 2011). One widely used definition of DT, given by Tim Brown, CEO of the design firm IDEO, is: "a human-centred approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology and the requirements for business success" (IDEO, 2019). The DT process is captured in a framework that supports problem understanding and ideation, as well as implementation and testing. The framework consists of five iterative elements: empathise, define, ideate, prototype and test (Hasso Plattner Institute of Design, 2020). DT helps in dealing with the uncertainty involved in the FEI process. We used the DT process in the classroom to create scaffolds for how students tackle an industry problem to be solved. The PCM served as an aid in focusing on the 'empathise' and 'define' elements of the DT process.

Evidence-based Practice/Management (EBP/EBM)

The data-driven evidence-based management (EBM) framework (Barends et al., 2014) defines evidence-based practice being "about making decisions through the conscientious, explicit and judicious use of the best available evidence from multiple sources through the following main skills:

1. Asking: translating a practical issue or problem into an answerable question

2. Acquiring: systematically searching for and retrieving evidence

3. Appraising: critically judging the trustworthiness and relevance of the evidence

4. Aggregating: weighing and pulling together the evidence

5. Applying: incorporating the evidence into the decision-making process

6. Assessing: evaluating the outcome of the decision taken to increase the likelihood of a favorable outcome."

This framework can be used to support exploring the 'empathy' and 'define' phases of DT, as a means to conceptually break down the problematisation process, that is, the path from problem identification to decision-making, where a solution to a given problem is found based on evidence gathered from a variety of sources. Furthermore, the emphases of EBP/EBM on applying critical and analytical skills together with moments of reflection that tap into metacognitive skills, ensure that students are faced with learning about their own learning by visualizing and questioning the possible directions and impacts of their solutions and decisions. The PCM tool we present in this paper uses EBP/EBM to develop a series of linked questions that require answers in order to capture the context surrounding a problem. EBP/EBM supports the PCM as a visual analysis tool to teach and support FEI.

Method

Artefact development
This early-stage study presents a novel artefact (the PCM) developed using a DSR approach (Hevner et al., 2004) for students working with industry partners, as a way to solve a real-world challenge as a classroom project. The tool was specifically developed for engineering and computer science students undertaking a professional practice course. The PCM aims to assist in the problem formulation part of FEI, before going into ideation.

We adopted the DSR approach following Peffers et al. (2008), consisting of the following steps: (1) problem identification, (2) defining the solution objectives, (3) design and development, (4) demonstration, (5) evaluation, and (6) communication. We first identified our research problem as the difficulty students have in grasping what industry problem they are actually trying to solve. The students were often confused about what existing tool they should use to assist them in the 'empathy' phase of DT that could help them define an industry problem (step 1). We clarified the objective of the PCM to serve as a development tool to guide students through the problematization process as they tackle an industry challenge (step 2). We used an exploratory research method based on participant observation by three researchers in a 'Lego Serious Play' workshop (Lear et al., 2020) during semester 2 of 2018, which was repeated for eight different tutorials. The results revealed that students struggled with problem identification (the rationale to the challenge) and formulating the problem to be solved.

We extracted key elements from EBP and DT to leverage the 'empathy' phase of DT as a way to determine what characterises evidence for the PCM. The intended outcome was for students to better circumscribe problematisation, so that based on the evidence collected they could better formulate their specific problem. Our research showed that students often revealed struggles with both problem identification and formulation. An initial PCM was built (step 3) based on the general concepts gleaned from EBP and DT literatures, together with insights gained in classroom observation. The components of the resultant 'map' were derived by synthesizing step 2 and 3. The PCM, in its initial form, was then introduced as a visual tool to the classroom in semester 1, 2019 (step 4). We then carried out an initial evaluation of the PCM for the purpose of preparing this paper through a case study (step 5). The demonstration (step 4) and evaluation phases (step 5) are both still works in progress, and we intend to further deploy and refine the PCM. This paper shares our findings so far regarding the PCM (step 6).

Artefact evaluation
Venable et al. (2014) proposed a four-step framework for DSR to evaluate an artefact : (1) explicate the goals of the evaluation, (2) choose the evaluation strategy, (3)

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determine the properties to evaluate, and (4) design the evaluation episode(s). Following this framework, we evaluated our visualisation tool to establish whether the PCM works in a real situation (step 1). We used the strategy described as 'quick & simple' (Venable et al., 2014), as the project scope was relatively small (step 2). We examined two broad aspects of our artefact, form and function, and sought to find answers to the following questions (step 3):

Table 1. The Project Client Map

	Component	*Short description*	*Questions*
1	Initial Challenge Description	This is what the industry project client initially brings to the students.	N/A Industry challenge as is.
2	Personal (personal-level information)	Relevant information about the project client on a personal level to get to know them and an understanding of their motivation.	Who is the Client? Names, Positions, Experience, etc. What motivates the Client? Why are they interested in this challenge on both a personal and an organisational level?
3	Organisational level (taking stock)	Current operational details of the organisation	What is the current operation of the business like?
4	Organisational level (reflections)	Reflecting on current operations of the business	What is currently working? What are the strengths of the business? What can be improved? What are the current weaknesses?
5	Environmental level (taking stock)	State of current operating environment and competitors	What environment do they operate in? What sector? What are the relevant statistics? What are the trends?
6	Customers / Users	Understanding the customers/users	Who do they currently see as their user/customer segments? Are there other customer segments? Who are they? What drives them?
7	Value Proposition	Perceived value proposition	What is/do they think is their current value proposition?
8	Environmental level (reflections)	What is the 'gap' or 'perceived pap'?	What do you see as the gap? What does the client see as the gap? What opportunities does this create?
9	Redefined Project Challenge	Iterated problem definition	What problem are you actually solving? What do you need to find out further?

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A. How did students interact with the form of the PCM (colour, shape and size)?

B. How did students use the PCM for analysis (function)?

C. Did the students successfully complete a problem formulation using the PCM (task-at-hand)?

D. Did the problem formulation (task-at-hand) have a valuable impact on solving the industry challenge (goal-at-hand)?

Our evaluation was done ex post using a case study approach (step 4) that focussed on one tutorial where students worked in two groups, hence providing a case study with two embedded units (Baxter & Jack, 2008). The following three factors were constant in both groups: tutor, industry client, and industry challenge. To answer question D, we interviewed the industry client and assessed the two groups' final project reports for their solutions (as presented below in the 'Preliminary Results' section).

DSR (Design and Development): The Project Client Map (PCM)

The PCM built in step 3 (design and development) is a visual mapping tool with nine components (Figure 1). Each component encapsulates questions that capture key aspects of an industry challenge under scrutiny by students (Table 1).

The following components can be explored further as follows: 4,5 and 8 using a SWOT analysis, 6 using Empathy Map Canvas and 7 using Value Proposition Canvas.

Preliminary Results

Table 2 shows the results of a preliminary evaluation of the PCM for the two embedded student groups in the tutorial. This work facilitates the building of a mental model (Scaife & Rogers, 1996; Goldschmidt, 2007) of the process of problematisation through a visual representation of the context surrounding a problem as its key contribution.

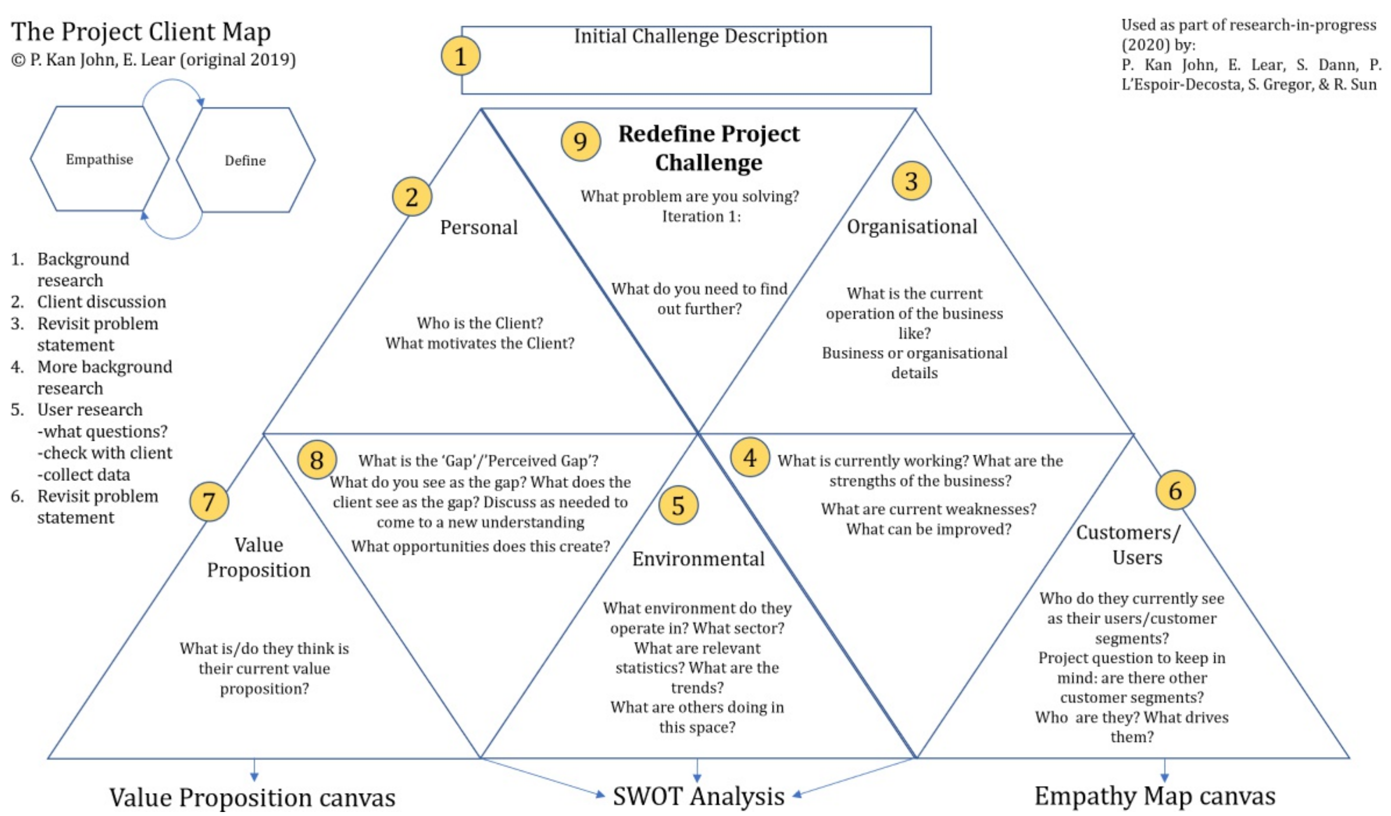

Figure 1. The Project Client Map (PCM)

Table 2. Case Analysis The PCM as used by 2 student groups in a tutorial

	Group X	***Group Y***
Group Characteristics	6 members (5 from Computer Science, 1 from Engineering)	5 members (4 from Computer Science, 1 from Engineering)
A: How did the students interact with the visual form of the PCM (colour, shape, and size)?	Group X uploaded an image file (png format) to their project repository. They made the colour of the PCM more pastel and wrote directly onto the different components.	Group Y uploaded a Word document (doc format) to their project repository. They kept the PCM as it is and pasted a reduced-size copy at the top of the Word document. They wrote text below this image to address questions.
B: How did students use the PCM for analysis (function)?	The students wrote a brief answer into the triangles representing each component, providing a response for the components. Their answers touched on the overall aspect of the components, but did not cover all PCM questions.	The students wrote detailed answers to most PCM questions asked in the different components. They completed a SWOT analysis and a VPC as part of the PCM, but left out addressing components 8 and 9.
C: Did the students successfully complete a problem formulation using the PCM (task-at-hand)?	The students distilled the problem given (see Appendix B) and presented a problem definition under component 9 as expected. Surprisingly, they also presented a problem definition under component 1. The definition under component 1 is more succinct and focussed in scope (but a bit too narrow), suggesting it was produced after iterating on the definition under component 9. Both problem definitions arising from use of the PCM are relevant to the industry challenge. Therefore, we can say that the PCM helped the group in problem formulation.	Although the students did not answer component 9, they provided a problem definition under component 1, which adequately addresses the industry challenge. Hence, we deduce that the PCM did help the group in problem formulation.
D: Did the problem formulation (task-at-hand) have a valuable impact on solving the industry challenge (goal-at-hand)?	In their final report, Group X recommended a system that can (i) digitise paper documents, (ii) classify digital documents by user role, and (iii) evaluate the document classifications to recommend relevant documents to users based on their role. The industry client indicated that they liked aspects of the solutions presented by both groups and are going forward with prototyping a	In their final report, Group Y recommended a system that focusses on three aspects: (i) a gamified pre-question session to induct new volunteers and identify their level of knowledge so that relevant material can be recommended, (ii) a document classification function to organise documents in the system,

Table 2. Case Analysis The PCM as used by 2 student groups in a tutorial (cont'd)

	system that has elements from both reports received. They mentioned that, out of Group X's solution, the ability to detect the content of documents and assign them to users based on relevance was of particular interest. This demonstrates valuable impact in solving the industry challenge.	and (iii) an automated FAQ function that can also be searched to provide a Q&A service. As mentioned for Group X, the industry client is planning to use elements of the solutions presented by both groups. They mentioned that the solution proposed by Group Y showed deep understanding of the problem they brought to be solved. This attests to valuable impact in solving the industry challenge.

In the tutorial, students were tasked with an initial challenge described as follows:

> "A solution is being sought to assist a time-poor group of widely dispersed volunteers to become more efficient and effective. Due to the demands of studying medicine, the group of 200 volunteer staff is required to step back from roles, and team members rotate every 12 months to avoid burn-out. The project challenge is to provide a framework and set of tools for the effective management and operation of the group of volunteer staff. This may involve looking at means to communicate effectively and share knowledge during rotations and hand-overs. Finding relevant information at the right time is an important consideration."

Comparison

A scheduled session with the client occurred within the two weeks following the introduction of the PCM. The client was pleased with the content and solutions that both groups produced. As a way to evaluate the PCM, the client was asked to suggest which group looked better prepared in the sessions. Group Y was praised for their "out-of-the-box" thinking that helped better showcase their understanding of the problem.Their solution subsequently was able to more closely solve the problem at hand. Group X demonstrated a structured approach with technical details that also impressed the client. Both groups seemed to have used component 1 to present the outcome of their analysis using the PCM, instead of just inserting the initial project challenge as intended. This suggests that component 1 either needs to be clarified or perhaps adapted.

Discussion and Future Work

This early-stage work describes a visual mapping tool to help students identify and formulate problems as part of tackling a real-life industry challenge in a classroom project. A DSR approach was useful in drawing from existing knowledge and observations to assist in designing the tool. The tool allowed exploration of the human, organisational, and environmental context of the innovation problem to be solved, which was presented in a compact visual form to aid in making connections among the components.

We evaluated the PCM using a case study analysis and followed the DSR evaluation framework in Venable et al. (2016) to provide both formative and summative insights. Our evaluation showed that the PCM helped students come up with an appropriate problem formulation, which subsequently lead them to propose a useful solution after ideation. The components of the PCM are not fixed at this stage, and may need to be adjusted as we do more in-depth analysis and evaluation. We note that the problem definitions presented by each group in our case study guided and influenced their final solution, thus emphasizing the importance of spending time doing problem formulation carefully, and hence the relevance of using the PCM.

Group Y presented many details of their solution in their PCM, thus suggesting that the completed PCM is likely not the first iteration. Studying how the PCM is

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used in successive iterations would make for interesting future class planning. As a next step, we would like to apply the same approach in other classes so we can eventually analyse more cases to further evaluate the PCM and update this visual tool based on insights gathered. Another interesting avenue to pursue will be to look at how to adapt the PCM for use in non-academic environments, such as start-ups, which would appear to have a natural affinity and progression with the DSR approach. Validating the process of problem identification by various industries might be another interesting avenue for applying the tool.

Another point to note is that in one group, students left out addressing some of the tool's components. This suggests that more guidance on how to use the tool is needed from educators. As a future step, it would also be useful to think about how to deliver the tool in a digital format for online collaboration.

Conclusion

In this paper, we presented a visual mapping tool for problem formulation and identification as part of tackling FEI. The context for the study was teaching Master-level students how to solve unstructured real-world industry challenges through their project work. The outcomes of this preliminary study show the potential of the PCM to support processes involved in problematisation. Two groups of students in one tutorial successfully derived problem definitions using the PCM to solve the same industry challenge. The group that did a more detailed exploration of the PCM components came up with the more innovative solution. We believe therefore that the PCM can be used iteratively throughout a project, and not just at one point in time.

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Seeking 'Strategy' in Business Intelligence Literature: Theorizing BI as part of strategy research

Yassine Talaoui, Marko Kohtamäki, and Risto Rajala

> "Business intelligence is not just about turning data into information, rather organizations need that data to impact how their business operates and responds to the changing marketplace."
>
> Gerald Cohen
> CEO and founder of Information Builders

This paper connects the business intelligence (BI) literature with research in strategic management by plotting the existing research strands on BI: environmental scanning, competitive intelligence, executive information systems, and business intelligence, against the strategic dimensions of a) orientation (External vs. Internal), b) focus (Content vs. Process), and c) practice realms. The article accordingly offers a new re-conceptualization of BI as a strategic artifact across four strategic clusters: BI as a system, BI as a planned process, BI as a product, and BI as a decisional paradigm. This conceptual article contributes to the literature by integrating disparate views on BI and placing them within the content, process, and practice streams of strategy research.

Introduction

In today's digitized world, executives need constant access to improved real-time knowledge regarding internal layers of their organizations, along with happenings in the external business environment (Howson, 2014). They, nevertheless, face challenges in making sense of data, and assimilating and using the resulting intelligence for strategic decision-making. This conundrum is due to a fragmented business intelligence (BI) research landscape (Talaoui & Kohtamäki, 2020) that has generated a proliferation of BI conceptualizations, which in turn has begotten overlapping views of BI at the operational and strategic levels. The proliferation of diverse concepts nurtures discrepancies between the intelligence executives need and what they receive. To date, BI research still desperately overlooks the strategic element of BI artifacts that are capable of providing measurable, and actionable information that bolsters executives' strategic decision making. This state of affairs calls for conceptual development that integrates the disparate views on BI (Hart, 1998) and connects them in a more coherent way with strategy research.

Against this backdrop, we inductively derive four views of BI from 120 articles spanning 35 years of research: a product view (Watson et al., 1991; Volonino et al., 1995), a process view (Calof & Wright, 2008; Dishman & Calof, 2008; Wright et al., 2009), a system view (Kohavi et al., 2002; Chung et al., 2005; Chaudhuri et al., 2011), and a view of BI as a decisional paradigm (Cheng et al., 2009; Holsapple et al., 2014). We then plot the four BI views against macro dimensions of strategy research: a) orientation (External vs. Internal), and b) focus (Content vs. Process). In addition, we also connect BI with strategy as practice research by juxtaposing each of the BI views against c) the practice realms of strategy work (institutional, organizational, and episodic). Overall, this paper provides an overarching conceptual view of BI and connects it with both macro and micro levels of strategy research.

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Uncovering BI Views

This paper adopts a systematic methodology to distill peer reviewed articles published in the top-tier journals (ABS4/ABS3) from 1985 until 2020, thus including early landmark works of environmental scanning and business intelligence, such as Sawy (1985), Lenz and Engledow (1986b), Lenz and Engledow (1986a), and Ghoshal and Kim (1986). For this purpose, four databases were selected for the search: ABI/Inform, EBSCO academic search elite, EBSCO business premier, and Emerald journals. We used Boolean operators (“AND” and “OR”), as well as asterisk wildcards to concatenate 35 keywords and generate query strings. The presence of at least one keyword in the title, keywords, or abstracts, determined the preliminary selection of the article:

> "Action* Intelligence" OR "Account* Intelligence" OR "Business Intelligence" OR "Business Analy*i*" OR "Competit* Intelligence" OR "Compet* Analy*i*" OR "Commerc* Intelligence" OR "Customer Intelligence" OR "EIS" OR "Environment* Scann*" OR "Environment* Analy*i*" OR "Financ* Intelligence" OR "Knowledge Intelligence" OR "Market* intelligence" OR "Market* Research" OR "Market* Analy*i*" OR "Network Intelligence" OR "Open Source Intelligence" OR "Operational intelligence" OR "Organizational intelligence" OR "Product* Intelligence" OR "peripheral vision" OR "Rational Intelligence" OR "Strateg* intelligence" OR "Strateg* competitiveness" OR "Srateg* Analy*i*" OR "strategic alliance intelligence" OR "Strateg* technolog* foresight" OR "Sales intelligence" OR "Service intelligence" OR "Executive information System*" OR "Industr* intelligence" OR "Indust* research" OR "Indust*Analy*i*" OR "Tactic* intelligence".

After scanning the titles, eliminating duplicates, and reviewing the abstracts, only 120 articles conceptualized the BI artifact, and therefore made the final sample. As Figure 1 illustrates, we followed Nag, Corley, and Gioia (2007) to analyze the articles for key findings and inductively distill third order categories and second order themes, as well as to derive four aggregate views of BI: BI as a product (26 Articles), BI as a planned process (36 Articles), BI as a system (34 articles), and BI as a decisional paradigm (24 articles).

From this volume of publications, one can say we know a considerable amount about BI and its conceptual underpinnings, although explanatory studies that depict concrete frameworks of analysis and ways to coherently measure intelligence value have yet to come. The choice to uphold multiple disparate definitions at the same time led to a fragmented literature, not to mention discontinuity between concept descriptions and their defined strategic roles. Missing strategic thinking appears to be common across the four research streams related to BI.

It thus seems now is a suitable time to connect BI to the strategy literature within which the need for BI is manifested at different schools of strategy work. These schools include content (Porter, 1991; Rumelt et al., 1994), process (Chakravarthy & Doz, 1992; Van de Ven, 1992), and practice (Johnson et al., 2003; Whittington, 2007). Closer scrutiny of the literature has now uncovered shades of strategy content and process schools, and strategy practice stream. Juxtaposing the four BI views with three strategic variables: environment layer, strategic focus of analysis, and realms of strategy practice, enabled us to connect BI views to the outside-in and inside-out perspectives of strategy as illustrated in Figure 2. Likewise, we were able to place the four views within the realms of strategy as practice research, indicated in Figure 3.

In the following two sections, we aim to bring together the four BI views and the three schools of strategy research in an attempt to delineate how each BI view is implemented on the strategy levels of analysis.

Bringing BI Views to the Strategy Content and Process Realms

BI as a product

Together environmental scanning and competitive intelligence (CI) represent the main constituents of BI within this dimension. They adopt an outside-in perspective that considers information collected about an external environment as the intelligence product itself. Thirty years of research has turned out vast amounts oriented towards information acquisition, which unless analyzed, remains of no avail and little value to decision makers. While some scholars have advocated information analysis, the focus and objective of such an evaluation has been largely missing (Vedder et al., 1999; Dishman & Calof, 2008; Wright et al., 2009). The lines of thinking underlying BI as a product dimension, nonetheless, seems to consort with the positioning school of strategic management, which,

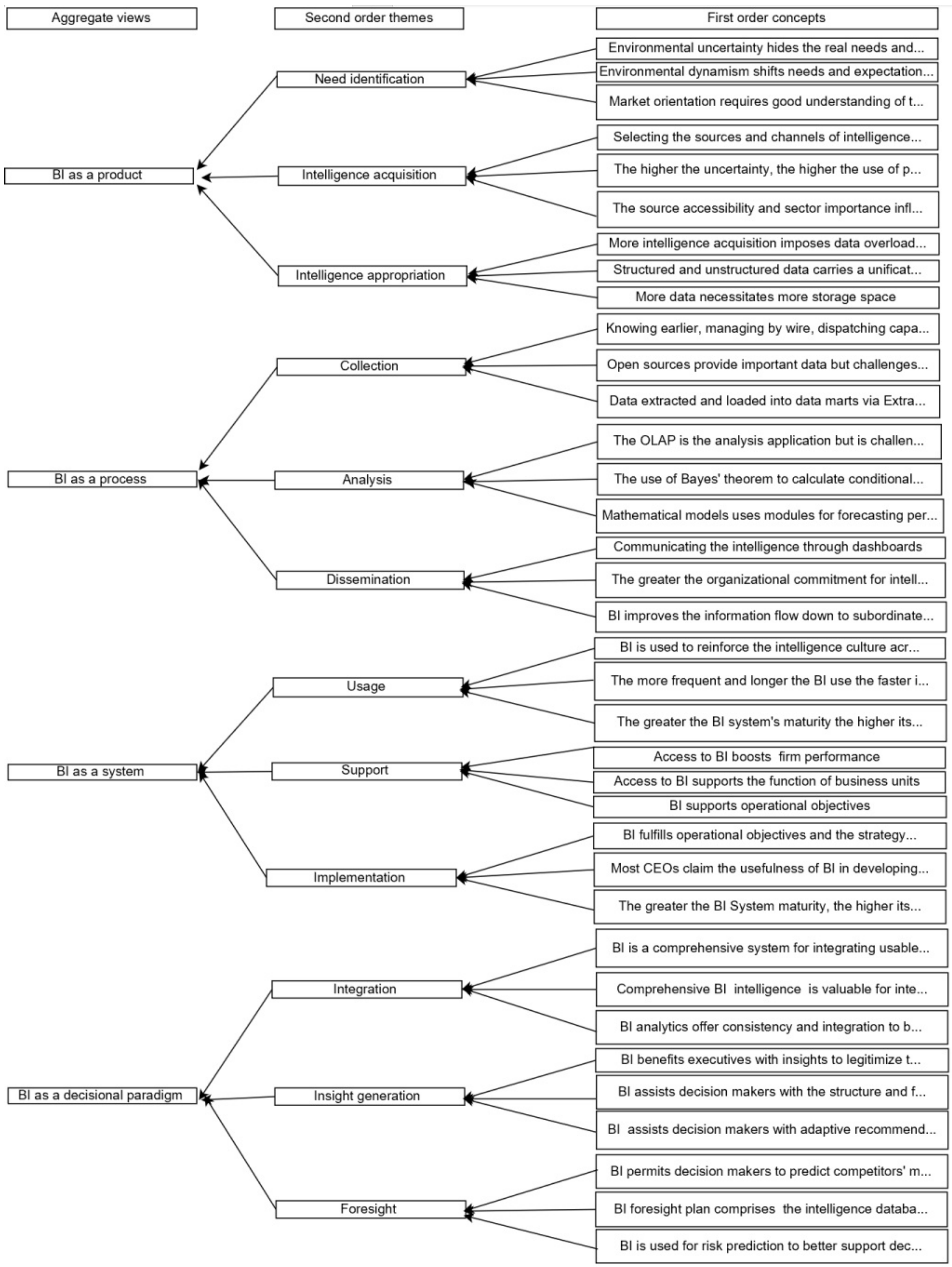

Figure 1. The 4 BI views derived inductively out of third and second order categories from the literature.

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thanks to its excessive external focus, posits that a firm's capacity to create and sustain competitive advantage hinges on how well it positions itself within its industry (Hoskinsson et al., 1999). Put differently, competitors' positioning along existing structural conditions of the industry have been claimed as primary determinants of company performance (Mintzberg et al., 1998).

In this vein, Porter's 1980 five forces analytical framework has allowed firms to assess their performance through scrutiny of their positioning within respective industries, as well as estimating their bargaining power vis-à-vis existing or potential rivalries (Rumelt et al., 1994). The five forces appraisal, while mostly quantitative, has been deemed essential for generic strategy formulation, in drawing a clear picture of industry structure (Porter, 1980; Mintzberg et al., 1998). Strangely, heuristics found within the positioning school are constantly mentioned by companies and appraised by scholars falling within this dimension, although no research so far has attempted to link BI constructs to the positioning paradigm of strategic management.

Furthermore, through primary human or open sources, environmental scanning and CI academics try to detect trends or events that might occur in the external environment that may jeopardize organizations' CI (Xu et al., 2011; Zheng et al., 2012). The rationale here stems from the new dynamics of business environment after the internet bubble of the late 1990s. During the last two decades, a new reality has emerged: competitive advantage is transitory and ephemeral. This fact broke with the positioning school's premise in favour of taking a competitive dynamics approach, wherein firm performance hinges upon effective action/reaction responses (Chen et al., 2012). Once again, prescriptive environmental scanning and CI research overlap with strategic management through competitive dynamics, and consequently comprise BI as a product dimension. This dimension combines environmental scanning and CI with two outside-in content schools: the positioning school and a competitive dynamics research stream. By doing this, BI as a product cluster puts two BI constructs into corresponding strategic context and holds twofold endeavours: (1) supplementing the existing theoretical framework of industry analysis that has long been criticized for its static nature and inability to sense industry alterations (Kim & Mauborgne, 2004), and (2) acknowledging the complementarity of both strategic management schools, by merging their underlying units of analysis, industry and products (Teece et al., 1997), as two crucial sides of the intelligence continuum.

BI as a planned process

This dimension draws from a myriad of studies adopting the CI process or cycle as a reference to evaluate firms' intelligence practices (Wright & Calof, 2006; Dishman & Calof, 2008; Fleisher, 2008). Such a process is composed of four steps: planning, collection, analysis, and dissemination. Put differently, the entire intelligence sequence hinges on a clear delineation of objectives and needs before subsequent stages are triggered. This CI cycle has enjoyed much interest since the late 60's, and is likely to continue its pace, particularly among the Society of Competitive Intelligence Professionals (SCIP). Although, CI practitioners were heavily focussed on the collection phase, likewise scholars advocated for an intertwined cycle that lays the building bricks of actionable intelligence.

Ostensibly, the intelligence is gauged as actionable if it limits executives' intuitions and feeds their rational decision making through a full gamut of activities. These range from an accurate assessment of data validity and quantitative analysis for underlying patterns to imparting knowledge with numerical face value. Needless to say, such a set of actions requires proper intelligence creation, while delivery stems from marketing research. This rational and prescriptive tradition shares a discernable similarity with Ansoff's (1965) planning school of strategy. In other words, both the CI process and strategy planning school draw upon a linear sequential model of development to generate intelligent solutions for wicked issues in strategy formulation (Mason & Mitroff, 1981).

Accordingly, strategy formulation result from a formal, sequential, and rational process comprised of closely weaved phases (Huff & Reger, 1987). At the same time, for the planning to succeed, strategies and objectives ought to be carefully explicated throughout an organization, along with establishing the need for a stable structure that behooves this iterative, if not strenuous, duty (Rialp-Criado et al., 2010). Surprisingly, the regular disparity between needed and produced intelligence has so far been misinterpreted by most scholars, who have opted to delve into the prowess of formalizing intelligence units, or favored a project-based approach for the entire intelligence process (Prescott & Smith, 1987; Ghosal & Westney, 1991).

This paper, therefore, suggests a similarity between the planning school and CI cycle, and places the latter within the confines of the former. Both are rooted in a rational-formal synoptic model and adopt a systematic,

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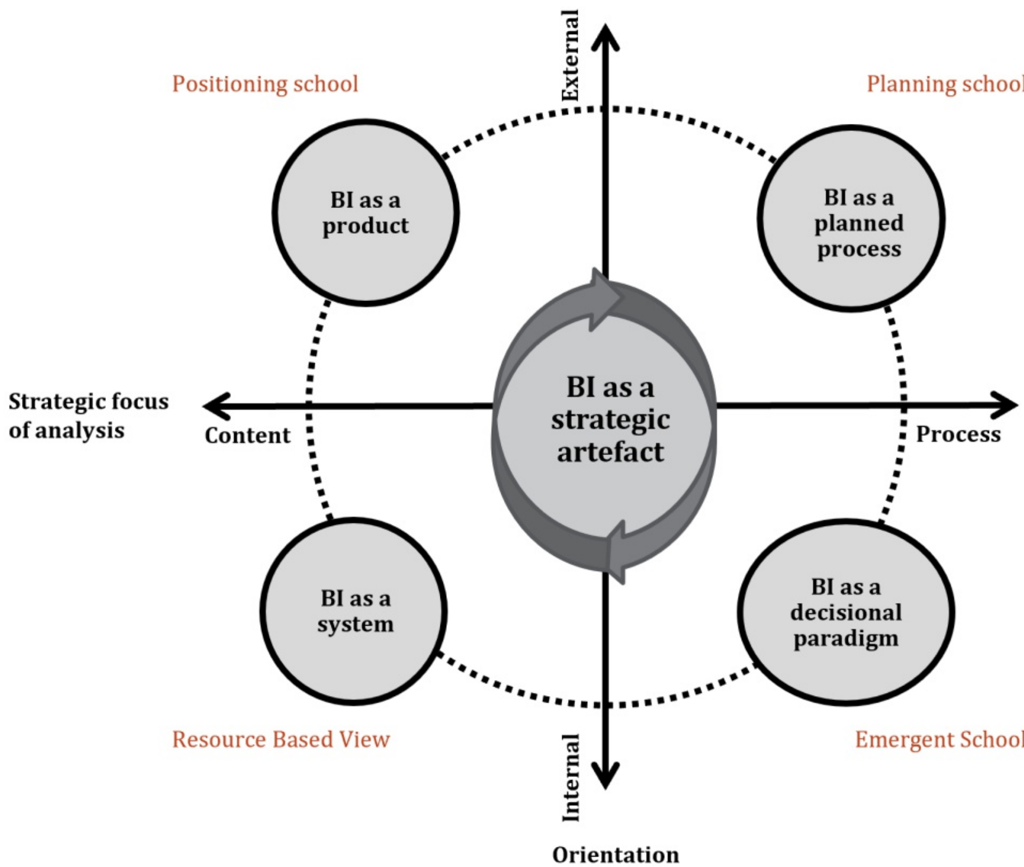

Figure 2. BI views against the outside-in and inside-out views of strategy.

comprehensive, and exhaustive analysis approach to the environment prior to decision execution (Fredrickson & Mitchell, 1984). Such an integration of CI cycles into the planning school is presumably considered key to synchronizing between what is needed at the top and what is offered as an intelligence outcome. Only then will rational strategy formulation supplant intuition.

BI as a system
To bridge the gap between the business user and information access, BI applications ranging from data warehousing, online analytical processing (OLAP), data mining, extract-transform-load (ETL), and user interface provide a company's executive information system with the necessary technologies to process huge volumes of unstructured data, in order to present it in a timely manner to executives. Whereas the research debate stressed WEB 2.0's information overload and the type of business user (executive vs. line manager) receiving the intelligence, studies addressing the strategic importance of such technologies are, unfortunately, nonexistent.

Ultimately, investing in state-of-the-art technologies to decipher meaning out of noisy internal and external data is necessary for companies to strive forward in today's turbulent business environment. However, if such technologies are not seen as a means to competitive advantage, then the continuous investment in updating and developing this arsenal will eventually come to an end. This implies an inside-out perspective to strategy formulation whereby focus shifts to the firm's internal capabilities as a determinant of its strategy and competitive advantage (Hoskinsson et al., 1999). In this respect, firms may earn above normal returns, by identifying and acquiring resources, for instance, BI technologies that are critical to the development of demanded products (Newbert, 2007). These resources are, nonetheless, heterogeneously distributed across competing firms and are imperfectly mobile, which in turn makes the heterogeneity persist over time (Barney, 1991). Firms owning valuable and rare resources would a priori attain a competitive advantage and enjoy improved performance in the short term (Barney, 1991).

This rationale, however, seems dubious in the context of volatile and unpredictable environments as it fails to address the influence of market dynamism and firm transformation over time (Wang & Pervaiz, 2007), let alone the ambiguity surrounding processes whereby resources yield competitive advantage (Barney, 2001). The latter involves making better use of resources by allocating them in such a way that maximizes performance (Mahoney & Pandian, 1992). In this respect, once a firm's valuable resources are properly leveraged, competitive advantage should hence be obtained (Peteraf, 1993).

Evidently, competitive advantage emanates from a combination of resource possession and resource exploitation, which is best captured under two theoretical approaches within the resource-based view: the VRIO framework (Barney, 1997), and the dynamic capabilities approach (Teece et al., 1997). Whereas the former stresses a firm's need to organize for full exploitation of its VRIN resources to potentially attain competitive advantage, the latter specifically defines the types of processes by which firms could reconfigure those resources (Teece et al., 1997).

As conjectured earlier, this line of thinking views BI technologies as necessary but not sufficient for a firm's competitive advantage. It ascertains that above normal rents are earned once firms possess and are capable of replicating routines, whereby resources can be coordinated and deployed. Resources themselves are thus seemingly of no real value to the firm in isolation. Instead, their latent value can only be made available to the firm via idiosyncratic dynamic capabilities (Eisenhardt & Martin, 2000), which: (a) are built rather than bought, (2) reflect a firm's ability to integrate, build, and reconfigure internal and external competences, (3) creation and evolution are embedded in organizational processes that are shaped by firms' asset positions and development paths adopted in the past (Barreto, 2010). In addition to the resource reconfiguring capability, two other sets of capabilities should be considered: the capability to sense and shape opportunities and the capability to seize them (Teece, 2007).

Ultimately, sustainable competitive advantage does not rely solely on dynamic capabilities themselves, but also on resource configurations through BI applications that permit using dynamic capabilities "sooner, more astutely, and more fortuitously than the competition" (Eisenhardt & Martin, 2000). In this respect, BI technologies, along with EIS form the basis for a firm's capabilities to create and sustain competitive advantage (Collis, 1994).

BI as a decisional paradigm

Although some studies have pictured BI as a decisional paradigm, their line of thinking has preached formal alignment between analytical culture, BI technologies, and the business unit (Holsapple et al., 2014). Put differently, this means supporting real time decision making through a combination of BI techniques (cube and ad hoc query analysis, statistical analysis, data mining) with a standard knowledge management process (knowledge retrieval, storage, and dissemination) to generate data, select and manipulate it (Cheng et al., 2009). The validity of such an argument depends on the kind of environment: benign vs. uncertain. While in the former, BI may be utilized for long-term strategic planning, in the latter, BI facilitates adaptation and strategic learning.

This seemingly dimension arises as the missing part of our puzzle. For BI to succeed as a decisional paradigm, an inside-out orientation is necessary, but not sufficient, as it should reckon business interactions with the external environment that imply unintended outcomes of the strategic process (Cyert & March, 1963). Strategy then becomes the result of adaptive opportunistic behavior rather than a plan, for the process is fragmentary and unpredictable, in which intended strategies frequently lead to unintended results (Mintzberg & Waters, 1985). In this regard, both strategy formation and implementation arise as inseparable and indistinguishable processes (Mintzberg et al., 1998). As a corollary, trial and error, continuous learning, and a two-way flow of information emerge as key determinants for resilient, astute real time decision making (Quinn, 1980; Mintzberg, 1987).

Meanwhile, learning is not exclusive to managers who are limited cognitively due to bounded rationality, but permeates the entire organization through a new culture and behaviour that favours retrospective thinking (Quinn, 1980; Mintzberg, 1987), and exudes considerable recognition of the contextual role in strategic thinking (Ezzamel & Willmott, 2004). Therefore, unlike the aforementioned dimensions, this article presents the fourth dimension of the literature in line with the processual school of strategy, wherein decision making process is unpredicted, and associated with a continuous learning process (Whittington & Cailluet, 2008). This double-loop, often triple-loop, type of learning depends on BI to provide the necessary inputs for incessant modifications to better cope with contextual changes before strategy can be formed in a collected and descriptive manner (Mintzberg & Waters, 1985; Balogun & Gleadle, 2005).

Placing BI within the Three Realms of Strategy as Practice

BI as a system within the strategy realm

Research rooted in information management and oriented toward technologies that drive intelligence currently offer potential within the operational realm, not to mention carrying a would-be role for accompanying the organizational realm. Research so far has been concerned a great deal with developing the ultimate BI software capable of generating reliable intelligence. This in turn has yielded hands-on technologies that are responsible for converting structured as well as mostly unstructured data into a homogenous piece of knowledge that reflects the actual conduct of business units. This episodic focus is achieved through an application dubbed extract-transform-load (ETL) because it alleviates heterogeneity and load extracted data into a data warehouse. The latter result contributes much to the organizational realm, thanks to a relational database management system (RDBMS) that enables business users to execute queries across a wide range of data.

The organizational focus is further corroborated by an online analytic processing (OLAP) server, which is tasked with deciphering patterns across data to better fathom competition and strategic change. In this regard, OLAP offers organizational actors the possibility to slice, dice, and drill down into data, and then to display it in a user friendly manner through dashboards or spreadsheets that constitute the interface for a decision support system (DSS), also known as an executive information system (EIS).

Finally, the potential role of BI technologies within the institutional realm is not as straightforward as one might think, despite the ability of data mining engines to "predict" scenarios vis-à-vis the focal firm's environment (March & Hevner, 2007; Chaudhuri et al., 2011). Besides the difficulty of predicting accurate scenarios, the currently rudimentary routines of companies to acquire external data also impedes the capability of data mining from making sense of the institutional realm. Thus far, research has addressed the potential role of BI technologies within the three strategy realms, yet more empirical research is needed to highlight how BI as a system shapes and is influenced by each realm.

BI as a product within the strategy realm

In line with the structure-conduct-performance paradigm and influenced by "industrial organization" (IO) economics, strategic management scholars have nurtured a particular interest in the structure of a given firm's industry as crucial to formulating viable business strategies. Their outside-in perspective has been referred to as environmental scanning and shares discernable synergy with the institutional realm, as it

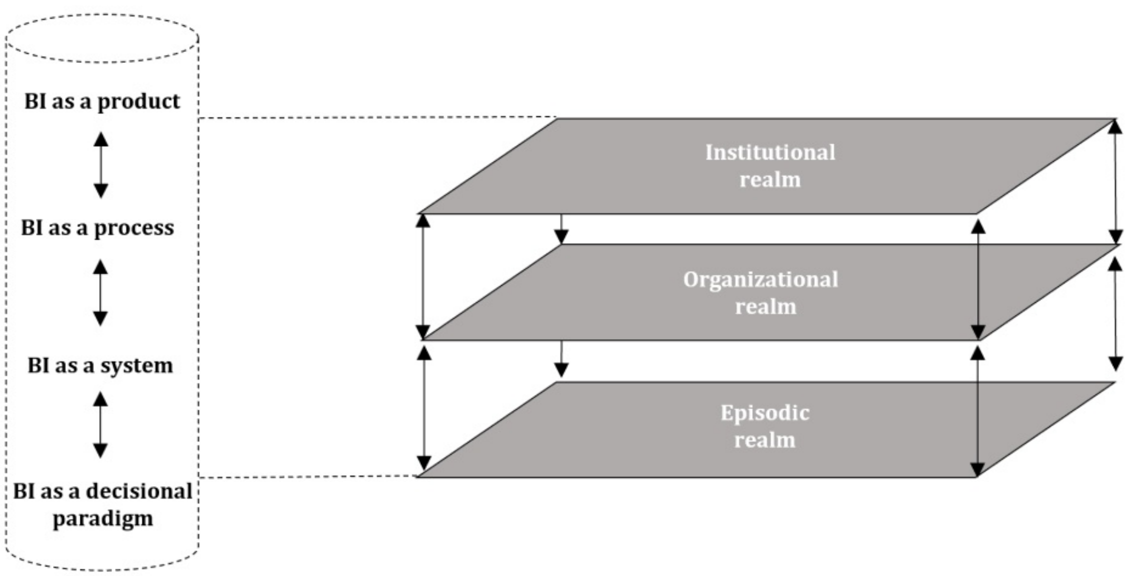

Figure 3. BI views against the three realms of strategy as practice.

strives to make sense of the task environment (which includes any area directly linked to the organization's operations, such as customers, competitors, and so forth), and the general environment (denoting all sectors remotely connected to the organization including government and economy) (Daft et al., 1988).

Nowadays, such market focused intelligence is generated through third party sources, customer reviews, and Web 2.0's overwhelming loads of information. These three modes represent major bases upon which CI is created within 21st century organizations. Whether developed internally or acquired by market researchers, mainly Nielsen, the operational efficiency concern of CI bears a striking resemblance to the organizational realm. Put differently, the acquisition techniques of CI through the mining of customer reviews or the inference of competitive measures (market share, competitors' share of wallet) seeks potential weaknesses or strengths of competitors' products or services in order to avoid competition and anticipate strategic change (Zheng et al., 2012).

Unfortunately, strategic management and marketing scholarship that has been preoccupied with strategic uncertainty and awed by the heuristics of Porter's positioning school, has produced much quantity aimed at the institutional realm, which however disregards the distinctive competence and capabilities of organizational actors. This in turn has engendered a challenge to trace the BI construct to the episodic realm. It has thus become evident that the extant literature has failed to notice the interplay between the three realms indicated above, which is reflected in the paramount weight given to the institutional realm, and a shocking lack of episodic level analyses engrained in many firms' resource base. Needless to say, though the many contributions of marketing scholars have benefited the organizational realm, their customer-oriented approach has accidently coincided with operational efficiency, while missing the CI entrenched in a business model's set of activities.

BI as a process within the strategy realm

BI as a process is by far and large the construct with the most prescriptive and descriptive studies. This state of affairs, fueled by a desire to bridge the gap between business users and their BI system, has lured researchers to reduce the time cycle from data collection to imparting knowledge via casual visualization that aims at simplifying common quantitative displays of data (Kohavi et al., 2002).This communication seemingly follows a predefined process that could be traced to the episodic and organizational realms. The episodic realm permeates the acquisition of internal data that exposes the distinctive competence of a company, its activities, and actors, while the latter shifts attention to the transformation of data into consistent and coherent actionable intelligence that serves immediate operational analysis or awaits more variables to foster sense making (Chen et al., 2012).

The organizational realm holds within its confines a striking disappointment for most readers, due to the absence of any tested analysis tools that are proficient in examining data according to different scenarios of consequence for competitive dynamics. Lastly, communication and intelligence sharing throughout an organization has been called for by scholars and mangers alike, despite the clear deficiency in comprehending the institutional realm. Along with its linkage to the aforementioned dimensions, this ultimately drives the persisting conflict and divergence between intelligence needed at the top and intelligence conveyed bottom up.

BI as a decisional paradigm within the strategy realm

As mentioned earlier, BI as a decisional paradigm hinges on the continuous input of intelligence needed for making necessary amendments prior to and during the strategy formation process, which involves trial and error learning (Quinn, 1980; Mintzberg, 1987). This BI dimension in tandem with the processual school of strategy carries also a synergy in accordance with the institutional realm, thanks to giving the utmost consideration to interactions with the external environment, due to the tension it exerts upon the decision making process (Whittington & Cailluet, 2008). On the contrary, the emphasis information management scholars have given to studying the impact of internal environments on BI as a set of core resources, has discovered a clear association between intelligence assimilation and managerial absorptive capacity (Elbashir et al., 2011).

Ostensibly, better intelligence assimilation needs to be supported by potential absorptive capacity (ACAP), which enables information acquisition and assimilation (Lane & Lubatkin, 1998). Regrettably, unless or until such a relationship is explored to indicate a clear link between BI and either potential absorptive capacity (ACAP) or absorptive capacity (RACAP) (Zahra & George, 2002), one cannot conjecture any role for BI in delineating the understating and motives that drive organizational actions taking place within the episodic realm.

Notwithstanding this fact, piecing together the tactical level with BI might not be utterly wrong, as a distinct relation seems to exist between the speed and extent of such actions and BI (Leidner & Elam, 1995; Leidner et al., 1999). This goes along with a discernable connection particularly in instances entailing prediction for mergers & acquisitions (Lau et al., 2012), and credit denial or approval (Moro et al., 2015). In contrast with the episodic level of analysis, linking BI to the organizational realm usually holds value, due for the most part to the ease of quantitatively measuring operational efficiency related constructs. For instance, resource and price optimization based on data mining forecasts from previous patterns and competitors' pricing, which ultimately enables retaliatory or pre-emptive actions with respect to competition (Heinrichs & Lim, 2003).

Conclusion

This conceptual paper aimed to integrate the BI and strategy literatures by clustering the BI body of knowledge around four BI views, which are further placed into the strategy schools: BI as a product, BI as a system, BI as planned process, and BI as a decisional paradigm. By so doing, this paper endeavoured to direct scholars' attention to the subtle strategic role of BI that has been long neglected. Thus, this paper intended to encourage a change in perspective for researchers to adopt a more comprehensive view of BI aimed at facilitating real time decision making and strategic learning (Mintzberg & Lampel, 1999). With its focus on four BI dimensions, the paper at hand has laid the first brick in a new BI wall, where more studies are expected to probe the influence of managerial cognition of BI usage and interpretation, as a way to enhance our understanding of the BI influence on strategy making. From a capability perspective, researchers should examine the role of BI to accumulate and share tacit knowledge throughout organizations. Further studies thus appear to be needed in order to shed light on the interaction between BI and different strategy constructs. In addition, we believe that taking a strategy-as-practice approach could provide fruitful grounds to study the utilization of BI technologies in management teams and middle management. This way studies can shed light on the material forms of BI systems, along with how BI systems and social practices get entangled.

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What are the Challenges of Building a Smart City?

Haven Allahar

> *Smart city development requires not only technological enablers but also a new way of thinking among cities, businesses, citizens and academia which includes key development stakeholders.*
>
> Heikki Ruohomaa, Vesa Salminen, Iivari Kunttu
> 'Smart City' Researchers

The recent emergence of the concept of 'smart cities' presents challenges to city administrators for planning, managing, and governing modern cities in the digital age. Research on smart cities has tended to focus on the attributes of cities at a more developed stage. Instead, this article departs from that trend by discussing an aspiring smart city in a small-island developing country. The purpose of the study is to examine the steps required for building a smart city against a background of the concept of smart cities, taken in the context of an empirical study of an aspiring small smart city. The main finding is that there is no single route to becoming a smart city, but rather there are critical steps that can be adopted as part of a building process for achieving that objective. This work adds value in presenting a way to synthesize the smart city concept with empirical work involving one small smart city's aspirations and achievements. The article fills a partial gap in the smart city literature and has implications for aspiring city administrators, smart city builders, persons concerned with the application of ICT to address city challenges, as well as for students of urban planning, development, and management.

Introduction

The concept of a 'smart city' emerged from studies in urbanism, combined with information and communications technologies (ICTs). It now extends to include interactions with and between governmental organizations, involving broader society, and the use of technology through technology-enablers such as the Internet, and early onset of 'artificial intelligence' (Ruohomaa et al., 2019). The term 'smart city' became popular around 2009, arising from several descriptive adjectives being used about cities, such as: virtual, digital, wired, intelligent, information, knowledge, creative, green, and clever (Kola-Bezka et al., 2016; Thompson, 2016; Veselitskaya et al., 2019; Min et al., 2019). In the course of this linguistic history, many definitions and classifications have been proposed, yet there is still no agreed upon definition of what constitutes a 'smart city'. Instead, multiple definitions are now available based on varying perspectives (Meijer & Bolivar, 2016; Serrano, 2018; Schipper & Silvius, 2018).

One appealing recent perspective proposed by Min et al. (2019), is to view the term 'smart city' as an umbrella concept, due to the absence of a consensus. This is largely because the concept is still emerging among scholars, and also since cities are or can be such diverse entities, each with unique attributes and challenges. Nevertheless, both residents and city administrators of many cities around the world at the current time claim to be 'smart', or aspire to achieve the status of being a 'smart city' (Thompson, 2016).

This article suggests a definition adapted by the author from the Inter-American Development Bank (IDB) together with a listing of various definitions compiled by Schipper and Silvius (2018), as follows:

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> "A smart city places people at the center of development, invests in human and social capital, manages resources wisely, incorporates ICT into urban management, emphasizes collaborative planning and citizen participation. The aim of a smart city is geared towards promoting sustainable development and improvement in the quality of life of its citizens through ongoing initiatives that support innovation, competitiveness, attractiveness, and resilience of the city".

Due to the fact that that studies of the development and operation of smart cities are still in their infancy, there are many gaps in the literature. These include small cities in developing countries being given less attention (Ruohomaa et al., 2019), inconsistencies in approaches because each city is deemed to be unique with no development template for how cities change over time and develop (Coletta et al., 2019), and deficient outcomes for studies trying to formulate a clear development pathway. Because of the ambiguity surrounding the term 'smart city' (Min et al., 2019), some scholars asserted that there are no 'flagship' examples of smart cities, but rather merely cities pursuing the 'smart' label (Snow et al., 2016). That said another look at the landscape anticipates 88 smart cities globally by 2025 (Glasmeier & Nebiolo, 2016). Smart city development has become associated with many initiatives, including urban living labs (31%), smart government (22%), smart environment (16%), and open data (13%) (Thompson, 2016).

One problem is whether a set of clear steps to developing a smart city can be identified in the context of the newness and fragmented condition of the concept. This paper adds proposed development actions for addressing the problem, which are outlined in (Table 1) as a suggested smart city development path. The purpose of this paper is to provide insights into the emergent phenomenon of smart cities and to trace the steps required for building a smart city, despite the complex and fragmented context. This article documents the findings of a case with a city located in a small island developing state, which is openly aspiring to be 'smart'. The research findings note the challenges and flaws of this novel initiative. The case involves the city of Port of Spain, the capital of Trinidad and Tobago, as an example of a single smart city case. their provides the rare scenario of a small developing island, and the only city in the Caribbean-island region that has embarked on the path of developing a 'smart city' (Yin, 2003; Siggelkow, 2007; Dasgupta, 2015). This Singapore is the most advanced small-island city where the 'becoming smart' approach was to emphasize transport, home and environment, business productivity, health and enabled ageing, and public-sector services, along with testing the application of smart technologies (Ho, 2017).

No accepted theory can be said to currently govern the design and operations of smart cities (Harrison & Donnelly, 2011). This article is therefore underpinned by theories about urban systems and the feature of stakeholder collaboration. Harrison and Donnelly (2011) viewed urban systems theory as comprising arbitrarily arranged layers of the natural environment, infrastructure, resources, services, and social systems. The authors argued that a theoretical foundation for smart city interventions was needed to provide links for the thinking of architects, planners, developers, city managers, and other city stakeholders.

Stakeholder participation in cities has generally been viewed within a triple-helix system of collaboration among universities/tertiary institutes, industry/business, and governmental authorities (Etzkowitz & Leydesdorff, 2000; Thompson, 2016). Such collaboration was then extended to a quadruple-helix, by including the media, creative industries, and culture as participants (van Waart, Mulder & de Bont, 2016); and next to a quintuple helix by adding the natural environment (Carayannis et al., 2012; McAdam & Debackere, 2018). The success of building smart cities has been traced by some scholars to depth of community engagement and level of citizen participation (Snow et al., 2016; Einola et al., 2019).

The rest of the paper presents an overview of the concept of 'smart cities' to add clarity to the concept's vagueness and promote greater understanding. It then introduces the challenge of developing a smart city as the central problem of the article. It turns next to discuss the case of Port of Spain as an island-based city aspiring to be 'smart', along with a critical analysis of its progress. After that, it highlights the findings related to both constraints and potential benefits of developing a smart city, and outlines the main conclusions from the article's insights.

Overview of the Concept of Smart Cities

Clarifying the Concept

Early research on smart cities focused on the application of ICTs to city operations, as well as the provision of

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services. Current research now focuses on the impacts of specific projects and initiatives that utilize technologies such as big data analytics (Bibri & Krogstie, 2017). A clear gap, however, has emerged regarding the role of human capital in the smart city development process. Moreover, specific flaws have been shown due to the lack of "a holistic orientation as to integrating environmental, economic, and social considerations and goals of sustainability with technological opportunities" (Bibri & Krogstie, 2017).

Recently, the term smart 'sustainable' city was suggested (Schipper & Silvius, 2018), which has been considered as a questionable addition (Allam & Newman, 2018), while sustainability was generally de-emphasized in the literature (Bibri & Krogstie, 2017). Moreover, the concept of 'smart cities' is currently in flux, and the many different labels applied merely highlight particular aspects of what a smart city should contain. This includes emphasis on each city's ICT features, various challenges, and overall uniqueness (Meijer & Bolivar, 2016; Caragliu & Del Bo, 2016; Ruohomma et al., 2019). The term 'smarter' city, meant to refer to the growing utilization of advanced ICT, has also emerged as a future concept (Bibri & Krogstie, 2017). The majority of smart city concepts also emphasize a critical need for wide stakeholder collaboration in planning and implementing initiatives from the outset (Markkula & Kune, 2015; Jussila et al., 2019).

Role of ICT

The increasing application of technology to the functioning of cities worldwide is generating a growing body of research work on smart cities. Nevertheless, these studies still remain fragmented (Meijer & Bolivar, 2016). Smart city concepts are drawn from several fields of knowledge, including ICT, urban studies, e-government, and public administration (Meijer et al., 2016). This diversity of contributions can sometimes lead to a confused understanding.

However, there is consensus that a city's overall 'smartness' is not measured by investment in expensive technology exclusively, but rather by the extent of improvement in citizens' lives (Thompson, 2016). Such improvement was said to require smart networks for activities such as transportation, water supply, and waste treatment (Hayat, 2016), using networks to integrate technologies, systems, and services, as well as provide capabilities for future development (Min et al., 2019).

The debate on smartness highlights two different approaches to the study of smart cities: the "ICT-oriented approach and the people-oriented approach" (Bibri & Krogstie, 2017). Similarly, smart cities were classified by Meijer and Bolivar (2016) as either having a focus on the application of technology to issues such as transportation, energy, and traffic congestion to foster urban development and sustainability; or a focus on human capital and resources as central to the efficient functioning of smart cities. The latter involves a governance focus that stresses stakeholder collaboration with tertiary institutes to create innovation hubs as described by Allahar and Sookram (2019), and a general focus that represents a combination of technology, human resources, and governance. The ICT approach has been criticized as promoting the sale of technological devices driven by IT corporations' profit motive, while being disruptive, expensive, and tending to disadvantage older citizens (Glasmeier & Nebiolo, 2016; van Waart, 2016; Allam & Newman, 2018).

Smart City Characteristics

The early characteristics of smart cities were identified as comprising:

a) smart economy (innovative and entrepreneurial, digital currency)
b) smart people (qualified, pursues life-long learning, creative)
c) smart governance (participatory, provision of public and social services)
d) smart mobility (access to transport, ICT infrastructure, sustainable and safe transport systems)
e) smart environment (attractiveness of natural environment, sustainable resource management)
f) smart living (facilities for culture, health, safety, housing, education, and social cohesion) (Giffinger et al., 2007).

The specific characteristics of smart governance, people, and infrastructure were later elaborated by researchers as:

1. smart governance emphasizes the need for a collaborative digital environment through knowledge networks that promote business competitiveness (Pereira et al., 2018)
2. the smart people aspect involves combining social and human capital within the city in a collaborative arrangement where citizens participate in decision-making and contribute to necessary changes (Snow et al., 2016; Bibri & Krogstie, 2017)

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3. smart infrastructure implies the application of ICTs to the challenges of urbanization, and to creating a city for the future (Sánchez-Corcuera et al., 2019).

Smart infrastructure has been identified as needing to go beyond the mere use of ICTs towards solution-finding and enabling greater efficiency through smart devices, big data capture and analysis. A need arises for using big data to exploit knowledge through human capital, that provides interconnectivity for knowledge sharing (Allam & Newman, 2018; Min et al., 2019).

Challenge of Developing a Smart City

Attributes and Distinguishing Features

Very few smart cities have been attempted and are rarely built from scratch. Instead, they are constructed upon existing systems, practices, infrastructure, and organizational structures (Glasmeier & Nebiolo, 2016; Meier et al., 2016). How can a smart city be distinguished from a traditional city? Generally, the attributes of smart cities include smart infrastructure including:

a) a smart electrical grid
b) smart water management
c) smart traffic and transportation systems
d) smart waste-water management systems that reduce, redeploy, recycle, and segregate waste
e) waste-to-energy compost
f) e-waste management
g) smart security systems
h) e-government with data sharing in real time across a secured network (Hayat, 2016).

In practice, a smart city displays the following features:

1. Shared ICT, common infrastructure for communications using an optical fiber backbone
2. Information collection via sensors like smart meters monitored from a central control center
3. Open government to bridge gaps between citizens and administrations
4. Energy-efficient technologies like smart streetlights
5. Time optimization like multi-level parking for revenue generation, global positioning system-enabled vehicles
6. Zero emissions which means reduced utility bills
7. Green rooftops and a green environment (Hayat, 2016).

Development Path

At the operational level, smart city development involves multilevel smart city municipal governance, and a socio-technical dynamic that reinforces “human collaboration and technological systems” (Meijer et al., 2016). However, the city of Dublin, Ireland was labeled an “accidental smart city”, because it was implementing smart city initiatives without a master plan (Coletta et al., 2019). While a general consensus holds that there is no single route or path to developing a smart city, and that cities are considered diverse and complex, with each city being unique, cities have utilized different approaches to achieving smartness and followed different development paths (Meijer et al., 2016). It has also been argued that “a smart city is far from stable and linear in nature, but unfolds through a set of contingent and relational processes” (Coletta et al., 2019). Colding, Colding and Barthel (2020) similarly lamented the absence of debate on the smart city model because “no one actually knows what type of society the SC model in the end will generate”, with high levels of complexity a likely result.

At the implementation level, research has pointed out that copying best practices from other cities was not always the best solution, but rather aligning initiatives with development strategies, human resource policies, ICTs, and configuring the city was required. However, evaluation of progress with smart city initiatives revealed that most cities did not go beyond creating open data portals, providing free Wi-Fi and smart phone applications, and that the data collected were rarely put to productive use in supplying new utility services (Sánchez-Corcuera et al., 2019). The insight gained from these authors suggests that smart city developers should first design the architecture and standards to be utilized in the given city to help expedite the implementation process.

Development Steps Applicable to the Case

According to Glasmeier and Nebiolo (2016), no consensus exists on the steps required for building a smart city. For the purpose of addressing the problem stated in this article, this paper proposes critical steps for developing a smart city that have been identified as relevant for early stage smart cities in the Latin American and Caribbean region detailed below (Bouskela et al., 2016). These steps are presented as a way to create a pathway to developing Port of Spain into a smart city, and address various problems posed in this regard.

Port of Spain - Smart City Planning

Port of Spain is the capital of Trinidad and Tobago, a small island state located in the Southern Caribbean

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Table 1. Steps for Developing a Smart City

Building Blocks	Activities
Leadership	Select a leadership team with the requisite technical knowledge and management skills, and build strong working relationships
Diagnosis	Conduct a deep diagnosis of city-specific challenges, including the technological infrastructure's capability regarding connectivity, systems, equipment, institutional and human resource capacities; and secure the involvement of key stakeholders through consultation
Action plan	Prepare a smart city action plan based on a cost-benefit analysis accounting for: technology issues, institutional elements, the regulatory framework, integrating technology and management systems, devising collaborative arrangements with key stakeholders, and sources of funding
Implementation plan	Develop an implementation plan that allows for setting timelines and targets focused on manageable pilot projects, while confirming available sources of finance and technology requirements. A project planning and management approach which includes foresight planning is recommended (Allahar, 2019)
Collaboration	Establish partnership arrangements that target the creation of a smart ecosystem for fostering startups, retaining talented people, promoting innovation, and pursuing competitiveness and entrepreneurship in the city, region, and country
Evaluation	Evaluate project results to determine which solutions are meeting objectives, eliminating errors through monitoring, evaluating, and providing feedback; and documenting lessons learnt for effecting public management changes and adjustments.

with the city aspiring to be smarter. The city is 12.3 km2 in size with a population of 50,000, and a density of 4,000 per km2. It is prone to flooding as a coastal city, characterized by informal housing settlements, traffic congestion, vehicle parking issues, and the non-application of sustainable indicators for guiding local development (Beard, 2012). The city offers the highest levels of commercial business operations, services, and public administrative functions in the country, and has benefitted, as a port city, from the downstream activities and industries of import and export business (UN Habitat, 2012). Port of Spain celebrated its 106-year anniversary as a city in 2020, based around the theme of "Resilience - a city recovering, a city rebuilding, a city rising" (Fletcher, 2020).

Action Plan and Evaluation

In collaboration with the IDB, two initiatives were undertaken relating to smart city development. A Sustainable Port of Spain Action Plan focused on the implementation of three groups of initiatives (IDB, 2012), and a case study evaluation of the Port of Spain Emerging and Sustainable Cities initiative (IDB, 2016).

The action plan outlined the initiatives required as:

- Environmental and infrastructure projects including protecting watersheds, upgrading settlements, improving public safety and water supply, rehabilitating drainage, solid waste management, and climate change adaptation
- Cultural and heritage activities, such as preservation of heritage sites and attractions and upgrading and beautifying urban spaces that were established as critical to tourism development in the city
- Social and economic development initiatives involving: empowering communities to execute local development plans; collaborating with local businesses; creating employment; and providing training.

In 2014, Port of Spain was included in the IDBs Emerging Sustainable Cities' initiative. A subsequent case study evaluation of the initiative identified the following trends and characteristics (Table 2) (IDB, 2016).

Critical Analysis of the Port of Spain Experience

Action Planning

This paper assesses the progress of Port of Spain towards becoming a smart city against the following markers: the

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Action Plan prepared for the city (IDB, 2012), the case study evaluation of implementing the action plan (IDB, 2016), the suggested critical steps for building a smart city (Bousekela et al., 2016), and the author's insider experience as a development planning consultant for the city. An assessment of the Action Plan revealed a slow progress of achievements, especially in rehabilitating drainage and mitigating the yearly flooding incidents in the city, and likewise in relocating a solid waste facility that is currently located on the city's outskirts. The city is home to the cruise shipping port facility, but efforts at developing and managing the visitor sites and attractions remain slow moving, despite having available a formulated development and management framework(Allahar, 2015). The social and economic development program is a collaborative approach, but implies the need for engaging a formal quintuple helix arrangement (Carayanis et al., 2012) to enable greater involvement of all citizens, institutions, non-governmental organizations, community-based organizations, and environmental activists with SME development.

Evaluation of Port of Spain

The sustainable cities case study revealed that many areas in Port of Spain were evaluated as having below minimum sustainability levels. This was emphasized by its vulnerability to flooding, risks of natural disaster, degradation of the urban environment, inadequate management of growth; low standard of urban mobility and safe transport (described as a smart mobility ecosystem by Pulkkinen, Jussila, Partanen, Trotskii, and Laiho, 2019), and poor competitiveness (IDB, 2016).

The city is still in its early stages of working towards becoming smarter, and the critical development steps have not yet been pursued diligently. A significant implication is that there are many deficiencies in the city's development process because of the lack of identifiable leadership. Instead, in Port of Spain, different city and governmental officials assume part-time leadership roles. This creates a problem of both responsibility and accountability, with fewer people in full-time roles available.

Further, the sustainable cities analysis of human and organizational requirements for implementing smart initiatives was not thorough. Port of Spain's 'smart city' plan has been pursued only in a piecemeal fashion, as in the Dublin case (Coletta et al., 2019). It has lacked a coherent implementation plan, and only managed to agree to a few pilot projects. The case study evaluation identified specific trends and characteristics of the city that mitigate against creating a smart city in Port of Spain. These trends have not been reversed and the eight-year timetable suggested by the Action Plan has not been met. In effect, the Port of Spain case mirrors the assessment of Dublin, Ireland, which, according to Coletta et al. (2019), will continue as an accidental, rather than definitively planned smart city.

Weaknesses of Smart City Model

Port of Spain's smart city action was reported in the media as a program of the public sector implementing an ICT platform for securing greater efficiency in the delivery of public services. This approach carries the risk that additional technological devices applied in cities will increase energy use and complexity of life, leave older citizens behind, heighten security risks, and face the profit motivation charge (Glasmeier & Nebiolo, 2016; Allam & Glasmeier, 2018).

Table 2. Case Study Evaluation of Port of Spain

Evaluation characteristics	Results
Economic context	The economy of the city and country was affected by the decline in commodity prices and production of oil and gas
Population trend	Population of the city is decreasing because of a lack of affordable housing inside the city, while such housing is available outside the city
Functions	The city is the main financial center and provides the bulk of the country's administrative capacities
Urban setting	The urbanization pattern renders the city vulnerable to natural disasters and income inequality
Governance	The City Corporation is limited by its governing legislation, and its dependence on central government resources.

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A smart city model for Port of Spain was conceptualized that sought to integrate smart urban solutions to enhance connectivity, transfer of e-government services, more energy efficient utilities, improved road and traffic management, and effective safety and security initiatives (Thorne-Mora, 2018). The launch of Wi-Fi connectivity and retrofitting of LED lights in public squares and spaces was a supporting initiative spearheaded by the national electricity and telephone companies (Loop News, 2020). However, city government actions suffered from implementation deficiencies, lack of dedicated resources, a concentration on traffic congestion-related initiatives, excluding traffic management and service development, as emphasized by Pulkkinen et al. (2019), and a lack of coordinated approaches. This led to a detriment of significant progress in attaining a higher level of city smartness.

These weaknesses reflect the flaws also recognized in the Dublin case (Coletta et al., 2019), the Aarhus, Denmark case (Snow et al., 2016), and some of the examples from Latin America (Jileta, 2016). This shows a need to balance the city core with its peripheral areas, which often are not accorded priority (de Falco et al., 2019).

ICT Development Proposals

A guide to the social and economic future of Port of Spain was produced that deals with implications for developing a smart city (The Roadmap Recovery Committee, 2020). The recommendations are as follows:

1. Accelerate the building of digital government
2. Introduce a digitization model that collaboratively delivers e-services, social support, and a data-driven decision-making environment
3. Create an e-identity for each citizen and permanent resident that enables them access to government services and digital commerce transactions, and addresses the digital divide between old and young, urban and rural, and rich and poor users
4. Develop an open-source data platform to stimulate economic activities
5. Implement e-payments for all city payment accounts
6. Provide incentives that support a technologically-oriented, innovation, and entrepreneurial culture
7. Institute an e-money (smart currency) system and a FinTech innovation hub, where company representatives delegate infrastructure management to the cloud to focus on business development
8. Execute a strategic public education campaign about smarter cities
9. Adopt legislation to enable digital transformation together with developing cybersecurity safeguards.

The implementation of these basic initiatives will place Port of Spain, or any other city, in a position to advance its pursuit as a smart city with long-term goals. Nevertheless, these initiatives will require the appointment of a full-time, dedicated multidisciplinary team to undertake the critical development steps outlined above, which has not yet proven to be part of the available resources in the case of Port of Spain.

Findings and Discussion

Building a smart city appears to require basic adherence to a systematic process. This process involving selecting a competent leader and supporting team, completing an extensive diagnostic of the city’s specific technology, human resources and institutional capacities, financial assets, limitations, and challenges, and especially building a coherent collaborative and engaging system among all stakeholders (Bouskela, et al., 2016).

Further, smart city builders can benefit from the following findings:

a) Idea champions and leaders should have expertise in digital technologies
b) Broad stakeholder involvement is vital; understanding the political, administrative, and cultural characteristics
c) Experiment with ideas and projects but focus on those attractive to citizens and firms
d) Leverage own and accessible resources
e) Create a platform private firms can use to develop new products and apps
f) Establish a research park where small firms can network and collaborate
g) Sustain a “collaborative community” (Snow et al., 2016).

Many constraints can restrict the development of smart cities. The relevant case of Dublin, Ireland (Coletta et al., 2019) provides sound insights into the flaws to avoid:

1. A piecemeal approach and lack of guiding strategy
2. Poor coordinated thinking among stakeholders
3. Weak governance structures and leadership
4. Lack of a formal process for local authorities to engage with stakeholders to advance collaboration
5. Lack of resources and capacity of staff
6. Imbalance in capacity and lack of cooperation among local authorities

7. Working practices that impede proper procurement, experimentation, and operations
8. Implementation impacted negatively by political and regulatory barriers.

Building smart cities must rest upon a suitable policy framework that supports:

a) Framing policies within an urban development strategy
b) Evaluating success by considering policy integration, clear branding strategy, and a demand-driven approach
c) Building on existing capabilities and strengths
d) Focusing on core areas of intervention
e) Coordinating departments of the developing smart city
f) Involving a broad representation of stakeholders
g) Combining digital improvements with physical and institutional changes
h) Implementing small-scale integrated projects for early success (Caragliu & Del Bo, 2016).

The empirical assessment of Port of Spain as an aspiring smart city, revealed that some of the key elements were being put in place, but that dedicated, focused leadership was lacking, no clear master plan was in evidence, ICT was applied in an uncoordinated manner, and greater efforts were needed to cement collaboration among a broad range of stakeholders. The latter especially was seen as an indispensable condition for achieving smart city objectives, because “a smart city is a collaborative community” (Snow et al., 2016).

Smart city development in Port of Spain is nevertheless still anticipated to deliver significant benefits with implications for city leaders and citizens. Some of the following are currently being anticipated there:

1. Generating integration which provides better information for decision-making
2. Optimizing the allocation of resources
3. Encouraging superior customer services
4. Improving public sector efficiency by creating common procedures and protocols
5. Capturing greater citizen participation on a collaborative basis facilitated by technological tools
6. Creating performance indicators for measuring, benchmarking
7. Enhancing public sector policy (IDB, 2016).

Conclusions

In the absence of a fixed definition of a smart city, this paper adopted a definition to focus the discussion by combining relevant aspects of available definitions in the literature. The definition here highlighted that people are at the core of smart cities, which invest in human and social capital, emphasize citizen collaboration, and incorporate ICTs geared to improving their citizens’ quality of life. Despite the tendency to emphasize the role of ICT and smart technological devices in gradually creating smarter cities, the narrative supported the contention that technology should not be the main focus of smart city builders. Instead, emphasis should be placed on both first securing the right leadership and then building deep collaboration among participants in an appropriate “helix-style” collaborative arrangement, whether triple, quadruple or other similar form. In attempting to create a smart city, the paper presents several lists with guidelines that can greatly assist smart city efforts, through initiatives that identify an effective leadership team, conduct analyses of challenges, implement plans efficiently, adopt wide stakeholder collaboration, and measure results.

Port of Spain is a city that is now equipped with the supporting studies and plans needed to enable its advance upon building-block steps towards having smarter city status. However, the organizational initiatives lag behind, including, first, identifying a leader, manager, and team to spearhead the project, and then developing collaboration with stakeholders on the basis of an appropriate helix arrangement. This situation has led to the current conditions, in which many key public and utility services, support facilities, and urban mobility have suffered, while urban degradation keeps it below a minimum sustainability level. Generally, the building of Port of Spain as a smart city is progressing slowly and greater stimulation of design, planning, and implementation is needed.

Cities are becoming increasingly complex and seemingly unmanageable entities. This highlights the need for a debate on the smart city model, especially in managing a city’s ICTs environment. In brief, a smart city places its residents at the center of development, incorporates ICTs into urban management, adopts coordinated thinking and strong governance, develops a collaborative implementation plan, and emphasizes competent leadership. Smart cities have an overarching

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objective to build and develop in ways that significantly improve the quality of life of citizens. This objective is linked to the city becoming more innovative, competitive, attractive, resilient, and sustainable as years go by.

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Haven Allahar has served for 25 years as an adjunct lecturer in entrepreneurship and innovation, and a coach of MBA teams' capstone projects at the Arthur Lok Jack Global School of Business of the University of the West Indies, Trinidad and Tobago. Haven has a wide academic and specialized training background in Economics (B.Sc. - Jamaica), Entrepreneurship and Management (M.A. and DBA - USA); Industrial Project Planning, Financing, and Management (UK and Poland). Haven served for over 40 years in senior management and CEO positions in companies involved in developing and managing an energy-based industrial park, SME development, urban development, and project planning and management. Haven, along with two partners, owned and operated a consulting firm for 15 years that provided project planning, design, and management services to a variety of clients in Trinidad and Tobago and the Caribbean. Haven's research interests are in broad areas of business, management, and economic development issues. His publications are available at Academia.edu and ResearchGate.

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Social Acceptance of Wind Energy in Urban Landscapes

Mika Westerlund

“*The restart of our economy needs to be green. It also needs to be equitable. It needs to be inclusive.*”

Chrystia Freeland
Finance Minister of Canada
on COVID-19 recovery plan

Although wind energy has high potential as a sustainable energy source to fight climate change, and the post COVID-19 world may require accelerated transition to renewable energy systems, many wind energy projects nevertheless face community resistance. Research on social acceptance of wind energy has increased rapidly, but understanding still lacks regarding the different types of acceptance, whether or not the acceptance correlates with demographics, and what drives acceptance of wind farms in the urban landscape. Our analysis of 2,376 residents in Helsinki, the capital of Finland, focused on the gaps in understanding and identified three groups of people: Protagonists, Centrists, and Antagonists. While Protagonists are highly positive about wind energy projects in the city, Antagonists oppose them, and Centrists adopt a middle-of-the-road approach. Further, three factors matter for social acceptance in urban landscapes: 1) distance, as residents prefer offshore wind farms to be farther away from the city’s inhabitants, 2) gender, as women are more accepting of wind energy compared with men, and outright opponents of wind energy are more likely men, and 3) participation, as residents wish to participate in decision-making processes regarding wind farms, but lack interest in having ownership of and responsibility for wind energy projects. The study discusses the implications of these findings for developers and policymakers of wind energy projects in the urban context.

Introduction

Promoting renewable energy has recently become a global priority to fight climate change (Hevia-Koch & Ladenburg, 2019; Liebe & Dobers, 2019; Sharpton et al. 2020). In particular, wind energy has been hailed as a promising clean energy technology for transition to post-fossil carbon-based societies (Caporale & De Lucia, 2015; Yuan et al., 2015; Hammami et al., 2016). News media (for example, Twidale, 2020) have reported that renewable energy has increased its share of global electricity production during the COVID-19 pandemic, thereby paving the way for a wide-scale transition away from fossil fuels to a decarbonized post-pandemic economy.

Transition to renewables such as wind energy, however, requires substantial financial investments, technical adaptation, and acceptance by the local society (Scherhaufer et al., 2017; de Araujo & de Freitas, 2008; Langer et al., 2018). Hence, there is a growing scholarly interest to study wind energy from the perspective of “social acceptance” (Hall et al., 2013; Langer et al., 2016; Rand & Hoen, 2017). Low social acceptance results in delays, public protests, cost escalation, and sometimes the obstruction of wind energy projects (D'Souza & Yiridoe, 2014; Reusswig et al., 2016; Bolwig et al., 2020), while increasing the risk of failing to reach environmental policy goals (Cohen et al., 2014). Thus, energy developers and policymakers need to understand social acceptance in order to ensure successful planning,

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implementation, and operation of wind energy systems (Jobert et al., 2007; Landeta-Manzano et al., 2018).

Public opinion polls usually show high levels of support for wind energy (Aitken, 2010; Rand & Hoen, 2017). Nevertheless, various factors, including socio-demographic characteristics such as age and gender, may affect the social acceptance of adopting renewable energy systems (Johansen & Emborg, 2018). For example, older groups and women are found to have lower acceptance of wind farms (Azarova et al., 2019; Ólafsdóttir & Sæþórsdóttir, 2019). According to Caporale and De Lucia (2015), women may be more sensitive to the aesthetic impact of wind farms to landscape; thus, the perceived impacts of wind farms on landscape warrant more research from the perspective of gender. On the other hand, Hoen et al. (2019) did not find support for the gender argument, and Liebe et al. (2017) suggest that the correlation between gender and wind energy acceptance varies by region. Nonetheless, the visual impacts of wind energy systems seem to be a common factor across regions and socio-demographic groups (de Araujo & de Freitas, 2008; Firestone et al., 2018; Hallan & Gonzalez, 2020). Further, since much of the research on wind energy acceptance focuses on rural areas (Khorsand et al. 2015; Lienhoop, 2018; Gebreslassie, 2020), more understanding is still needed in urban contexts (Zaunbrecher & Ziefle, 2016).

The objectives of this study of wind farms in urban landscapes are to investigate, 1) the types of social acceptance, 2) whether acceptance correlates with gender, and 3) what drives social acceptance. The study applies explorative, quantitative research methods on a publicly available survey data set derived from an open data service in Finland. The analyzed data include 2,376 responses from Helsinki, the capital of Finland, to a survey about residents' perceptions of (hypothetical) wind farms in the city's landscape. In so doing, the study identifies different groups of people (for example, based on gender) that vary by acceptance, and discusses the key factors that matter for social acceptance of wind energy systems in urban landscapes. The results contribute to the extant literature on social acceptance of renewable energy systems (for example, Reusswig et al., 2016; Rand & Hoen, 2017; Giordono et al., 2018; Bolwig et al., 2020; Leiren et al., 2020) by providing further evidence from the urban context regarding three highly debated areas in wind energy acceptance, namely a) the distance of wind farms from the city's inhabited coastal areas, b) the role of gender in acceptance, and c) the relevance of citizen participation in wind energy projects.

The paper is structured as follows. After this introduction, the paper reviews literature on social acceptance of wind energy and the visual impacts of wind energy systems on urban landscapes. The paper then describes the data and methods of analysis. Thereafter, it provides results from quantitative analyses, and, finally, concludes with a discussion on key findings, their contributions to theory and practice, as well as limitations and future research avenues.

Literature review

Definition and levels of social acceptance

Scholarly interest in "social acceptance" emerged in the 1980s when renewable energy developers noticed that the implementation of wind farms was facing notable opposition in communities, although the surveys conducted had suggested high levels of support (Wüstenhagen et al., 2007; Bolwig et al., 2020). Since then, it has become apparent that people can "accept" wind power, while it does not mean at the same time that they "support" installing wind farms in their city (Khorsand et al., 2015; Enevoldsen & Sovacool, 2016). Dermont et al. (2017) distinguish between "acceptability" (characteristic), "acceptance" (passive behaviour), and "support" (active behavior) for positive behaviour toward renewable energy technologies. Similarly to the negative, Friedl and Reichl (2016) label the opposing behaviour as "rejection" (passive behaviour that does not lead to taking action) and "resistance" (active behaviour, such as protesting or not using a technology). In this paper, social acceptance is defined as "the lack of noticeable opposition and active resistance, and the abundance of passive tolerance and positive attitudes, leading to support from majority for adopting low-carbon technology in a community" (Cohen et al., 2014; Khorsand et al., 2015; Wolsink, 2018).

While social acceptance can be examined at various levels, including macro (country), meso (city), or micro (individual) (Upham et al., 2015), it cannot be explained by any single factor. Rather, social acceptance combines individual and collective preferences that are rooted with economic, political, cultural, linguistic, and other social aspects (Scherhaufer et al., 2017). Further, Azarova et al. (2019) argue that social acceptance of renewable energy is not only about accepting a specific energy technology, or locally installing it, but also about the acceptance of administrative, technological, and social elements that come with it. Nevertheless, most studies

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Table 1. Factors affecting acceptance of wind energy

Factor	Examples	References
Social	Social interaction; potential conflicts with others in the community; impact on the social image and attractiveness of the community; social welfare; community ties and trust toward unfamiliar actors such as energy developers; perception of peer acceptance of wind energy	Sovacool & Ratan (2012), Hall et al. (2013), Yuan et al. (2015), Walker et al. (2018), Suškevičs et al. (2019), Diogenes et al. (2020)
Environmental	Ecological change versus green benefits; adverse impacts of wind turbines on biodiversity (flora and fauna, wildlife, including felling of trees and hazards of turbine blades to birds); impacts on cliffs and other natural formations; recyclability of metals and parts used in wind turbines	Enevoldsen & Sovacool (2016), Zaunbrecher & Ziefle (2016), Rand & Hoen (2017), Roddis et al. (2018), Suškevičs et al. (2019), Bolwig et al. (2020), Caporale et al. (2020), Jørgensen et al. (2020)
Economic	Installation and maintenance costs; economic feasibility; financial situation of the community; foreign direct investments; increased employment opportunities; impacts on tourism; consumer costs vs. monetary compensation and government subsidies; negative impact on property values; energy price; impact on taxes	Khorsand et al. (2015), Spiess et al. (2015), Yuan et al. (2015), Enevoldsen & Sovacool (2016), Bhowmik et al. (2018), Roddis et al. (2018), Hoen et al. (2019), Ólafsdóttir & Sæþórsdóttir (2019), Bolwig et al. (2020), Caporale et al. (2020), Diogenes et al. (2020), Jørgensen et al. (2020), Kim et al. (2020), Leiren et al. (2020)
Technical	Operational life of the system; performance and functional efficiency; reliability, capacity and energy supply security; system constraints; need for transmission lines and pylons; changes in grid infrastructure; distance of turbines to residence; physical appearance such as the design, type of movement, and the size of turbines; number of turbines in the area; interference with TV, radio, or mobile communications	Spiess et al. (2015), Westerberg et al. (2015), Enevoldsen & Sovacool (2016), Langer et al. (2016), Zaunbrecher & Ziefle (2016), Bhowmik et al. (2018), Landeta-Manzano et al. (2018), Langer et al. (2018), Roddis et al. (2018), Hoen et al. (2019), Caporale et al. (2020), Diogenes et al. (2020), Leiren et al. (2020)
Institutional	Political commitment; favorable regulations and legal frameworks; sufficient information sharing; transparency of governmental institutions and processes; prevalence or lack of innovative culture; engagement of local actors; public involvement in decision-making; perceived distributional fairness (how well the benefits, risks and costs are distributed within the community), procedural justice (how open, fair and unbiased the decision-making and planning processes are)	Sovacool & Ratan (2012), Hall et al. (2013), Cohen et al. (2014), Walker et al. (2014), Khorsand et al. (2015), Langer et al. (2016), Scherhaufer et al. (2017), Sonnberger & Ruddat (2017), Johansen & Emborg (2018), Hoen et al. (2019), Vuichard et al. (2019), Bolwig et al. (2020), Caporale et al. (2020), Diogenes et al. (2020), Jørgensen et al. (2020)
Health	Noise and acoustic pollution; infrasound; non-ionizing radiation; physiological health effects (e.g., headaches and dizziness), psychological health effects (sleep disturbances and stress from potential long-term health risks, annoyance from flickering and shadowing), safety concerns such as falling ice	Songsore & Buzzelli (2014), Khorsand et al. (2015), Langer et al. (2016), Landeta-Manzano et al. (2018), Langer et al. (2018), Ferreira et al. (2019), Hoen et al. (2019), Kim & Chung (2019), Bolwig et al. (2020), Jørgensen et al. (2020), Leiren et al. (2020)
Contextual	Place-related visual impacts in terms of aesthetics and visual appearance of the turbines; visibility of the turbines at place of residence; visual intrusion of the view; land occupation needed for the project; place identity and attachment, altered landscapes, and landscape destruction	Jobert et al. (2007), Hall et al. (2013), D'Souza & Yiridoe (2014), Khorsand et al. (2015), Enevoldsen & Sovacool (2016), Langer et al. (2016), Zaunbrecher & Ziefle (2016), Langer et al. (2017), Rand & Hoen (2017), Langer et al. (2018), Ferreira et al. (2019), Hevia-Koch & Ladenburg (2019), Hoen et al. (2019), Kim & Chung (2019), Bolwig et al. (2020), Caporale et al. (2020), Diogenes et al. (2020), Jørgensen et al. (2020), Leiren et al. (2020)

on renewable energy investigate social acceptance broadly as either "general acceptance", measuring general public attitudes toward a new energy technology, or as "local acceptance", focusing on specific situations where a local community is faced with installing a renewable energy system in their habitat (Emmerich et al., 2020). Studies that combine both are valuable because, while social acceptance affects the realization of national renewable energy policy targets (Bhowmik et al., 2018), it matters especially at the local level regarding site-related decisions for residents and city planners.

Previous literature on social acceptance of renewable energy systems (for example, Wüstenhagen et al., 2007; Sovacool & Ratan, 2012; Caporale & De Lucia, 2015; Hammami et al., 2016; Landeta-Manzano et al., 2018; Rand & Hoen, 2017; Roddis et al., 2018; Bolwig et al., 2020; Devine-Wright & Wiersma, 2020) suggests that social acceptance has three dimensions: 1) "Market acceptance" concerning investment needs, opportunities, and profits for investors, project developers, energy-suppliers, utilities and grid-owners, as well as changes in electricity costs for consumers and businesses. 2) "Socio-political acceptance" in terms of opinions of the energy technology as acceptable and useful, as well as the tone of the debate in the national media, politics, and public institutions. 3) "Community acceptance" including the activity and opinions of people and businesses living, working, and operating in the environment of specific energy projects and technology installations, who must therefore bear most of the direct external impacts.

Given that COVID-19 has pushed governments across the globe to stress the role of environmental sustainability in their economic recovery and growth plans (BNN Bloomberg, 2020; Janse & Tsanova, 2020), it is now more than ever important to understand the factors that affect social acceptance or rejection of renewable energy.

Factors affecting social acceptance or rejection of wind energy systems

In general, social acceptance is affected by "perceived effects" (the risks, costs, and benefits of implementing renewable energy systems), as well as "perceived problems" (the adverse effects of relying on "traditional" energy sources). Such issues include CO_2 emissions, waning fossil fuel reserves, and the risks of adopting nuclear power (Huijts et al., 2012; Walker et al., 2014; Gaede & Rowlands, 2018). That said, general public opinion about wind energy has been typically positive (Ferreira et al. 2019; Hoen et al., 2019), while local opposition usually tends to hinge upon the selection of a particular site for wind farms (Caporale et al., 2020). Even though this paradox is sometimes explained with the increasingly unpopular concept of NIMBY ("Not In My Backyard"), which refers to one's own self-interests, it is likely more related to "place-protective" attitudes, associated with "place identity" and the emotions that connect people with particular places (Jami & Walsh, 2017; Kim & Chung, 2019).

In any case, more affects the acceptance of wind energy than a mere comparison of costs and benefits or one's self-interests. Previous research has identified various factors that influence the acceptance of wind energy systems: 1) social, 2) environmental, 3) economic, 4) technical, 5) institutional, 6) health, and 7) contextual. To provide a compact reference that has resulted from this research, Table 1 lists examples of these factors along with literature references.

Visual impacts of wind farms on the urban landscape

Wüstenhagen et al. (2007) argue that the impact of wind energy systems on local landscape is central for social acceptance. Landscape is defined as "a natural resource that provides social use and non-use benefits, and that has economic (land value) and non-economic (aesthetic) value to people" (Caporale & De Lucia, 2015; Roddis et al., 2018). Indeed, Diogenes et al. (2020) and Spiess et al. (2015) note that concerns over visual impacts have surfaced as a primary reason for wind energy objections due to both economic value and aesthetic value reasons. Wind farms tend to turn a place of "romantic and unspoilt nature" into having the appearance of an "industrial space with artificial, mechanical and urban character" (Kim & Chung, 2019; Ólafsdóttir & Sæþórsdóttir, 2019). That said, after wind farm installation, communities often perceive that the wind turbines actually did not damage the scenic beauty of the area (Gebreslassie, 2020), and that turbines and their blades may even be perceived as aesthetically pleasant, creating a "postcard-like" landscape, thus having positive visual impacts (Kongprasit et al., 2017; Rand & Hoen, 2017; Firestone et al., 2018).

Urban residents seem to be more supportive of wind energy than rural residents (Yuan et al., 2015), although acceptance decreases if wind turbines are installed nearby peoples' homes (Guo et al., 2015). That said, while a correlation between low acceptance and close proximity of wind farms to people's homes has been

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suggested time and again, empirical evidence to prove this "proximity hypothesis" remains unconvincing (Harper et al., 2019; Hoen et al., 2019). Nonetheless, while remote off-shore installations may be more accepted than those nearby peoples' homes, due to limited visual and auditory impacts, the trade-off people face is higher financial requirements as a result of spatial distance and lack of grid connection (Devine-Wright & Wiersma, 2020; Hall et al., 2013). Further, offshore windfarms have visual impacts on the seascape, especially from the perspective of recreational activities such as boating and yachting, as well as posing various environmental risks to birds and marine life from noise and vibration (Haggett, 2011; Guo et al., 2015; Westerberg et al., 2015; Kim et al., 2019). Thus, directly engaging local communities is essential to avoid long or failed planning processes, for both onshore and offshore wind power (Haggett, 2011; Bolwig et al., 2020; Lamy et al., 2020).

Method

Data collection
This study makes use of publicly available data from the "Wind Power Survey for Helsinki 2015", which was collected in Helsinki, Finland. The data set was obtained from the open data service "Helsinki Region Infoshare" (https://hri.fi/) under the Creative Commons Attribution 4.0 (CC-BY-4.0) license. The data set's maintainer is "Helsingin kaupunkiympäristön toimiala / Maankäytön yleissuunnittelu".

According to Sonnberger and Ruddat (2017), representative random samples, such as survey data in the present study, make a beneficial method for analyzing social acceptance of renewable energy. When investigating social acceptance of wind energy in the Finnish context, Jung et al. (2016) pointed out that Finland is among the top European Union member states in terms of using renewable energy sources, and is solidly on track to increase the share of renewables in order to reach both national and European Union's climate and energy targets. The Finnish government has agreed on a supplementary budget proposal for 2020 as part of its COVID-19 recovery package, in an effort to ensure "an economically, ecologically and socially sustainable emergence from the crisis", that aims to make "Finland the world's first carbon-neutral welfare state" (Evans & Gabbatis, 2020).

The social context for this budgetary policy making situation in Finland is that the climate change hypothesis is largely accepted by Finnish people, while public attitudes toward both solar energy and wind energy are generally positive (Jung et al., 2016). A recent study by Suškevičs et al. (2019) shows that residents in Northern Europe, including those in Finland, have little concerns about the impacts of wind farms on their regional public image, but that instead people are concerned about visual impacts on their local landscape.

The initial data set contained anonymous responses from 2,426 respondents to an open online survey conducted in 2015. The survey focused on the social acceptance of wind energy in Helsinki, the capital and most populous city of Finland. Helsinki is in the south coast of the country, and has a population of 650,000 people, totaling 1.3 million people if including the city's urban area (Wikipedia, 2020). The vast majority (86%) of respondents identified themselves as residents of Helsinki, while the rest did not identify their residence or were non-residents in the city (Helsingin kaupunki, 2015). Of note, Johansen (2019) found that residency influences place attachment and, therefore, people's perceptions of landscape change due to wind farm installations.

The survey included a total of 14 questions on citizen attitudes in four areas, indicated with a letter from A through D, along with the number of questions in the results section of this study:

> *A) What should Helsinki city do regarding wind energy?*
>
> *B) What kinds of effects would wind farms have on the city's image and landscape?*
>
> *C) Visibility and proper distance of wind turbines from the city's inhabited areas*
>
> *D) Respondent's willingness to participate in decision*-making, consumption, and investments in wind energy.

Data analysis
To understand the relationship between demographics and social acceptance of wind energy in urban landscapes, only respondents who provided information on their gender were included. The final data set included 2,376 respondents of which 903 (38%) were female and 1,473 (62%) were male. This is like the gender distribution in many other survey-based studies on social acceptance of sustainable energy; for example,

Table 2. Wind energy acceptance in Helsinki by gender

		Female	Male	df	t-value, sig.
	The city should… (1=totally disagree, 5= totally agree)				
A01	… be an example in reducing CO2 gases	M =4.67, SD=0.93	M=4.15, SD=1.43	2364.86	10.719, p<0.001
A02	… produce wind power locally	M=4.40, SD=1.23	M=3.88, SD=1.64	2283.69	8.843, p<0.001
	Wind turbines would have a positive effect on … (1=totally disagree, 5= totally agree)				
B01	… the city's image	M=4.44, SD=1.21	M=3.90, SD=1.61	2282.05	9.418, p<0.001
B02	… the city's landscape	M=3.73, SD=1.41	M=3.33, SD=1.66	2140.05	6.285, p<0.001
	Attitude toward having wind turbines in the city if they are…. (1=very negative, 5= very positive)				
C01	… visible from the city's shipping lanes	M=4.40, SD=1.15	M=3.90, SD=1.54	2283.15	9.001, p<0.001
C02	… visible from the city's world heritage site	M=3.97, SD=1.38	M=3.53, SD=1.66	2172.55	7.076, p<0.001
C03	… built within the city's harbour area	M=4.43, SD=1.18	M=3.82, SD=1.61	2302.08	10.628, p<0.001
C04	… built on the city's landfill areas	M=4.24, SD=1.27	M=3.73, SD=1.61	2225.40	8.615, p<0.001
C05	… built within 8-10 km from the city's shore	M=4.37, SD=1.20	M=3.90, SD=1.59	2272.48	8.285, p<0.001
C06	… built within 4-5 km from the city's shore	M=3.73, SD=1.44	M=3.44, SD=1.65	2106.69	4.731, p<0.001
C07	… built within 1-2 km from the city's shore	M=3.50, SD=1.54	M=3.14, SD=1.69	2036.22	5.214, p<0.001
	How willing are you to … (1=totally disagree, 5= totally agree)				
D01	… influence on the location of wind turbines	M=3.86, SD=1.15	M=4.10, SD=1.14	2374.00	-4.876, p<0.001
D02	… buy locally produced wind power	M=3.98, SD=1.36	M=3.28, SD=1.68	2201.52	10.991, p<0.001
D03	… become a private investor in wind power	M=2.93, SD=1.36	M=2.93, SD=1.56	2099.43	-0.071, p=0.943

approximately a 40% female-60% male proportion in Bhowmik et al. (2018), Guo et al. (2015), and Langer et al. (2017). However, according to Helsingin kaupunginkanslia (2020), the population of Helsinki in 2015 was 53% female-47% male, thus suggesting that the sample has male dominance compared with the city's actual gender distribution. An equal split analysis of data to examine gender prevalence among early and late respondents did not suggest any selection bias ($p=0.22$).

The analysis here follows a recommendation by Bhowmik et al. (2018) to apply explorative techniques as a preferred approach to analyzing survey data in the social acceptance context. The data used for this study originally comprised responses to a number of attitudinal questions, measured on a 5-point Likert scale, where -2 equaled to "totally disagree" or "very negative" and +2 represented "totally agree" or "very positive". For the purposes of this study, the responses were rescaled to a range of 1 through 5, to follow standard reporting style in academic research. The Likert-scale enabled this research to analyze the data using various explorative techniques, including t-tests for overall differences in means between men and women, cluster analysis for identifying several types of groups by their acceptance of wind energy, and cross-tabulation for analyzing whether these groups vary by their gender distribution.

Results

An independent samples t-test analysis showed that women were more positive than men regarding all questions except their interest to participate in decision-making and become private investors in wind energy. In respect to these two questions, women were less interested to participate than men, and there was no difference between the genders in terms of their investment willingness. Overall, both women and men were positive about installing wind energy farms in Helsinki, but neither of the genders was in the majority willing to become investors in such projects.

Although visibility of wind turbines from the city's inhabited areas was not deemed a major issue, both genders clearly preferred offshore turbines located farther away from the shore, suggesting that distance matters for the social acceptance of wind farms in urban contexts. Further, acceptance of having wind turbines near a city's world heritage site was clearly lower across both genders than if the turbines were installed in a more industrial area, such as the city's harbour or landfill areas (Table 2).

Next, we performed a K-means cluster analysis to identify groups of people in the sample by their type of wind energy social acceptance. K-means is a non-hierarchical clustering method in which the number of clusters has to be determined in advance (Steinley, 2006). After performing the analysis repeatedly with the number of clusters ranging from two to five, a three-cluster solution was selected because it was reasonably balanced, easy to interpret, and theoretically meaningful. Each cluster was labeled in a manner that was deemed to best describe its characteristics. The three groups from the cluster analysis were labeled as 1) "Protagonists", which represented more than half of respondents, 2) "Centrists", and 3) "Antagonists". The latter two accounted fairly equally for the remainder of the sample's respondents. As table 3 illustrates, these three clusters varied significantly from each other.

"Protagonists" (Cluster 1) comprise people who show highly positive attitudes toward wind power. High values in all variables (M=4.71, SD=0.47) suggest that "Protagonists" think positively of having wind farms in their city, and that doing so would have a favourable effect on the city's image and landscape. They strongly promote the idea that their city should provide locally produced wind power, and lead by example in reducing carbon dioxide emissions. Further, "Protagonists" are not ignorant of the best locations for wind power, but rather accept wind turbines both offshore and onshore, including highly visible locations in and around the city, and even the world heritage site on nearby islands in front of the city's harbor area. "Protagonists" would also like to influence decision making in regard to the location of placement for wind turbines, and would like to consume locally-produced wind power even if it was more expensive than alternatives, as well invest financially in wind power at the personal level.

"Centrists" (Cluster 2) are people who, similarly to cluster 1, have a generally positive attitude toward wind power, and consider it as a great way to improve the city's image, especially if the city provides an example to others by reducing CO_2 emissions. However, "Centrists" take a middle-of-the-road approach (M=3.57, SD=0.76) by being more conservative when it comes to the effects of wind turbines on the city's landscape. They are clearly

Table 3. Clusters and their characteristics

	Protagonists (Cluster 1)	**Centrists** (Cluster 2)	**Antagonists** (Cluster 3)
	n=1342 (56.5%)	n=550 (23.1%)	n=484 (20.4%)
A01	5	5	2
A02	5	4	1
B01	5	4	1
B02	5	3	1
C01	5	4	2
C02	5	3	1
C03	5	4	2
C04	5	4	2
C05	5	4	2
C06	5	3	1
C07	4	2	1
D01	4	4	4
D02	4	3	1
D03	4	3	1
Mean	*4.71*	*3.57*	*1.57*
SD	*0.47*	*0.76*	*0.85*

pickier than "Protagonists" in regard to the locations for wind farms and are in favour of installing wind turbines farther offshore or on the city's landfill areas, or other less visible on-shore areas around the city. Further, "Centrists" are less prone to consume only locally-produced wind energy given that it would be more expensive that alternatives, and less willing to personally invest in wind power projects. However, similar to "Protagonists", they are willing to participate in decision making regarding the location of wind turbine installments in and around the city.

"Antagonists" (Cluster 3) consist of people who are quite opposite to the other clusters regarding wind energy prospects (M=1.57, SD=0.85). Put briefly, "Antagonists" are against the idea that Helsinki should build local wind power plants, and that having wind farms in the city's area would have positive effects on the city's image or landscape, especially when it comes to wind farm locations closer to the city's inhabited and other visible, non-industrial areas. They are rather against having wind turbines anywhere in the city, and would not consume locally-produced wind energy if cheaper alternatives are present, nor are they willing to invest in wind power projects at the personal level. "Antagonists" would however, equal to their counterparts in the other clusters, be interested to participate in decision-making regarding the location of wind turbines in the city. Of note, "Antagonists" were the smallest cluster, representing a mere one-fifth of the sample, whereas "Protagonists" represented more than half of respondents in the sample. Figure 1 illustrates the differences in cluster profiles between the three groups.

Finally, we cross-tabulated the data to find out if the three clusters differed from each other in terms of gender distribution. We used Pearson's Chi-Square ($\chi 2$) to test for statistically significant differences between observed and expected frequencies in gender distribution between the groups. This test excluded the possibility that any differences would arise by chance.

Table 4 suggests that the three clusters differ in terms of their gender distribution ($\chi 2$ [2, 2376] = 77.83, $p<0.001$). Bearing in mind that the gender distribution of the sample was 38% female and 62% male, the differences between the clusters become quite explicit. Both "Protagonists" (42% female, 58% male) and "Centrists" (43% female, 57% male) include more women and fewer men than expected. Overall, almost 90 percent of all females in the sample fall into "Protagonists" and "Centrists", the two clusters that reflect positive or more positive views toward having wind energy in and around the city. Conversely, "Antagonists", who are characterized by negative or more negative attitudes toward wind energy, include significantly more men than women (21% female, 79% male), making the cluster distinctively male-dominated compared with the other clusters. While 20% of respondents in the whole sample represent "Antagonists", a total of 26% of all males in the sample fall into this cluster.

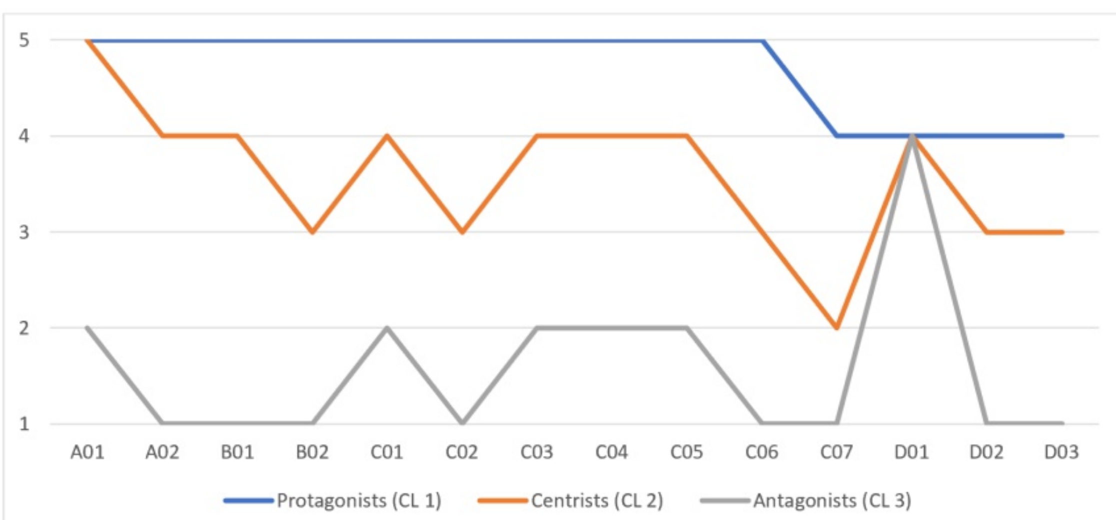

Figure 1. Illustration of cluster profiles

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Table 4. Gender distribution within clusters

Gender	N	Protagonists (CL 1)	Centrists (CL 2)	Antagonists (CL 3)	χ^2
Female	903	565/510 (62.6%, 42.1%)	238/209 (26.4%, 43.3%)	100/184 (11.1%, 20.7%	77.83 *
Male	1,473	777/832 (52.7%, 57.9%)	312/341 (21.2%, 56.7%)	384/300 (26.1%, 79.3%)	

Note: observed/expected value, (% within gender, % within cluster), N=2376, df=2, * p<0.001

Discussion

This study has aimed to understand the different types of social acceptance, whether acceptance correlates with demographics, and what drives social acceptance of wind farms in urban landscapes. The analysis based on open sourced survey data from 2,376 residents in Helsinki, Finland, identified three groups of people by their acceptance or rejection of wind energy systems: “Protagonists”, “Centrists”, and “Antagonists”. These groups represent different types of social acceptance. “Protagonists” have highly supportive and positive attitudes toward wind energy. “Centrists“ also adopting a positive but more moderate approach. “Antagonists” show explicitly negative and oppositional attitudes to wind energy.

While women were predominantly represented among “Protagonists” and “Centrists”, the opposing group of “Antagonists” was distinctively male-dominated. The three groups differed on almost every investigated factor, while all of them wanted to participate in decision-making processes related to wind energy projects in and around the city. Overall, three factors seem to matter for social acceptance of wind farms in urban landscapes: 1) distance of wind farms from inhabited coastal areas, 2) demographics in terms of gender, and 3) willingness to participate in decision-making processes related to wind energy projects.

Contributions to theory and practice

These results contribute to theory in several ways. First, the study contributes to the literature on social acceptance by showing once again that distance matters in wind energy acceptance. The farther wind farms are located away from inhabited coastal areas, the more accepting people are of them. Of note, the increased distance in this study was associated with installing offshore, rather than onshore wind turbines. Previous literature (for example, Harper et al., 2019; Hoen et al., 2019) only provided weak or controversial evidence on the role of distance in wind energy acceptance. This study thus provides empirical support for the “proximity hypothesis”, while keeping in mind Leiren et al.’s (2020) argument that distance itself does not matter, but rather that reducing the visual impact by increasing distance and visual awareness of the wind farms does. Also, the study partially validates previous literature that suggested the proximity of wind farms to protected areas and areas with high environmental, historical, or archaeological value are less accepted (Cohen et al., 2014; Leiren et al., 2020). In the present study, location of wind farms near the city’s world heritage site was also not surprisingly less accepted than installing turbines in more industrial areas, such as nearer to the harbour.

Second, the results contribute to the debate on social acceptance by showing that gender demographics matter for wind energy acceptance. In the Finnish urban context, women come out as more supportive of wind energy than men. In this vein, the results here are in marked contrast with arguments by, for example, Azarova et al. (2019) and Ólafsdóttir and Sæþórsdóttir (2019), who found that women are less accepting of wind energy compared with men. In this research sample, the results were quite the opposite, and women were overrepresented in both clusters that support adoption of wind energy systems, as well as underrepresented in the cluster that opposes wind energy. Further, these results suggest that women are not significantly different from men in terms of having a (somewhat low) willingness to invest in wind energy. Notably, urban residents, in general, had higher investment willingness associated with their attitudes toward wind energy. Again, this finding contrasts with some previous literature. For example, Johansen and Emborg (2018) found that, overall, men are more willing to invest in sustainable energy systems, either to support sustainable energy or for economic gains. The specific motivational differences across genders were not covered by the current study.

Third, the results contribute to the literature on general social acceptance by confirming that there are different

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types of acceptance, in this case with respect to wind energy. While previous literature tends to make a dichotomous distinction between proponents and opponents of wind energy, our results support the arguments by, for example, Aitken (2010) and Khorsand et al. (2015), who suggest that there are more nuanced distinctions between the dichotomies. In this sense, our results are in line with Gross (2007), who argued that there are three kinds of people in terms of their attitude toward wind energy (positive, neutral or negative), and Langer et al. (2018), who proposed three acceptance modes (active acceptance, ambivalence, active non-acceptance). Interestingly, our results suggest that the differences between the three groups are quite distinctive in all but one factor: willingness to participate in wind energy planning processes. This finding is novel in that it suggests all groups, including "Centrists", are quite certain about their opinions in the sense of being willing to actively influence public decision-making.

In terms of contributions to practice, in line with previous research (Bolwig et al., 2020; Giordono et al., 2018; Zaunbrecher & Ziefle, 2016), the research suggests open consultation with the community, including transparent, comprehensive, and participatory processes in renewable energy projects can contribute to social acceptance, while a lack of such processes when discussing energy and the environment can contribute to conflicts. Renewable energy developers and policy-makers should ensure that such participatory planning engages all members of community, including those who oppose wind energy. In fact, opponents of wind energy should be specifically addressed, not to mitigate their opposition by changing "wrong" attitudes into "right" attitudes, but rather because they may be asking for different types of "exchanges" than the rest of the community (Aitken, 2010; Groth & Vogt, 2014).

For example, objectors tend to emphasize aesthetics compared to supporters of wind energy (Groth & Vogt, 2014; Enevoldsen & Sovacool, 2016). Hence, in order to increase social acceptance of wind energy systems in urban landscapes, energy developers and policy makers are advised to focus on finding ways to reduce the visual impacts of wind farms, rather than providing an unlikely community with increased opportunities to invest in wind energy projects. The possibilities for innovative transformation have become a topical notion as we live now during a pandemic, and hopefully soon shift to a post-COVID-19 world, where governments across the globe are planning to boost de-carbonization of their economies, in order to increase both human societal and environmental welfare.

Limitations and Future Research

This kind of open data research puts forward various challenges. First, the data has limitations given the fact that the survey was not designed, nor was the data collected by the author of this research paper. Wolsink (2018) emphasizes that, social acceptance being a set of processes, a researcher should examine all dimensions of social acceptance simultaneously, in order to understand the acceptance processes. In the present data set, the focus was on community acceptance and, thus, not all dimensions of social acceptance such as market and socio-political acceptance were covered. This is likely due to the specific research objectives of the City of Helsinki at the time of conducting their survey.

Second, previous research (for example, Aitken, 2010; Cohen et al., 2014; Enevoldsen & Sonacool, 2016; Harper et al., 2019) has noted that in addition to socio-demographical factors, people's knowledge and experience of a technology also matters. Those without having had any experience with wind energy are more likely to oppose it. In contrast, this study relied on anonymous survey responses collected through an open online survey and published as open data. The data lacked information about respondents' level of knowledge and experience about wind energy technology, such as their political views, environmental self-identity, education, income, marital status, length of residence, and so forth.

Third, the survey covered visual impacts of wind farms, but did not utilize visual exposure to the spatial location of wind farms. Visual exposure, such as showing the respondents still images of wind turbines inserted into real photographs of their city, can influence social acceptance responses (Westerberg et al., 2015; Hevia-Koch & Ladenburg, 2019; Cranmer et al., 2020).

Future research should focus on the role of "place identity" (Hallan & Gonzalez, 2020) in social acceptance of wind energy. Likewise, it should examine place-related and other "deeper" values (Hammami et al., 2016) that people have, which can affect social acceptance or rejection of wind energy in an urban community. Research that advances further should investigate the connection between place identity and perceived visual impacts in the urban landscape.

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Social Acceptance of Wind Energy in Urban Landscapes

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