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## Book of Abstracts



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**Management of technology in developing countries / 5****The Technological Development of Cloud Computing Industry in China****Author(s):** Ms. YIN, Conghui<sup>1</sup>**Co-author(s):** Mr. YU, Xiang<sup>1</sup><sup>1</sup> *Chinese-German Institute for Intellectual Property, School of Management, HuaZhong University of Science and Technology***Corresponding Author(s):** yinconghui@126.com

Cloud computing is major technological revolution which represents the future development of ICT industry. It has gained vast attention and been actively promoted by governments, enterprises, research institutions and industry alliances around the world due to its technological advancement and availability. This study seeks to investigate the technological trends, competition status, key technologies and regional distribution of cloud computing industry in China based on patent analysis, including inventor analysis, assignee analysis, citation analysis and IPC analysis. An innovative cooperation network is established to further analyze the cooperative relationship between patent owners by using a social network analysis tool-UCIENT software. On this basis, the R&D strategies and technological strength of two major Chinese enterprises, namely Huawei technologies and ZTE Corporation, are studied and compared to indicate the strength and weakness of Chinese enterprise's process in developing cloud computing technologies. According to the research results, several suggestions are put forward to guide an in-depth layout blueprint of cloud computing industry development in China. The findings of this study are expected to provide valuable references for enterprises to develop cloud computing technologies and for government to make decisions. Key words: Cloud computing, technological development, patent analysis, social network analysis, suggestions

**Future thinking, strategy development, and theory of technology / 6****Technology Disruption for Development and Peace****Author(s):** Mr. AZZAM, Mohamed<sup>1</sup>**Co-author(s):** Mr. SAMI, Nezar<sup>2</sup> ; Prof. KHALIL, Tarek<sup>2</sup><sup>1</sup> *Federation of the Egyptian Chambers of Commerce, IT General Division*<sup>2</sup> *Nile University***Corresponding Author(s):** mohamed.azzam@nileu.edu.eg

Everything is going digital around us! Disruptive technologies and their disruptive use models are creating a new world and a different future. Over the last few years, the creation and utilization of technologies have played a critical role to improve the life quality of people, advance economies, and open new horizons for individuals, businesses, and even nations around the world. This is the bright side! On the other side, the world is experiencing nowadays exceptional technology disruption that has triggered an enormous change; a change that is behind the classical control of the governments and local authorities, and fueled by ongoing nonstop innovation and substantial evolution in the means people employ technology. Governments are usually are not aware of these disruption and its effects; even if they are aware, the structure of most governments is not agile enough to deal with such disruptions and governments are not fully taking advantages for such disruption to progress their nations and the whole world on the social and economic levels. Technology disruption is affecting seriously the markets, the governments, the organizations, the financial markets and the employment, so consequently is affecting the lives of the people. In other words, technology is disrupting the classical models on the economic, political and social levels. This is happening at a pace that could lead to an unprecedented advancement coupled with a complete chaos. Therefore, the role of the management of technology has become more vital and critical than ever. A role that should be seriously considered while thinking of the future model of governments. Based on that, the paper outlines the major technological trends, such as Artificial Intelligence (AI), Cognitive Machines, Drones, and Mesh Computing, and their possible effect on the economic, political and social levels. Also, the paper draws the future role of the management of technology, as well as the future model of government, in this regards to maximize the positive impact of the technological disruption and minimize the chances that could lead to the chaos. The approach used in the paper is based on thorough analysis of the reports issued by

international institutions in the areas of technological disruption and its effect, desk research, and interviews with key personnel in the government, Business Representative Organizations (BROs), NGOs and private sector, in addition to youth, startups and entrepreneurs.

**Technology management and competitiveness in the globalized world / 7**

## **Total Cost of Ownership – a Strategic Sourcing Intent**

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Organisational market competitiveness goes beyond reengineering and continuous improvement initiatives on supply chain processes. It requires that organisations should seek and adopt Total Cost of Ownership (TCO) which is designed to deliver a beyond price-based outlook upon sourcing decisions, TCO allows that all possible costs elements incurable during the acquired services and / or products' life cycle are fully accounted, outlined and considered accordingly. This study evaluates and analyse the common perceptions towards the widespread adoption of the TCO concept by organisations' key acquisitions decision-makers. Further evaluating the overall implications of adopting TCO towards strategic sourcing objectives to enable organisations' key bottom-lines for market competitiveness, sourcing process effectiveness, and cost savings. The study's empirical findings highlight the prevalence of quality and reliability of the suppliers' offering and its capability to adequately meet the purchaser's stipulated requirements over other considered parameters upon supplier selection. Notably is the dominance of lower price preferences as a major contributor to the reduction of TCO of the purchasing function leaving a loophole for non-quantified cost impacts, which is detrimental to organisational effectiveness and profitability. Conclusively, the study stresses the significance of quality and reliability in suppliers offering towards reducing the Life Cycle Cost (LCC). It also reveals how supplier-buyer relationship directly impact on the TCO strategic sourcing and thus emphasising the significance of good supplier delivery performances to the value chain. Key words: Total Cost of Ownership, Strategic sourcing, Supplier Selection, Supplier performances, Value creation.

**Technology management and competitiveness in the globalized world / 8**

## **Total Quality Management (TQM) Practices and Supply Chain Performance on Improving Organisational Performance**

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Organisations in South Africa ever more than before need Total Quality Management (TQM) in terms of organisational culture and supply chain system thinking in providing outstanding products and services to their customers. Although TQM has been proposed to improve organisational performance it is perceived that some organisations have not accomplished much over the years. Accomplishing TQM and supply chain strategy is challenging and is based on the organisational performance measures in terms of (i) Quality Improvement, (ii) Product / Service Quality, (iii) Customer Satisfaction, (iv) Employee Satisfaction and (v) Supply Chain and supplier Performance. Moreover, to remain competitive, TQM and supply chain systems thinking should be should be synchronised end-to-end. Achieving this is a complex endeavour and involves business strategy and technology which focusses on TQM and supply chain systems, within a structured business system. Current research in both manufacturing and service industries in South Africa revealed that TQM and supply chain strategy have an influence on organisational performance measures

and plays an important role in the performance and success of an organisation. This paper debates, by means of research, conducted, which is generally understood as “total systems thinking” as a basic “concept” towards TQM and supply chain strategy and is much broader than what is normally accepted in the industry. The “concept” includes synchronising every process and sub-processes where each of these factors has its own set of defined objectives, involving workflow, cut across departmental boundaries and require the input of resources from several departments within an organisation. The results of this study have a methodological significance and provided valuable information in the development of a measurement framework assisting identifying gaps that may exist between TQM and supply chain strategy. Furthermore, the results obtained from the study suggest a range of possible solutions which may assist organizations to obtain the desired TQM and supply chain performance level.

Keywords: total quality management, end-to-end, organisational performance, supply chain

## Product and service development / 10

# The New Green Transformation Performance for Technological Innovation of High Patent-Intensive Industries

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The American economist Siwek S E. first proposed the concept of "intellectual property industry", and pointed out that the patent-intensive industry is an important part of the intellectual property industry. In April 2012, the United States Department of commerce and the United States Patent and trademark office jointly issued a statistical report "Intellectual property and the United States economy", the report pointed out that the patent-intensive industry contribution rate of 5.3% for U.S. economy in 2010. In September 2013, the European Patent Office and The Office for Harmonization in the Internal Market jointly issued the report: "Intellectual Property Rights Intensive Industries: Contribution to Economic Performance and Employment in Europe" which said that patent-intensive industries accounted for 14% of the EU's GDP, and 70.6% of the export trade volume is the contribution of the patent intensive industries in 2008-2010. Following the United States and the European Union, in April 2014, China's Intellectual Property Office officially announced its latest research results: "China's regional industry patent density statistics report", which pointed out that China's high patent-intensive industry added value reached 4700000000 yuan, which is accounting for 24.3% of GDP, and created an average of 32900000 jobs per year for China in 2007-2011. Thus, high patent-intensive industry is an important carrier to promote the creation of intellectual property and support industrial transformation and upgrading, which has become the pillar of economic development of country and the key to improve its international competitiveness in the world economy, and technological innovation is the key point to enhance the competitiveness of high patent-intensive industries.

However, China is still a developing country, not a power. Whether from the industry RD investment or from the new product output value, China has a big gap with the developed countries in the world, which shows that China is not a country with strong independent innovation ability and lack of the core technology with independent intellectual property rights. At the same time, due to the extensive development of the industrialization process, China faces a series of environmental and energy issues. Especially in recent years, China has a significant impact on the severity of the haze. The situation of Sulfur dioxide emissions, industrial waste water discharge and solid waste generation is grim, and the energy consumption is in crisis. According to the forecast of the internationally renowned Millennium Research Institute, energy in the world can only be consumed in China for 74 years.

In the next few years (2016-2020), China is faced with the task which is not only to catch up on the innovation ability, also needs to protect the environment and improve the utilization efficiency of energy resources. Simply emphasizing technological innovation would change the production constraint function to create new products or improve the quality of the production mode to promote economic growth. But it may not be able to protect the environment and save resources

very well, Because the main body of innovation is enterprise, and the externality of public goods makes the enterprise may not be very concerned about the impact of a new technology, and may be more concerned about the technology whether can bring the actual economic benefits, this Make technological innovation may further damage to the environment.

As a consequence, high patent-intensive industries in urgent need of transforming and upgrading for green ecological technological innovation. How to promote the ability of independent innovation and pay attention to resource conservation and environmental friendly at the same time is a must face the urgent problem.

In this presentation, we taking into account the combination of environmental effect, random error and dynamic analysis and delving into the heterogeneity and influence mechanisms of green transformation performance of technology innovation of high-patent intensive industries from the improved method and content.

We first calculate the original green innovation performance through the traditional Malmquist index model; Secondly, the offset of sample input is separated by BCC model, and then the SFA model is used to decompose the sample input; Third, the adjusted investment amount again into the Malmquist index model to measure the performance of dynamic panel data. Thus, we not only considering the influence of environment and error factors, also overcome the Defect that three stage DEA model cannot effectively measure the dynamic change of the efficiency of the input units. Finally, test the influence mechanism of the performance by using Tobit model. The results show that green transformation performance of technology innovation which is eliminated the environmental effect and random error is significantly different; The adjusted performance is fluctuation, and the difference is obvious in each period; After the adjustment, the performance is relatively large, and the green technical level index is improved in different degrees; Enterprise scale, capital deepening, technological digestion and absorption capacity, market competition and government environmental regulation have a significant impact mechanism on the performance and each is different.

R&D Management / 14

## Identifying Potential Valuable Patents Based on Standard-Essential Patent (SEP) : The Case of HEVC

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Standard-essential patents (SEPs) refer to officially recognized patents for an industrial standard. SEPs are crucial nevertheless not all important patents related to a standard are listed as its SEPs. In this paper, we propose a method to identify potential valuable patents which are missing from a standard's SEP list. The method begins with expanding the scope of SEPs through a citation-based process. A citation network made of SEPs and their expanded patents is constructed and classified into clusters where each cluster contains patents with similar technologies. One then apply main paths analysis to the selected clusters to uncover significant patents for those technologies. The method allows us to observe potential valuable patents, crucial patent owners, and technological trends. The analysis results can be useful references for anyone who are active in SEP research and development, especially business leaders, R&D managers, or intellectual property participants who are involved in standard making and patent portfolio production. To demonstrate the methodology, we take high-efficiency video coding (HEVC) SEP portfolio (250 U.S. patents) declared by MPEG LA as the study case and use another HEVC patent portfolio declared by HEVC Advance as the benchmark sample. The results show that the proposed method is able to identify potential SEPs (not declared or not yet identified), or patents with technology partially related to the standards. Finally, we suggest an analysis plan to further extract critical patents from the potential valuable patents through supplementary information such as technology roadmaps, patent classifications, patent prosecutions, patent litigations, patent transactions, or patent licensing, etc..

Technology transfer, marketing and commercialization / 15

## An Empirical Analysis of Technology Industrialization Propensity based on Chinese Patent Data

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China has already been ranked number one in the number of patent applications in the world, however the rate of patent industrialization in China is still less than 10%. This research firstly constructs and analyzes the theoretical relevance between the two concepts of industry patent propensity and patent industrialization applicability qualitatively, thus providing a new research path towards a quantitative evaluation of patent industrialization applicability and stimulating effective implementation of patent from industrial perspective. Then, we select 829 items of Chinese National Prize for Progress in Science and Technology awarded from 2010 to 2014 as research samples of technology industrialization. The hotspots of patent technology industrialization fields and patent propensity of 36 different industries in China are drawn, traditional manufacture industries are with the highest patent industrialization applicability index while Basic materials chemistry, Textile and paper Machines, Organic fine chemistry, Pharmaceuticals, Medical technology and Semiconductors are with the lowest index. We calculate the interrelationships of the three objects in patent industrialization based on the modified triple helix model. The mutual information entropy of three different collaboration models were got and analyzed, the collaborations between research institutes and enterprises are more effective in patent industrialization in China. Finally, k-means cluster algorithm is used to evaluate and classify the applicability of patent in various industries which reveals the whole panorama of patent industrialization in China and helps patent assignees to select appropriate industrial domains for patent industrialization. This evaluation process provides an approach to stimulate the patent industrialization and to ensure a realistic-based innovation policy-making in China.

Small and medium sized enterprises and innovation / 16

## Environmental Pressures and Business Model Moderation in Innovation Performance

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**Introduction:** In this paper, we have tried to contribute to the theoretical perspective of organizational institutionalism in relation to the result of innovation organizations. We have investigated, under the conditioning of business models, the influence of environmental pressures on innovative result of industries and companies in the metal-mechanic industry that has operated in the two States of Brazil, in other words, how have business models conditioned the results of innovation in the face of environmental pressures? The study of the innovation's results is justified by its pragmatic, commercial and financial nature within organizations so that their performance can result from technical pressures for efficiency as well as from institutional pressures linked to social adequacy of organizational practices. Thus, with the theoretical framework of organizational institutionalism, it is assumed that environmental pressures, usually presented as isomorphic, contribute to an understanding of the phenomenon in question, since the literature presents them as actions that demand for compliance and legitimacy. The organizational response is represented by business model - which will be focused on efficiency or focused on innovation - that is the way of how a company behaves and relates to its main stakeholders. **Methodology:** This is a quantitative, descriptive and explanatory research; operationalized by a survey as the data collection instrument with 59 indicators. Obtained the participation of 131 companies. Data analysis was performed using statistical software (SPSS) and parametric tests in order to find explanation of the relationship among variables by acceptance or rejection of six hypotheses. **Findings:** The research findings indicated that the institutional pressures as well as the technical pressures positively influence the results of innovation. Additionally, it has been verified the existence of moderation: the greater the effects of business models centered innovation, the lower

the influences of institutional pressure on the result of innovation. Closing: In this paper, we have tried to contribute to the conference theme: small and medium enterprises and innovation. It has been proven that companies that may take the business model focused on innovation as its transaction management mechanism end up having better results of innovation individually. This indicates that the relation, the tie or link among the actors of the metal-mechanic sector becomes an analysis unit that is able to generate innovative results. With that, it migrates part of the result of innovation of the internal environment, the actions and individual skills of each industry or company for the type of existing link among the actors of the metal-mechanic sector. Therefore, an innovative transaction management (the relation, the tie, the link), involving company A with industry B, impacts the outcome of individual innovation of both actors separately.

**Small and medium sized enterprises and innovation / 17**

## Concepts Assigned to Innovation Management of Digital Consumer

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This paper presents an analysis of concepts covering the use of technology, the relationship between technological change in e-commerce and buying behavior of digital consumers. In this study, the relationship between theory and practice is derived from knowledge acquired in four research projects conducted over the past six years, with the first two in Brazil and the last two in Mexico. The first project, (2010), presented the influence of innovation, participation, attitude and experience with the internet in the purchase decision, according to the various national cultures. The second project, (2013), identified the variables of consumers' motivation to buy luxury goods through the internet, and had a mental map of consumers' motivation who use the Internet for this purpose. The third project, (2014), considered the question of the components that allows its effectiveness, including marketing retail activities and e-payments. Finally, the fourth project, (2015), reviewed the progress in the regulation of e-commerce, in addition to presenting the legal and economic impacts of this activity in a global context. As research methodology, this papers is defined as an exploratory, descriptive, and quantitative, using the Technology Index Availability (Techqual) described by Parasuraman (2000), and applied to consumers in Brazil and Mexico, highlighting four concepts: optimism, innovation, discomfort and insecurity, in order to obtain the Index of Digital Consumer Behavior Mexico-Brazil. The results are relevant for small and medium enterprises, as it can generate a better understanding of the consumer's decision making in the digital environment. Previous and current subject studies, approach the characteristics of a single dimension, and are applied in a single market. The value and originality of this work lies in its application as a comparative study between Mexico and Brazil, which have in the digital world, and between theory and practice in studies of digital consumer behavior.

**New business and investment models in the digital world / 20**

## A Conceptual Model for IT Outsourcing

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Companies engage in outsourcing when it enters a contractual agreement to source a particular expertise from another company with the intent to meet specific business objectives. In outsourcing agreements, the client transfers completely or partially the operational responsibility related to a set of processes within a specific scope and over a set period of time. When the outsourced processes are related to the Information Technology (IT) infrastructure and regardless of where



the processes are hosted - on premise or cloud based, the type of outsourcing is said to be IT outsourcing (ITO). This paper focuses on IT outsourcing and introduces a conceptual model for ensuring successful ITO. While the client and vendor share responsibility for success or failure in the outsourcing project, this study is conducted primarily from the perspective of outsourcing clients. Based on a literature review on ITO, the study proposes a theoretical model across the life span of an outsourcing project, of which the main steps include:

1. Defining the outsourcing strategy
2. Determining the appropriate delivery model
3. Following the outsourcing process
4. Identifying the causes of outsourcing failure and
5. Applying remedies towards successful outsourcing;

As part of validating the theoretical model, data from outsourcing practitioners was collected through a structured questionnaire completed by professionals having participated in outsourcing projects as clients. The following findings resulted from analysing questionnaire responses:

1. Clients are prepared to give full responsibility to external vendors and partial responsibility to external vendors
2. Rather than using internal vendors, clients are more comfortable working with external vendors on a shared responsibility basis
3. Less experienced clients are more likely to retain operational responsibility, but paradoxically also tend to engage with multiple vendors.
4. The main reason why clients outsource is in order to focus on core business while vendors manage the IT processes and infrastructure
5. Clients are most successful at formalising expectations into a binding client-vendor contract.
6. Poor communication is the biggest barrier to successful outsourcing.
7. Responsibility for outsourcing failure is most likely shared between client and vendor.

While clients are not inclined to outsourcing all strategic processes at once, many do outsource a significant portion of processes considered strategic. This research proposes a model for successful outsourcing in the specific context of outsourcing clients and in a manner that is consistent with the client's outsourcing strategy. The rigor with which the present framework is researched lays a strong foundation for a similar research being done with the outsourcing vendor as a primary focus. A similar study on BPO would also constitute an invaluable addition to the outsourcing body of knowledge.

**R&D Management / 22**

## **A study on a decision framework to prioritize government R&D budgets based on Multi-Criteria Decision Making**

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In Korea, not only government but also private sector continues to increase investment in R&D, and then Facilities, apparatus, and human resources reached higher position comparing decade ago. The investment has been mentioned as a primary factor in nurturing companies, heightening national competitiveness, and securing sustainable development. The government has made efforts to establish various institutions for a more efficient resource allocation with the increase in R&D investment. In particular, as an appropriate budget allocation is crucial part in R&D [U+3000] policy, various attempts to improve the system have been made by policy analyst or government officers fostering the linkage between government policies and budget portfolio in science and technology. In this study, we divided the government R&D investment areas in

Korea and carried out comparative analysis. The main technological areas were divided into nine groups: life sciences, healthcare and medicine; food, agriculture, and livestock; machinery and production; materials and nano-technology; ICT and software; energy and resources; environment and climate; construction and transportation; and space, aerospace, and maritime industries. Each technological area was further divided into sub-classes. National Standard Classifications in Science and Technology were used as basic units in order to efficiently use the data of Korean R&D and policy activities. The priority is determined by using well known tool in policy decision-making: cluster analysis and the Analytic Hierarchy Process with intensive discussion among high level experts in R&D. We found that various data related with R&D policy have been generated and accumulated with careful consideration by many professionals in Korea. We found that gaps between current budgets and expert opinions varies according to the technology area, which should be dealt with in communication process in policy decision-making. However, we also found some restrictions. First, the data in policy fields in Korea has issues: are data quality as well as compatibility between various data sources in the area of government R&D decision-making. It becomes even worse from the perspective of multi-year mid- to long-term investment strategy. Second, we identified that there exist various differences in R&D environments in diverse technology areas. Through quantifying the size of government R&D investments and comparing the degree of monopoly in each technology area, it is found that each area has its own characteristics and the differences also exist in expert opinions. Despite such shortfalls, the application of objective data in the government R&D budgeting process is necessary, and the mid- to long-term data formulation and analysis for each technology is necessary in order to assign responsibilities to policy activities such as the strategic foresight, planning, and evaluation.

**Economic and societal impact of technology / 26**

## **Ethical values as factors for social acceptance: the case of smart energy systems**

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Smart energy systems are considered an important enabler in the transition to more sustainable energy systems, because they support the integration of rising shares of renewable energy sources into energy systems. “Smart” means that energy networks are equipped with ICT technologies to account for higher volatility and a larger number of decentral production sites that come with wind and solar energy (Mathiesen et al. 2015).

However, they are not yet adopted on a large scale. One barrier is related to social challenges that might lead to a lack of acceptance amongst end users (Xenias et al. 2015). These challenges may be related to ethical values, which might or might not be fulfilled in specific designs of smart energy systems.

In this paper, we explore the effect of fulfilling ethical values for enhancing the social acceptance of smart energy systems. We strive to understand which values are at stake for smart energy systems and how their fulfillment might be related to social acceptance. We identify a research agenda to give design recommendations for increasingly value-robust smart energy systems.

We conduct a literature review covering the fields of technology management and ethics of technology and a case study on smart energy systems. The literature review provides an overall definition of social acceptance and an overview of values that might influence acceptance. The case study gives a first indication of which values influence acceptance of smart energy systems. Our findings show that ethical values can form a barrier for the social acceptance of smart energy systems. We provide examples of such values. We argue for a systematic inclusion of relevant values into studies of social acceptance of smart energy systems. We propose that a complementary approach of normative evaluation and descriptive/empirical investigations is suitable to give design recommendations for increasingly value-robust smart energy systems. A normative evaluation of the relevance of different values can be done from the perspective of the contribution of smart energy systems to well-being in a society. The descriptive/empirical investigations are related to the impact of value fulfillment on social acceptance of existing smart energy systems by different actor groups.

The paper closes with a research agenda for a complementary normative and descriptive approach to investigate the societal impact of smart energy systems. Our paper contributes to the conference theme 'economic and societal impact of technology', because it deals with societal concerns connected to technological change and increased ICT implementation in energy systems. References Mathiesen, B. V., et al., 2015. Smart Energy Systems for coherent 100% renewable energy and transport solutions. *Applied Energy*, 145, pp.139–154. Xenias, D., et al., 2015. UK smart grid development: An expert assessment of the benefits, pitfalls and functions. *Renewable Energy*, 81, pp.89–102.

## Small and medium sized enterprises and innovation / 27

### The Base of the Pyramid (BOP): towards a high growth framework for Small to Medium-sized Enterprise (SME) action

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The South African BOP is gaining increasing popularity as a lucrative market for entrepreneurs who are willing to align their businesses with the particular requirements necessary for operating in the BOP. Though SME owners are coming to appreciate the potential for alleviating poverty profitably, they lack a framework by which they can guide their efforts to achieve higher levels of growth. Of the many types of organisations that operate in the BOP, for-profit SMEs have come into the limelight in recent years as an ideal mechanism for dealing with social inequalities and promoting economic growth. In this paper the aim is to develop a framework to guide SME owners and managers operating in the BOP towards attaining sustained profitable growth.

Under the tenets of Soft Systems Methodology (SSM), a systematic literature review of high growth factors was conducted in order to arrive at a comprehensive list of factors which arguably contribute most significantly to an SME's ability to attain sustained high growth. In total, 25 high growth factors were identified from the systematic literature review, of which four were found to be of pivotal importance to SME owners and managers pursuing high growth. The four factors include: the use of a business model for detailed planning; the incorporation of a suitable and detailed business strategy for long-term growth; the utilisation of innovation to consistently improve value offerings and respond promptly to changes in the market, and; the implementation of good marketing practices to ensure value is delivered to the customer. In addition to the high growth factors, an area of concern determined to be necessary for sustained growth in the BOP was that of sustainable development. The four high growth factors and the additional sustainable development factor were scrutinised in light of the South African BOP context, and then developed into unique yet inter-dependent systems. The systems act so as to guide the owners and managers of SMEs operating in the BOP towards the attainment of higher growth. Each of the systems were combined to arrive at the high growth promoting framework for SME action at the BOP.

The framework was validated via two routes. Firstly, a semi-structured interview with experts in the field was conducted, i.e. expert analyses. Secondly, a retrospective case study was employed wherein the framework was applied successfully. The framework was deemed valid according to both the expert analyses and the case study. Potential for future research exists in way of the remaining high growth factors that were not addressed in this study, due to limitations of scope. Addressing these with respect to the BOP context, and amending the framework appropriately, will improve the framework's ability to guide SME owners and managers towards sustainable high growth.

## Product and service development / 28

## Customer engagement behavior throughout the digital service process

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Digitalization has brought extensive changes to businesses. The complex nature of the digital economy is characterized by various functions and provides global access to knowledge and information. It furthers transitions in the way people and organizations interact and behave. One of the current challenges facing businesses in digitalized world is how to engage and build longer-lasting and deeper connections with customers (Wiersema, 2013; Saunila et al., 2016; Ukko et al., 2016). In recognition of this challenge, the last decade has seen an increased recognition and understanding of the concept of ‘customer engagement behavior’, which refers to customer’s behavioral manifestations that have a brand or firm focus, beyond purchase, resulting from motivational drivers (Van Doorn et al., 2010). However, there has been few studies conducted focusing on engagement in digital context. In this paper, we contribute to this research gap by examining how customer engagement behavior changes throughout the digital product and service development process.

The paper builds on a longitudinal, qualitative single-case study (Yin, 2003) due to its suitability in holistically analyzing previously unexplored phenomena (Eisenhardt, 1989). A company providing pay-tv services is used as a descriptive case study to explain a phenomenon and the real-life context in which it occurred (Yin, 2003). The case study approach was chosen because the research field of customer engagement is still in its early stage; there is even less evidence available about engagement in digital business environments. To conduct the empirical study, we utilized a broad repertoire of secondary data to gain an in-depth view of the empirical environment. The limitations of secondary data were tackled by utilizing primary data that was gathered through interviews, focus groups, and participant observations in meetings in which a selected focus group was involved.

This study shows that the most important factors of customer engagement behavior in digital product and service development are personality of the service as well as the understanding of what the customer has bought and what he/she is committed to. Latter user experience must reflect those expectations in practice. The study highlights the importance of engagement during the front-end phase of the process. At the back-end phase, the complete services and solutions are provided in a digital format; thus, the role of engagement in creating value is shaped by the maintenance and updating of the solutions provided.

This study put the results of previous studies forward by concentrating on digital environment. As a main contribution, the study clarifies the engagement factors of digital product and service development. This study suggests that the factors affecting customer engagement differs among different phases of the product and service development process.

**Project and program management / 30**

## Project portfolio management in technology transformation situations

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Project portfolio management (PPM) is central for project-based firms to achieve structure and prioritization among multiple projects. Competitive pressures, emergence of new technology and constantly changing customer demand imply a dynamic nature of PPM that calls for adjustments

to different situations. This paper investigates PPM challenges that a company in the lighting industry face during a transformation from fluorescent technology to LED technology, by asking the question: *How does technology transformation influence the project selection process?* The findings rest upon an in-depth case study where data was collected via internal company documentation and narrative interviews with representatives having detailed insights into the company's PPM activities and decisions, specifically addressing the technology transformation. The analysis was carried out according to the established procedure of data display, data reduction and drawing conclusions.

The findings show that project selection during the technology transformation period deviated from how it is visualized in the company's PPM model, which resembles a funnel profile where the number of presumptive projects are continuously reduced by evaluation and selection for further development. Since the technology transformation called for projects where most products in the portfolio were converted to the new technology there were no need for explicit selection activities aiming for investigation of alternatives, and consequently no continuous reduction of potential projects to carry out took place during the selection process. On the other hand, more attention was paid on other selection criteria, such as in what order the projects should be executed, and how many projects that could be run simultaneously, but these changes were not reflected in the company's PPM model. The study therefore confirms that PPM selection is more dynamic than postulated in most PPM models found in the literature. It also emphasizes that related to specific situations the decision criteria are of different importance.

This paper contributes with increased insights into the dynamic nature of project selection, specifically related to a technology transformation situation. Further studies are needed regarding effects of other kinds of technology transformations on project selection activities and decisions as well as other factors contributing to the dynamics of PPM.

**Complexity of innovation systems in the future digital world / 31**

## **Technology roadmapping and the fourth industrial revolution: a case of mining automation roadmapping**

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**Introduction and Purpose:** the fourth industrial revolution presents both opportunities and uncertainties to various industries. Mining is among such industries in which there is a race towards autonomous mining that make use of technologies such as remote laser cutting of rocks, insitu processing of minerals, real-time excavations imaging, autonomous load-haul-dump (LHD) vehicles, etc. The purpose of this paper is to illustrate the sociotechnical transition technology roadmap for mining automation.

**Methodology:** the sociotechnical transition technology roadmapping framework is used as a basis to map the mining digital revolution complexity. A global mining company based in South Africa is used as a case study. The qualitative interviews are complemented by document analysis for data collection purposes.

**Findings:** in transitioning a mine from a labour-intensive to a capital intensive one, the innovation landscape needs to provide a conducive environment in terms of skilled labour, technology readiness, explicit desired labour and capital ratio as well as availability of funding and mineral deposits. The vendors for relevant mining equipment need to be involved at an onset as their various niche innovations can contribute positively to the roadmap. Continuous monitoring is necessary to decide on whether to accelerate, decelerate or discontinue certain technology development efforts.

**Conclusion:** this paper integrates the sociotechnical transition technology roadmapping framework with the concept of a fourth industrial revolution. The digital evolution of the mining industry presents itself in the form of niche innovations, promising niche innovations and finally the emergent niche innovations that have potential for transition into new mining business models.

The findings are useful to mining companies who are seeking to adopt automation as a competitive route but also to the policymakers for an appropriate framework condition in support of this revolution.

Keywords: Technology Roadmap, Mining Automation, Digital Evolution, Sociotechnical Transition; Niche Innovation

## Safety and risk management / 32

### Using risk simulation to set contingency guidelines for port and rail capital projects

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This paper presents quantitative evidence of the advantages of modern estimating tools and techniques, such as Monte Carlo Simulation, over more traditional, “rules based on experience” to estimate project contingency. These rules refer to statements such as “Add 10% of the project capital cost as contingency to the estimate when going into project execution”.

Project contingency may be calculated by using a percentage of the estimated cost, a fixed number, or be developed by using quantitative analysis methods (Project Management Institute, 2009, p. 173). The research presented here tested "rules based on experience" by comparing their results against the contingency estimates of a portfolio of 86 port and rail capital projects, using Monte Carlo simulation.

The research outcome started with a practical problem in a technological environment related to port and rail capital projects. The project portfolio included seven groupings of projects which were arranged per their scope. The idea was that since the projects were of a similar scope, one could conduct a Monte Carlo simulation of the individual project risk registers and use the simulation result to predict the contingency requirements for the various groups of projects. The outcome of this could then be employed during estimating project cost by using statements like “When building a stacking area for containers, a contingency of 12% should be added to the project budget to fund the consequence of risks realising on the project”.

The following steps were followed during this research:

- The risk registers for the 86 projects were cleaned up and combined into one risk register and allocated to one of seven groups, based on project scope.
- Aggregation functions were created to determine the contingency requirements for each of the individual projects. The P80 value of the individual risks registers were simulated and compared to a contingency of 10%, based on the project capital values.
- The individual P80 values of the risk registers were then calculated using @Risk software. The graphical results of the individual projects and groupings were interpreted.

The simulation research results included the following:

- The P80 values of the risk registers varied from 4.0% to 475% over the 86 projects.
- Significant variance existed inside the seven project groups, leading to conclude that “rules based on experience” are not appropriate in estimating project contingency.

These findings are important in the technological environment of port and rail capital projects because they highlight the following aspects related to project management:

- Project contingency estimates are context specific.
- “Rules based on experience” may overestimate the contingency requirements of a project.

## Technology transfer, marketing and commercialization / 34

## Technology transfer in sub-Saharan Africa Facilitating private to public transfer of e-Technologies

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Technology transfer is a vital structured procedure for developing nations as it provides the opportunity to implement a technology that would otherwise be unobtainable due to economic, social, political and other constraints. In the highly technical fields of ICT and healthcare, technology transfer could play a critical role in the development and widespread implementation of various devices and systems. The aim of this paper is the elucidation the technology transfer process from private to public in the ICT and healthcare sectors. This included the highlighting of key components that a domestic environment requires to ensure the successful adoption and implantation of an external construct. The primary objective is to determine the various methods that are available to facilitate technology transfer along with the specific barriers that accompany each method. Universal barriers were also of interest with a critical focus on how the presence (or absence) of different infrastructure components in developing African countries would influence the process. A conceptual review was undertaken to establish a foundation for the theory behind technology transfer, infrastructure analysis and e-Health technologies. This conceptual review holds technology transfer as the core component and attempted to incorporate the concepts of infrastructure analysis and e-Health into a technology transfer framework. To unpack the various nuances of successful technology transfer, a cross-sectional analysis was performed. This analysis focussed on how real world case studies attempted to approach the various aspects of technology transfer that were identified in the conceptual review. This analysis also enabled the comparison of technology transfer methods with one another and then gauge their relative success. This paper found that the major methods for technology transfer include FDIs, joint ventures and the utilization of TTOs. Due to the knowledge component of a technology transfer venture, it was concluded that the lack of soft infrastructure (such as a technically skilled workforce) will have an equally detrimental impact as the lack of fundamental infrastructure (such as stable power supplies). Governments were determined to be the critical stakeholders with the primary responsibilities of establish infrastructure and creating an attractive environment for foreign investors while still protecting local suppliers through legislation. This paper promotes several reflexions of technology uses in the digital world with regards to cultural, management and legal aspects and as such supports the conference's themes. The paper also addressed the challenges that the present digital world is facing through highlighting key strategies that are need to bridge the digital divide in African LDCs.

Keywords: technology transfer, infrastructure, e-Health

Management of technology in developing countries / 38

## A conceptual framework towards the development of Innovation Platforms that facilitate the integration of technology in healthcare value chains

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The impetus of improved access to healthcare services in Sub-Saharan Africa necessitates that various challenges be addressed within healthcare value chains. The most commonly faced challenges have been proven to be major supply chain constraints, a shortage of skilled staff, stock outages, diminished funds, difficulty tracking patient data, cultural biases towards western medicine and a lack of managerial infrastructure (Gray & Vawda, 2016). The result of these challenges not being overcome is limited access to preventative care services. In order to overcome these value chain challenges, more effective approaches to adopt technology and innovation need to be identified. In Sub-Saharan Africa, the interaction between value chain participants and stakeholders is limited when in pursuit of solutions to common issues and challenges. In this paper we introduce innovation platforms as a means through which this chasm can be overcome. Innovation platforms provide a means to bring together different stakeholders such as producers, input suppliers, processors, environmentalists, researchers and public sector players to identify solutions to common problems or to achieve common goals. The members of the innovation platform collectively identify issues to address. Emphasis is placed on developing solutions that are realistic, timely and context appropriate. This is achieved through the inclusion of multiple perspectives across the innovation platform. Successful innovation platforms are commonly developed over a period of time and undergo a series of transitions prior to being fully established and functional. This article adds to the body of knowledge of innovation platforms by delving into its application within the healthcare value chain as well as addressing the role of innovation platforms in tech-transfer.

This article presents the findings of a systematic literature review of 52 studies through which the authors explore the core processes and principles required for the development and functioning of successful innovation platforms in the healthcare value chains sector in Sub-Saharan Africa. These findings are synthesised to support the development of a conceptual framework to review and extract key success factors, areas of practice and design guidelines and criteria that will facilitate the integration and management of technology in healthcare value chains.

Keywords: innovation platforms; multi-stakeholder platforms; technology management; healthcare value chain; systematic literature review

#### Small and medium sized enterprises and innovation / 40

### A Decision Support System (DSS) framework for developing a sustainable sharing economy enterprise

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Various social issues, which include unemployment, homelessness and skill shortages, exist in especially developing country contexts. In the same environment as the social issues, there are often resources (physical and non-physical) available that are not utilised to their full capacity. Theoretically certain idle resources could potentially be applied in different ways in order to address a social issue but also to benefit the owner economically. In order to achieve above objective, the possible role and contribution of employing engineers and in particular industrial engineers in addressing social problems and designing efficient and effective social services delivery systems hold exciting prospects. The aim of this paper therefore is to develop a decision support tool and process that makes use of core industrial engineering tools to investigate how idle resources in a community may be redeployed and utilised best to develop a sustainable and profitable social enterprise.

The sharing economy is a principle that optimize the utilization of resources. The resources are shared when it is not fully utilized by the original owner and usually one party of the partnership would not be able to afford the resource. This principle can take on many forms for example sharing of physical assets, knowledge or even skills or information.

The methodology of Multi-Criteria Decision Analysis (MCDA) is used to develop a decision support system framework and tool. A social issue within a community is identified and possible alternatives for business models to address the issue are generated and investigated, given the



idle resource(s) available in the same community. A filtering process define the alternatives to three possible concepts and a business model analysis is created for each. With the necessary economic parameters and potential social value each enterprise will contribute to the community, the necessary trade-offs and comparisons can be made. The risks involved in each enterprise are taken in account and the champion of the project can make informed decisions regarding which concept to execute.

The model is built to be generic and flexible in order to be applied in any environment where different resources are available to utilize. The paper present the validation of the model and its application to a case study of an idle resource in the form of a house in a rural context.

**Industrial and manufacturing technologies / 41**

## **An International Review of Energy Models: Introduction of a new Paradigm**

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Energy modelling is not a new concept and has always been utilised in its most basic form as energy balances. The oil crisis of the 1970's focused attention to the benefits of energy modelling [1, 2]. Energy modelling application has since become a norm from governmental institutions to industries to policy makers for; analysis and optimisation of current energy systems, forecasting energy demand, assisting in policy analysis development and identifying the interaction and relationships between energy-economy, energy-environment and energy-environment-economy [1]. As energy systems developed from simple to complex, so have the energy models evolved from simple supply and demand models to complex and dynamic multi-criteria models incorporating technological detail, economics and econometrics. Numerous energy models are available, which have been developed by organisations such as government, academia, private enterprises, consultants and energy bodies such as the International Energy Agency and the World Energy Council. Most commonly these models have been classified into two categories; top-down, which are macro-economic models and bottom-up, which are detailed technological models [1, 2, 3]. In recent times a third approach has been utilised, the hybrid approach integrating features of both the bottom-up and top-down models. These models have specific objectives/criteria and specific applications due to the internal model assumptions and structure. A significant number of these models require a high level of expertise, technical detail, economic detail and historical data and are time intensive. These requirements can sometimes encumber the use of the models, as they are not readily available, potentially affecting the accuracy, reliability and evaluation time resulting in additional costs and resources. This paper proposes a review of current toolsets together with a proposed novel business centric approach to energy modelling. The approach maximises on current energy evaluation tools limitations, as analysed in this paper, delivering a dynamic option in energy modelling.

**Small and medium sized enterprises and innovation / 43**

## **Innovation Metrics: Analysis of Six Brazilian Industrial Companies**

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Innovating in a systematic and regular way is a fundamental concern for organizations in order to achieve competitiveness. In this context, Innovation Management Systems (IMS) constitute an important organizational approach to foster the capabilities to innovate continuously. One of the central elements of an IMS is the set of metrics that support the monitoring and control of

the innovation process, its subjacent efforts and the outcomes achieved. However, due to some characteristics of the innovation such as the level of uncertainties, nonlinearity and the time required to achieve results, defining and implementing adequate innovation metrics remains a very complex task. Therefore, the central question posed in this research is: how innovation metrics are selected and implemented in companies when designing their IMS and which are the main concerns? The study starts with a literature review on innovation management and innovation metrics. Case-studies were performed with six Brazilian industrial companies that had their IMS formally established. The companies selected come from very distinct sectors: electrical equipment, information technology, ophthalmologic lenses, mining, wire-drawing products and transportation. The frameworks of Dewangan and Godse (2014) and Adams, Bessant, and Phelps (2006) were combined in an interview protocol applied to companies' managers, all them directly responsible for the IMS implementation in their companies. Semi-structured interviews and access to internal and public documents were the main instruments for data collection. Then, a critical analysis was made on how the six companies have established and dealing with their metrics and what were the challenges and gaps. Finally, considerations were made on how to improve innovation metrics, how metrics evolve over time, how metrics impact on people's behavior, how metrics relate (or had to relate) to the companies' goals and the implications concerning the absence of metrics related to some elements of the IMS. The field study revealed relevant gaps, conflicts and implementation barriers in the practice of these companies. One important concern is that metrics stimulate behavior. Thus, before associating innovation metrics with front-line goals and action plans, metrics must be prototyped and used to improve managerial knowledge about the dynamics of the IMS in the company. Innovation is a complex process that needs to be transversely tied among several points in the organization; also, innovation strongly depends on people motivation and the way they get involved in the efforts. Therefore, simple metrics are desirable, but focus on the strategic objectives for innovation should be also observed. Further research is needed to evaluate other experiences in setting innovation metrics and analyze their implications for the management of innovation in companies.

**Management of technology in developing countries / 45**

## **The application of Fuzzy Multi Criteria Decision Making for Cloud Computing Adoption in India**

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Cloud Computing (CC) has altered the way infrastructure, platform and applications are developed and deployed in the enterprises. Various sectors like manufacturing, banking services, healthcare, government and academics rely on IT functionalities along with data centres. This requires heavy investment due to high energy consumption, maintenance and infrastructural expenses. Cloud computing provides the solution by allowing dynamic and on-demand access to various shared resources via internet with flexible "pay as you go" pricing model. The adoption of cloud computing has different trends in developed and developing countries. However, only a limited number of studies have highlighted the underlying causes. Although the dispel literature presents various factors across globe influencing cloud computing adoption. There is dearth of studies that prioritise factors responsible for cloud computing adoption, especially in developing countries. The adoption of cloud computing is still in nascent stage in India with public cloud service spending of less than 0.1% as compared to worldwide (Gartner, 2014). Hence it is crucial to identify and prioritise the factors in Indian context to exploit the untapped potential of cloud computing. This study aims to provide a systematic approach towards factor selection. It is conducted using qualitative (semi-structured interviews) and quantitative (experts' opinion for ranking critical factors) through Fuzzy Analytic Hierarchy Process (FAHP). The degree of importance is formulated by fuzzy pairwise comparison matrix. Literature and qualitative phase revealed eighteen factors and twenty-six concepts which are categorized into technology, organization, environment and economic perspective. The cumulative assessment of FAHP indicated "time to market" with deployment time as the most critical decisive factor for cloud computing adoption. The results not only provide a fuzzy evaluation model for calculation of priorities of variously identified factors but also help managers focus on the most important factors to identify the best

policy for promoting adoption of cloud computing. It will also help service providers as well as potential adopters to take the decision based on the criticality of the factors.

**Economic and societal impact of technology / 46**

## **Cognitive Computing: Benefits, Challenges and Opportunities**

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Cognitive computing is a result of the radical advance in the evolution of computing, which transforms the business operation. It will give many opportunities for business to prosper. It will generate new business models and change the way of industries operation. Now, there are many startups have been established based on cognitive computing and availing cognitive systems. The major contribution of this paper is giving an overview of cognitive computing by describing its definition, related fields, and applications in business, top emerging trends challenges, and benefits. In addition, it gives a brief description about top cognitive systems as IBM Watson, IPsoft Amelia, Microsoft Oxford, Google DeepMind, Qualcomm Zeroth, Wipro HOLMES and Intel Saffron.

**Complexity of innovation systems in the future digital world / 47**

## **Ethics, Legal, Privacy, and Security in Big Data**

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Big data has become one of the most prominent technologies over the past years in all science and technology domains and has been everywhere applied in industries and organizations. Big data analytics helps for increasing executive efficiency and effectiveness, speeding up decision making, identifying new trends, developing new products, providing services, and generating revenue. Big data analytics allow users to extract useful information from a large amount of structured and/or unstructured raw data and gain deeper insight for decision making. However, it has faced the challenges in ethics, legal, privacy, and security (ELPS) issue to the general public. Many side effects have accompanied with the benefits of big data applications. It is worthwhile to review what have been done and what's missing in social concerns in the literature of big data. We retrieve 2416 relevant articles over 2006 to 2016 from database Scopus via using the keywords "big data", "cloud computing", "legal", "ethic\*", "privacy", and "security" to search the fields of title, author keywords, and abstract. A citation network among these 2416 articles is built. We apply the main path analysis to analyze the citation network and identify the overall development trajectory of ethics, legal, privacy, and security issues in different fields. We also adopt the cluster analysis and word clouding techniques to explore the major topics that have been discussed by researchers on ELPS. We found that privacy preserving is the hottest topic among ELPS. Many privacy concerns are disclosed on the processes of data storage, data transmission, and data sharing. Various techniques of anonymization, encryption and authentication are proposed to keep the data security and preserve customers' privacy. Big data can bring benefits in various fields, such as healthcare, mobile, smart grid, traffic management, retail, payments, and online. However, big data also carries big concerns and challenges to the human being. Therefore, the solutions should be worked out to balance the benefits and risks of the big data applications. The concerns in big data include profiling, tracking, discrimination, government surveillance, and loss of control. To cope with such complex issues, laws and regulations must be enforced with clear-cut boundaries in terms of unauthorized access, data sharing, misuse, and reproduction of personal information. The results concluded indicate that there are a lot of efforts should be done to maximize the benefits of big data applications and minimize its potential harm.

**Complexity of innovation systems in the future digital world / 49****Machine innovation – a future reality?**Dr. BOTHA, Anthon<sup>1</sup><sup>1</sup> *Graduate School of Technology Management, Faculty of Engineering, Built Environment and IT, University of Pretoria and TechnoScene (Pty) Ltd, South Africa***Corresponding Author(s):** anthon@technoscene.co.za

As digitalisation and machine intelligence are rapidly emerging towards disruptive status, the question should be asked whether humans will or should remain in control of innovation? Often people only think of artificial intelligence boosting growth by substituting humans, but actually huge value is going to come from the new goods, services and innovations artificial intelligence will enable. The 4th industrial revolution; the Internet of Things; smart everything, from wearables to cities; and artificial intelligence are future waves that will change forever the world as we know it today. We tend to think that future “smartness” is hidden in the creative abilities that humans have to innovate. But as machines are entering the workplace and our daily lives, not only as static robots on a manufacturing line, but with the potential to replace lawyers and accountants, doctors and teachers, companions and partners, their role in innovation in complex environments need to be explored. Innovating machines have been demonstrated. Already, governments are considering introducing new systems for protecting intellectual property that is generated by a non-human entity. This means that the notion of innovation, which up to now has been an attribute of humans only, will have to be redefined to accommodate these new innovators of the cyber world. An analysis will be done, based on the maturity of machine intelligence and human-machine relationships, on the potential of machines becoming autonomous innovators. Innovation is dependent on the ability to recognise patterns, combine and integrate existing properties and knowledge to represent something that is perceived as new by the user, seeing the gap in the market and intuition. This is exactly what machines are taught to do and teach themselves to do better in a conceptualisation era that follows the knowledge economy and takes us along into the algorithm economy. This paper relates to a better understanding of future innovation systems and strategic thinking and the complexity of innovation systems in the future digital world. It will present a thought model of how individual innovation, company innovation, industry innovation and national systems of innovation could be replaced by a global machine innovation network in future.

**Future thinking, strategy development, and theory of technology / 50****Future Thinking for Strategic Visioning**Dr. BOTHA, Anthon<sup>1</sup><sup>1</sup> *Graduate School of Technology Management, Faculty of Engineering, Built Environment and IT, University of Pretoria and TechnoScene (Pty) Ltd, South Africa***Corresponding Author(s):** anthon@technoscene.co.za

Strategic planning and technology management have become part of executive training, but very few opportunities are available to prepare executives for imagining the future. The future lies beyond strategy and Future Thinking shapes the landscape on which enterprises of tomorrow will exist. The future is not predictable; neither is it pre-determined. This opens the possibility of designing a desired future by being able to project ahead one's thoughts and experience what could be. It is important that the increasingly complex world and fast change in which business is conducted are supported by holistic thinking.

The workshop comprises a combination of short presentations, facilitated debate, individual and group work. It introduces several Future Thinking tools to determine a strategic vision. Mind-time travel related to high level future mapping reveals the barriers of the past, drivers of the present and potential of the future. Anticipation of emerging issues and their impact is done by looking at the the impact of technology (emerging and disruptive), behaviour of people (in the marketplace and inside the enterprise) and events that change the world (geopolitical, natural, economic, social, demographic, predictable and unpredictable, avoidable and unavoidable). The edge of disruption between the present and future is determined by looking at the technologies, behaviour and events through a Future Thinking lens. Their impact and probabilities are determined by

mapping them on a relevance matrix and their knock-on effects or higher order impacts by doing the Futures Wheel. The relevance matrix is defined by emerging issues, disruptive issues, wild cards and weak signals. The vision is then formulated based on deepening the future through Causal Layered Analysis (CLA) and doing scenario analysis based on the Future Thinking lens and selecting preferred futures. The vision will now inform strategy and policy to be adopted in the present through applying a back-casting approach.

This Future Thinking approach differs from traditional strategy planning in the sense that it is not only based on a macro-environment scan of the current situation, strengths, weaknesses, opportunities and threats analysis and visioning from a basis of extrapolating the present, but enables the strategic planner to “visit” the future by imagining it, making selections in the future and then return to the present. It employs modified scenario thinking where the narratives originate from the cross impacts of emergent issues, and metaphoric thinking is used, based on the degree of uncertainty (events) and control (technology and behaviour) that is expected.

Participants will take away an understanding of using mind-time travel to do strategic visioning and to generate a future landscape that is shaped by emergent and disruptive forces and to select from multiple futures a preferred future state from where back-casting enables present strategies.

### **Technology management and competitiveness in the globalized world / 51**

## **Role of Quality Management on Firm’s Innovation**

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Innovation is commonly recognized as the practice of implementing an idea which wholly encompasses series of processes in a firm. At the middle of the series, manufacture resides and connects R&D with marketing activities. We regard that manufacture acts out ‘a bottle neck’ which can either leverage or retard a firm’s innovation output, depending on its capability. This paper, therefore, addresses on a firm’s manufacturing capability and its roles on innovation rather than focus on R&D and patenting activities.

Since literatures point out that quality management programs improve management practice, production process, employee skill; we use ISO9000, the widest used quality program withstanding management fashions as a proxy to examine 1) how quality improvement contributes to a firm’s manufacturing capacity, 2) does the improvement eventually turn into increase in a firm’s innovation output?

We develop a formula based on Cobb-Douglas Production Function to compare manufacturing capacities between ISO certificated firms and non-ISO certificated firms. Later, we obtain the elasticity calculated from the formula as a proxy of a firm’s capacity, and make derivation of the production function to test the relationship of R&D with sale growth. Finally, we improve the patents-R&D formula by taking into account the elasticity value to test the relationship of R&D with the numbers of patent applicants.

We shall compile data from small and medium hi-tech companies registered in Growth Enterprise Market of China, ISO accredited bodies, and patent applicant database. The results would shed light on how quality management program up-lifts innovation and enables a firm to stay competence, which is beneficial to practitioners and policy.

### **Knowledge management / 58**

## **Wiki-based knowledge management for tool making and sheet metal forming**

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Wikipedia is by far the most popular website and one of the most widely viewed sites of any kind of the world. Wikis also became a collaborative tool in many companies to collect, organise, share, review and approve various forms of information. Internal know-how can be handled without loss of information to external persons. Links to open literature, standards, internal reports or documents (drawings) and search for experts in a particular field can be managed by such a groupware system. The presentation/paper describes the development of a wiki-based knowledge system for tool making, i.e. sheet metal forming, stamping, common die materials, FEM-simulation etc. The system should avoid losses of knowledge in cases of retirement, especially in the world of tool making, which is rather non-structured and mainly based on practical experiences. However, by a proper design using well defined categories and chapters, it is also possible to create a flexible education or training system for young engineers.

**Complexity of innovation systems in the future digital world / 60**

## **Co-evolution of Industry and Policy -Case of Global Semiconductor Industry**

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When global selection forces a divergence between policy co-evolution with economic development and policy co-evolution with technological innovation. A true resilient industry protects itself by strategic adaptive processes for future selection, variation, and retention. These industries are sensitive to recognize various changes and adapt to them. Therefore, the relationship between policy and industrial development is reciprocal. It is essential to see industrial development as feedback mechanisms, with policy making as a means to transform information to new interpretations and action. Strategies would be more trusting when the feedback is not based on a few industrial figures of trends, but rather on wide conversations and versatile range of information. This study aims to investigate co-evolution of global semiconductor industry and policy in order to understand how governmental policy co-evolves with industry by case study of global semiconductor industry. Whether a causal relation, interaction, circulation, co-evolution exists between global semiconductor industry and STI policy.

**Technology management and competitiveness in the globalized world / 62**

## **Technology Resilience of High-Tech Industry**

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This paper explores technology resilience of high-tech industry by examining the process from technology decline to resilience. There are three research questions raised and answered by this paper: 1) Why some high-tech industries enter technological crises while others are less vulnerable? 2) Why some high-tech industries suffer more from technological crises? 3) Why some high-tech industries recover more quickly from technological crises? The research begins by reviewing some of the challenges in defining resilience by different level of analytical units, then a parsimonious, generic technology resilience indicator framework comprising construct and variables is proposed.

This paper shows what analytical shifts are needed to unravel the technological resilience of industries' longer-term competitiveness. Building upon an understanding of technological resilience in large-scale industries, this paper stresses the need to focus on systems of knowledge convergence and cross-border collaboration, rather than just knowledge production and accumulation.

The process for using the framework in the analysis of global semiconductor, pharmaceutical and smartphone industry is subsequently demonstrated and compared. Finally, findings and implications obtained from the analysis of the current state of industrial initiatives are summarized. The intended contribution is conceptual as well as methodological. The conceptual framework and proposed indicators provide the context based on which the straightforward and replicable methodology is consolidated.

**Technology management and competitiveness in the globalized world / 67**

## Network Effects in the Laptop Market

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The strategy utilizing direct and indirect network effects has attracted attention. Direct network effects mean that the value of a good for the consumer is positively influenced by an increase in the number of users. Indirect network effects mean that the value of a good for the consumer is positively influenced by an attractive offer of complements. In markets with network effects, the first firm that establishes a large installed base of customers has a decided advantage (Besanko et al., 2013). Thus, once a firm successfully wins a large market share, it is difficult for other firms to capture the market share. However, although the Windows OS-based laptop retained a large market share for a long time in the laptop PC market, where the network effects are typically at work, the Apple Inc. has increased its market share rapidly in recent years. Around the same time, the markets of smartphone and tablet terminal have been expanded rapidly. Owing to an expansion in the range of devices, consumers today seem to be emphasizing on features for syncing and sharing data across tablet, smartphone and laptop, and network services (e.g. App Store, etc.) while making their laptop purchase decisions. Thus, it can be hypothesized that not only the traditional direct and indirect network effects but also network effects from other product markets (smartphone and tablet terminal markets) affect customers' purchase decisions. In this paper, we attempted to reveal the reason behind Apple's success in capturing the market share by analyzing the factors that influence customers' decision to choose between Windows and Mac OS-based laptop. First, a questionnaire probing into the factors that influence the decisions of customers to choose between Windows and Mac OS-based laptop was administered to 800 men and women aged between 20s and 50s. Second, using the questionnaire data, a factor analysis was conducted and five factors regarding the evaluation of laptop (product performance, switching costs, direct network effects, indirect network effects, and network effects from other markets) were extracted. Finally, a logistic regression analysis was conducted to analyze the factors affecting customers' purchasing decisions. As a result, it was demonstrated that direct network effects have a relatively small impact, while indirect network effects do not have an impact on the laptop market. On the other hand, network effects from other product markets have a large impact. These results suggest that Apple succeeded to make the direct and indirect networks, which were advantage of the Windows laptop, relatively weak by introducing iPhone and iPad and utilizing the network effects from these markets to laptop market. This study showed the reason of behind Apple's success. Our findings provided important suggestions for market challengers to capture the market share in a market with network effects. In addition, we contributed to a further understanding of the network effects.

**Project and program management / 68**

## Project Management and System Engineering: Towards a common Practice

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**Introduction and Purpose:** Most work is defined and executed as projects nowadays. Business strategy implementation is typically done via project portfolios (not functional lines anymore).

Deliverables of projects, i.e. products, systems and services have become more complicated and complex. These are due to rapidly changing technologies, globalisation, mass customisation, uncertain international economic situation and competition to name a few. Hence a systems approach is required to comprehend and manage complex technology-based projects.

Due to the largely independent development of project management and system engineering, a cultural barrier has been growing between practitioners in the two domains. This results in different approaches when addressing the key stakeholders, work, planning, implementation, and control creating friction between the two roles. The disintegration of the two processes results in a sub-optimal solution for customers, costing more and taking longer to deliver. With system engineering providing the biggest return on investment during the early phase of the system life cycle, it is vital that the correct integration and interrelationship between the two domains are established to deliver a baseline that can be executed with a high level of success. Technology-based companies should be able to master Project Management and System Engineering to remain competitive.

Prior research was done leading to this research paper. A number of masters' student participated focussing on different perspectives of the interaction between Project Management and System Engineering.

The study is largely an exploratory process with the objective to evaluate the interrelationship between project management (project) and systems engineering (product/system/service) determining the critical elements and to what extent the roles of project managers and system engineers are aligned towards the identified elements.

**Methodology:** This paper is to a large extent based on experience and the ability to integrate previous/ongoing related research sub-projects. A study of an international company based in Canada and two South-African research projects were supervised and used. Significant literature studies were done as well as interviews (supported by content analysis) and surveys.

**Findings:** A huge divide still exist between system engineering practices and culture (including basic detail engineering practices) and project managers. The classic thinking problem that "project managers are concerned with money and schedules, while engineering people caters for the technical work" is still prevalent! A high-level integration model is proposed to better plan, manage and execute technology-based projects. Reasons why projects of this nature fail and associated improvement strategies and practices are proposed. Specific training and induction programmes are suggested. Further research is undertaken to elaborate on and validate the proposed Integration Model.

**Closing:** Technology-based companies should be able to take advantage of the findings of this research. An integrated planning approach, starting with required project deliverables (products/systems/services) to actively integrate the technical, budget and schedules requirements as early as possible is defined. This integrated planning draws from successful approaches from the project management and system engineering worlds.

R&D Management / 70

## R&D Mode, Vertical Integration and Innovation Performance of Indigenous Brand in the Introduction Period

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Although R&D and production are both indispensable in firms' innovation activities, existing studies on innovation performance always consider the two processes separately when trying to find out factors that determine firms' innovation performance. Considering only one process makes it hard to figure out which is more important for firms' innovation performance. To compensate the aforementioned deficiencies, this article analyzes joint impacts of R&D mode and vertical integration on innovation performance of indigenous-brand automobile manufacturers ("indigenous brands" for short) in the background of Chinese automobile industry.

Through reviewing existing literature, this article builds a conceptual framework of relationship between R&D mode, vertical integration and innovation performance. With micro data of



Chinese indigenous brands from 1998 to 2007, Poisson regression and frontier stochastic method are used to test impacts of R&D mode and vertical integration on firms' two different kinds of innovation performance: patent quantity and new product value. The result reveals that R&D mode and vertical integration exist total different impacts on firms' different kinds of innovation output. Compared with independent R&D, two other R&D modes: technology import and technology outsourcing have insignificant crowding out effects on indigenous brands' patent invention. However, technology outsourcing improves firms' technical efficiency of new product production significantly and increases firms' new product value; The relationship between vertical integration and patent quantity exhibits inverted U-shape while the relationship between vertical integration and new product value is negative; This result demonstrates that only with desirable coordination between activities of R&D and production, can indigenous brands transfer innovation input into efficient output.

This research contributes both to literature of innovation performance and practice of innovation performance improvement for indigenous brands. On the one hand, the finding of different impacts of R&D mode and vertical integration on firms' different kinds of innovation output certifies the necessity to consider different processes of innovation activities and to measure innovation performance in various ways. Concentrating on a single industry also helps avoid potential problems from ignorance on industry heterogeneity in traditional cross-industry analysis. On the other hand, this research provides direct guidelines to both policy makers and firm managers on helping indigenous brands improve their innovation performance, and the government's indigenous brands support policies should make more emphasis on traditional manufacture technology when encouraging new energy technology. The indigenous brands themselves should also spend more resources on improving ability of key component manufacture and production management instead of only focusing on high speed new product development.

**Future thinking, strategy development, and theory of technology / 72**

## **Towards a Conceptual Model for Cloud Computing Affordance**

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This study proposes a conceptual model for cloud computing affordance for SMEs. Since the mid-90s, technology management, information systems, and business management scholars have shown a growing interest in understanding how investments in cloud computing technology can lead to improved business performance in small and medium-sized enterprises (SME). Therefore, understanding what cloud computing can achieve for small businesses is extremely important as SMEs are the main source of employment worldwide. For instance, in developing countries such as Thailand, 95% of the businesses are SMEs. There, they contribute to the employment of 11 million people, accounting for 80% of total employment. Hence, it is important to understand what technology can do to help these businesses. A central concept to help us in this task is the concept of 'technology affordance'. However, firstly, it is necessary to understand the definition of affordance itself. This concept describes how objects are perceived by their 'visual' use rather than as object themselves in an ecological sense. The concept of affordance is in fact suitable for application in technology management. Majchrzak and Markus (2012) provide a comprehensive definition to technology affordance: "The concept of technology affordance refers to an action potential, that is, to what an individual or organization with a particular purpose can do with a technology or information system." (Majchrzak and Markus, 2012) Therefore, the main objective of this paper is to offer a model that links technology affordance theory, cloud computing, and business performance. We believe the proposed conceptual model enriches the literature in Technology Affordance theory. Its contribution resides in describing the relationship amongst cloud affordance perception, cloud affordance actualisation, and cloud affordance effect. The conceptual model was developed from a robust and systematic literature review on the fields of: management of technology (MOT), information systems (IS), and business management. While, MOT provided a basis to investigate technology affordance models; IS literature was more instrumental in understanding the specifics of cloud computing systems. Finally, business

management studies contributed to our model in assessing cloud computing adoption impacts on business performance. The approach of evaluating business performance through the lenses of balanced scorecard came from business management literature. The conceptual model for cloud computing affordance is now being further developed to empirical work. A survey questionnaire will be administered to construct a view of how cloud computing is seen by SMEs in major cities of Thailand. This model supplements theoretically to Technology Affordance theory. It will also help SMEs understanding cloud computing better and what factors are associated with their adoption, especially for companies with low levels of in-house IT resources.

**Panel-WS / 73**

## How Digitalization drives Business Model Innovation

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Increased implementation of technologies and their widespread diffusion enables various new forms of cooperation between companies, leads to new product and service offerings as well as to new forms of company's relationships to customers and employees (Kiel et al., 2016 referring to Kagermann, 2013). At the same time this digitalization puts pressure on companies "to critically reflect their current strategy" and "to systematically and early identify new business opportunities" (Kiel et al., 2016, p. 675). Hence, technological progress is one of the trends requiring "managers to significantly adapt one or more aspects of their business models" (Wirtz et al. 2010, p. 273) or even design completely new ones. The ultimate goal of this business model innovation (BMI) is the creation of long-term competitive advantage (Wirtz et al., 2010). In this context the business model itself is this subject of innovation (Clauss, 2016 referring to Baden-Fuller & Haefliger, 2013; Chesbrough 2007; 2010). Hence, BMI can be understood as the process of innovating the business model itself, and simultaneously as the outcome of the respected change resulting in new business models (e.g. Mitchell & Coles, 2004). According to Clauss (2016), business model innovation thereby needs to have impact on the three basic dimensions of a business model, namely value creation, value proposition and value capture. The purpose of this research is to explore if and how increased digitalization leads to BMI, whereby BMI is understood as the change of certain elements of a business model or even the introduction of a completely new business model due to increased digitalization. For the workshop, the methodology of a world café is used. In a world café, participants are distributed throughout the room on tables. Each table has a host and a specific question that should be discussed (Brown & Isaacs, 2005). The workshop starts with a short introduction of the topic followed by a presentation of the workshop objectives. Afterwards, the participants are spread around the tables and discuss the questions on the table about 20 minutes. Then, the participants change the table and discuss the next question. With the aid of this method, participants are encouraged to discuss different perspectives and share their experiences, which also provides ideas and avenues for future research. Within the workshop, questions like the following ones will be discussed: Which role does digitalization play for value creation, value proposition and value capturing? Is there a linkage between digitalization and BMI? And if yes, up to which extent does digitalization influence BMI? So far there exists only limited research on internal and external drivers of BMI and even less when it comes to digitalization and BMI (e.g., Bucherer et al., 2012; Sorescu et al., 2011). Hence, a better understanding of how digitalization influences changes in business models is important both for practitioners and researchers.

**Technology transfer, marketing and commercialization / 75**

## TECHNOLOGY EXTENSION FOR ELECTRIFICATION IN RURAL AREAS

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The electrification of rural areas is a process that has the ability to allow isolated populations to meet their basic needs and promote their development. For this activity to have the necessary impact, the use of new technology that can be transmitted is required. In this aspect, a method of technological transmission is the technology extension, which has been allowing users to access and incorporate know-how, procedures, techniques and technologies to their lives. This paper presents a study of the assessment on impact, sustainability and replicability of the implementation of a development project through the use of technological extension for rural electrification.

The methodology to develop this paper includes a review of literature references related to technological extension, development projects with technological component and unsatisfied basic needs. The methodology also demanded to research case study (qualitative), which contemplates the use of in-depth interviews to both the project managers and the distributors of technology, surveys to the most underprivileged inhabitants of the target populations, and estimations of CO2 reduction.

The qualitative case study method, using critical case sampling, has shown the positive changes generated by this project in Peruvian rural areas. Regarding sustainability, an increased comfort within the community was registered, which permits to keep purchasing the product in the long term. On the side of replicability, it was noted that zero maintenance cost of the product during its five - year lifetime is a convincing factor that facilitates the decision process to purchase the product. By the looks of the impact, there was an elimination of more than 40,000 kg of CO2 in five years of the implementation of the project, which is a benefit both for the improvement of air quality in the homes and for the reduction of greenhouse gases.

Based on the results' analysis, it can be inferred that the PicoFV panels are suitable products to achieve the development of populations in poverty; it can further be inferred that they can be expanded and implemented through technological extension in other similar areas in Peru. Therefore, a suitable combination between technology extension and a focus on development, liberties, capabilities and / or unsatisfied basic needs can achieve the efficient implementation of development projects.

**Technology management and competitiveness in the globalized world / 77**

## **ADAPTING INFORMATION TECHNOLOGY MANAGEMENT FOR EFFECTIVE INFORMATION TECHNOLOGY STRATEGY LEADERSHIP**

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In this article, it is argued that the lack of consistent information technology (IT) and organisational strategies heightens the proclivity to cancel IT initiatives. Organisational strategy loosely conveys a compounded perspective pertaining to business and organisational strategies. Business, IT and organisational strategies logically hinge on efficient enterprise IT integration concepts that contextualise conceptual links between business, IT and organisational architectures to best address contextual business and socioeconomic needs. However, an effective socioeconomy demands contextual awareness of strategic management of IT, leadership and management, geopolitical and other factors affecting the evolutionary nature of IT, enterprise architecture, enterprise risk optimisation and principles of governance and management. Business and IT leadership's contextual awareness is necessitated by the concept of levels of abstraction inherent in the principles of separation of concerns. Hence the strategic use of the concept in 'opinion' formulation within the paradigm of a sociotechnical system design, development and management. Thus, optimal business performance demands that business and IT leadership and management develop mechanisms to establish symbiosis between governance and management principles, glued together by an adaptive enterprise-wide standard architecture. There is therefore a contended need to integrate IT, processes and strategies. This demands that business and IT professionals possess an interdisciplinary and a multidisciplinary set of competencies. The perceived set of competencies supposedly help professionals to effectively navigate the interdisciplinary and multidisciplinary

nature of information technology management (ITM). Thus the ensuing sociotechnical system constructs represent the challenge imposed by the journey to purposefully adapt ITM for effective IT strategy leadership for a competitive economic system. The research uses an advanced mixed research methodology embedding quantitative methods in a qualitative study and balances deontological and teleological philosophies. These theories underline systemic and deliberate practice aimed at optimising similarly credible research findings as well as provide a realistic perspective. Consequently, analysis employs a systematic approach based on four contextual themes, viz. administrative, investment management, management and technology practices and a closing perspective, in deliberate efforts to optimise triangulation. The outcome is an adaptive ITM process model facilitating discovery, assessment, governance and management of a purposeful sociotechnical system in any given geopolitical context. In principle, the research introduces a general theory of collaboration theoretically thriving on ITM as the art, philosophy and science of orchestrating strategic management principles to enliven the value of IT in pursuit of an optimum strategic intent in a continuum.

**Green technologies and sustainability / 78**

## **The green innovation ability of Chinese equipment manufacturing enterprises based on PCA**

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With the rapid development of economy in our country. The waste of resources, environmental pollution and ecological destruction and other issues are becoming more and more obvious. Manufacturing industry, especially the equipment manufacturing industry, is a strategic industry which provides technical equipment for the national economy and is the important guarantee of industrial upgrading of all industry and the technological progress. The establishment of a strong equipment manufacturing industry is to improve Chinese comprehensive national strength and guarantee to achieve industrialization. But Chinese manufacturing industry is still in the middle stage of development from lower level to higher level at present. The annual energy consumption of the manufacturing industry is about 57% of the total energy consumption in China. 60% of the water pollution, 40% of the SO<sub>2</sub>, 75% of harmless waste and 90% of hazardous waste are produced by the manufacturing industry. The extensive mode of economic development has seriously restricted the sustainable development of Chinese economy. Chinese equipment manufacturing industry is also a major cause of environmental pollution in the industry. Chinese economy is in a period of rapid growth, the contradiction between man and nature has never been so urgent as today, we have not enough resources to support high consumption, high pollution economic growth. The evaluation method selected in this paper has the following advantages. PCA can transform multiple indicators into a small number of unrelated indicators. And PCA is a multivariate statistical method that can maximize the response of the original indicator information. The advantage of PCA is that it will reduce the dimension of the variables and simplified data structure to bring convenience to the analysis and research. And the calculated principal components are independent of each other and reduce the cross of information. It is feasible to carry out an empirical analysis on the evaluation of the green innovation ability of Chinese equipment manufacturing industry. Firstly, this paper constructs the evaluation system of green innovation capability of Chinese equipment manufacturing industry from 4 aspects, and it selects twelve indexes related with green innovation ability of Chinese equipment manufacturing enterprises. It employs PCA method to comprehensively evaluate and rank the Chinese green innovation ability of seven equipment manufacturing industry in 2013. Research shows: The green innovation ability of communications equipment, computers and other electronic manufacturing is the strongest, and the instruments instrumentation and culture, green innovation office machinery manufacturing industry is the worst. Through the empirical analysis, it can provide reference for the improvement of Chinese equipment manufacturing enterprise's green innovation ability, and promote the development process of the green innovation of manufacturing enterprises.

**Industrial and manufacturing technologies / 79**

## Key Drivers Affecting Technological Catch-up in Complex Product Systems: Iran's Gas Turbine Industry

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### Introduction

During last decades a large amount of efforts have been done by developing countries in order to technological catch-up and acquiring essential capabilities for manufacturing complex products and systems. As a considerable case, Iran has been doing a lot of efforts in order to acquire key knowledge and capabilities for manufacturing and gas turbines and it achieved favorable and remarkable results. This paper aims at investigating the case of technological catching up and acquiring technological capabilities of manufacturing gas turbines in Oil Turbo Compressor Company (OTC) as an Iranian latecomer firms and identifying key drivers and factors affecting on this process.

### Methodology

In this paper, the qualitative approach and case study method was applied. Regarding to data collection, a total of 11 in depth and semi-structured interviews were performed in several companies and organizations. In addition, several documents such as long-term planning documents, organizational charts, projects reports and websites were studied and analyzed. In order to analyzing data, we have extracted a preliminary theoretical framework based on research background including six major drivers. Then, we have used this theoretical framework in order to analyzing our collected data.

### Findings

Our findings showed that below-mentioned drivers have significant role in technological catching-up by OTC in gas turbine industry as complex product systems:

- Government policies, supports and initiatives such as accumulation all domestic demands to gas turbine; signing the most costly research contract between NIGC as a government agency and OTC; and leading, coordinating and monitoring progress of project via establishing steering committee
- Networking, interactions and collaboration among key actors and stakeholders like NIGC as customer, investor, coordinator and regulator; OTC and its subsidiaries (Turbo Tech, OTech and MIGT) as producer and executor of project and some domestic universities
- Technological acquisition strategies adopted by OTC like co-manufacturing under license of Siemens, acquiring a knowledge-based company in order to establish a research and design center, adopting bottom-up approach
- Existence of large and remarkable domestic market and demand for industrial gas turbines in Iran, accumulating of this volume of demand and ordering it to domestic producers and suppliers
- Managerial and organizational capabilities of OTC such as system integration, mega-project management, intra and inter-organizational knowledge management
- The context surrounding OTC including national science and technology policies, energy policies and environmental factors like international sanctions

### Closing

This paper intends to contribute to the literature of technology management in developing countries by examining an Iranian specific case of technological catch-up in gas turbine industry as a CoPS example by a latecomer firm.

**Technology transfer, marketing and commercialization / 81**

## Technology Commercialization in Biotechnology Sector: An Indian Case Study

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In the era of globalization, with shorter technology and product life cycle, it is not only the technological development, but its commercial exploitation that makes the difference. Thus commercializing technologies successfully with reduced time to market becomes crucial for organizations not only to survive but also to gain competitive advantage worldwide. Limited non-renewable resources, increasing environmental and health concerns (air pollution, crop productivity, vaccination) has made biotechnology sector as a potential source to contribute towards the national growth. India is amongst the top 12 biotechnology destinations in the world and ranks third in the Asia-Pacific region. However it is found that Indian biotechnology sector has recorded lowest growth (of 6.98 %) in last 12 years for the year 2014 indicating gap for technology commercialization (TC) in biotechnology sector in Indian context. In existing literature various TC models - Linear (Goldsmith model, biotech innovations sequential model) and Non-linear (Jolly's model, Allen model) have been proposed. However these models lag to address specific requirements of biotechnology commercialization especially in Indian context like specialized infrastructure and raw material, and longer gestation period. In addition it is also observed that the linkage between the stages of TC process and factors influencing these individual stages has been studied in a very limited way. Therefore the objective of research is to understand the TC in biotechnology sector in Indian context and to identify the factors influencing success of biotechnology commercialization. An exploratory descriptive research design is selected through qualitative approach. A case study method is selected to understand the TC process by mapping with existing models. Evidences are collected through in-depth interviews with senior management of an organization. A case of bio-ethanol production has been selected and analyzed through explanation building technique. The successful commercialization of bio-ethanol production can lead to lowered fuel prices and reduced air pollution. From the case analysis three factors were identified with the addition of new stage in the existing TC process model. This research will add useful dimension to the existing body of TC process models by adding useful element and enriching TC process models in Indian context. The case analysis highlights the significance of the interactions between university, industry, and government for managing the technology. Thus it will help organizations as well as policy makers to formulate strategies and policies respectively to enhance biotechnology commercialization in India.

**Green technologies and sustainability / 83**

## **Barriers and strategies for diffusion of electric vehicles in BRICS countries**

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Worldwide, many countries are facilitating the development and diffusion of sustainable energy based technologies. Such technologies reduce CO<sub>2</sub> emissions by limiting the use of fossil fuels. An example of such a technology is the electric vehicle. Most diffusion of electric vehicles takes place in industrialized countries, such as the Netherlands and Norway. But also in other countries electric vehicles begin to enter the market. Examples of such countries are the so-called BRICS countries: Brazil, Russia, India, China and South-Africa. These countries account for nearly half of the World population, with economic growth exceeding the growth of industrialized countries. Therefore, these countries become an interesting target markets for all sorts of sustainable technologies, including electric vehicles.

Companies that bring a new product to the market or enter a new market with an existing product, come across a number of barriers that prevent large-scale diffusion. In order to circumvent or remove these barriers, they can adopt alternative strategies. This paper looks into these barriers and strategies for electric vehicles in BRICS countries.

The paper builds on existing literature describing barriers and strategies for introducing innovative technological products in western markets and in BoP markets. The paper starts with a literature review that discusses which barriers and strategies from the existing literature are relevant for

the case of electric vehicles and for BRICS countries, and which strategies are the best solutions for particular (combinations of) barriers. Then the empirical part of the research is described, which is based on semi-structured interviews with electric vehicle companies in Brazil (Renault), India (Mahindra Reva) and South Africa (Renault).

The results of the paper indicate that for the case of electric vehicles in BRICS countries the three main barriers are: “Lack of Demand”, “Institutional barriers”, and “Lack of infrastructure”. The two main strategies are found to be “Lobbying” and “Development of infrastructure”. The lobbying strategy is important to get government support in order to accelerate the adoption of electric vehicles. Infrastructure development is important in order to provide the customers with sufficient public charging stations and eliminate range anxiety.

The findings in this research have important implications for managers and academics. For managers, this research can serve as a tool in deciding when to enter the electric vehicles market in BRICS countries as well as what kinds of barriers to expect in these countries. This research could also serve as a tool in identifying appropriate strategies to be implemented in order to overcome the barriers to large-scale diffusion. For academics, this research opens up the research field into barriers and strategies for market entrance of innovations in BRICS countries. An interesting further research direction is how these barriers and strategies develop over time.

**Future thinking, strategy development, and theory of technology / 84**

## Formulation of strategic map of Melli bank of Ilam province

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Strategic planning process is applied by the successful companies at national and international level. These companies consider strategic planning as a tool to achieve long-term goals and most of them consider their success based on this type of planning. This study aims to formulate a strategic map for Melli bank of Ilam province based on balanced score card using bank tangible assets and intangible assets as: Human capital (people), information capital (information systems and organizational knowledge) and organizational capital to achieve effectiveness and value creation for organization. Also, coherent plan is fulfilled for the progress and saving in costs and learning growth of organization and its employees. The present study is applied in terms of purpose and descriptive-analytic and survey in terms of nature. The study population is staff and queue employees of Melli bank branches of Ilam province. Based on Cochran’s formula, 185 people are estimated. For data collection, explorative interviews and group sessions, a 55-item questionnaire (5-item Likert scale) is used from very much to very low defining the significance of each of items in evaluation of performance of bank affairs experts, employees and cashiers of Melli Bank branches of Ilam province. The data are analyzed using single t-test with SPSS software. Keywords: Strategic map, Financial, Customer, Internal processes, Growth and learning, Bank.

**Management of technology in developing countries / 85**

## A System Dynamics Approach to Cloud Computing Adoption

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The core research issue of the present study is to understand the adoption of cloud computing (CC) in Information and Communication Technology (ICT) firms in India. A system dynamics-based, user and service provider factor interrelationship model is developed to help evaluate the

adoption of cloud computing in the firm. Different relationships and linkages between the service provider and user, are identified to establish feedback loops that analyse the system over time. An exploratory-descriptive qualitative research design was used. Open-ended semi-structured questionnaire was developed and pilot-tested with industry experts. Questions were added on the recommendation of experts from pilot study, and the final questionnaire consisted 3 sections namely organizational and interviewee profile; adoption of IT; and adoption of CC. Employees from 13 organizations who have adopted CC (including both cloud service providers (CSPs) and cloud service users (CSUs)) were invited to participate in the study. The responses were transcribed and analyzed using open coding. Causal loop diagram (CLD) was developed using the analysis of qualitative study showing interrelationship among factors. Causal loop diagrams (CLD) can be read using two constructs – link and loop polarity. ‘Link polarity’ is presented by positive and negative symbols at the head of the arrows indicating a ‘causal link’. A positive symbol indicates that any change in the cause will create a movement in the same direction in the effect beyond what it would otherwise have been. Stock and flow diagrams (SFD) are used to capture the stock and flow structures of systems. The stock and flow model is based on the causal loop diagram where the variables selected are converted into stocks according to their relevant respective relationships and relevance to systems. Once the model is developed, all the adoption related factors and behavioural graphical relationships such as the resistance to change and the top management decision are neutralized by setting the growth factors to zero and all the values in the graphical input relationships to one. The purpose for the examination is to observe the behaviour of the model in equilibrium so that the inflow values are equal to the outflow values in the initial stage. The analysis of the cloud computing adoption model shows that revenue and clients’ demand are the key leverage point affecting adoption rate of the firm. Further, time to market and competitor pressure also play important role in influencing the rate of adoption. However, trading partner pressure and resistance to change have only minor effects on adoption rate.

**R&D Management / 87**

## **Expert knowledge worker role in growing collaboration R&D (Based on Iran case study)**

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Nowadays all companies around the world are considering about their costs in different parts. They are searching for different ways to decrease their overhead costs. So most of the big companies moved their product lines to some countries such as China, Bangladesh, Vietnam and India to access to the cheaper employee (manpower). One of the important and high cost parts in the companies is the R&D departments. In this part we need special experts that we know them as knowledge workers. Employing knowledge workers in R&D departments is very expensive in the developed countries in Europe, North America and etc. Since the prime cost (final cost) is very important to compete with competitors in the market, we should find some solutions to decrease the R&D costs, same as producing costs that we found cheap employee. One solution is to use the potential that exist in some under developing and less developed countries. In the other hand, we have a lot of expert knowledge workers with high university degree in some countries such as Turkey, India, Brazil & Iran and we can employ these experts with very cheaper costs in comparison with developed countries. In this study we are focusing on knowledge workers for establish the collaboration R&Ds in Iran on based on our previous studies about collaboration R&Ds. Our solution is to launch the collaboration R&D in these developing countries such as Iran to use the cheaper expert knowledge workers to reduce the overhead costs.

**Small and medium sized enterprises and innovation / 88**

## **The relationship between structural and relational network**



## characteristics and innovation performance for knowledge based South African SMEs

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Small and Medium Enterprises (SMEs) are widely accepted as the drivers of economic growth. SMEs depend on innovation for survival. The literature indicates that innovation performance can be improved through collaboration with other organisations. For SMEs, however, spending valuable resources collaborating with organisations that do not add value, could lead to a decrease in innovation performance. This paper explores the effect of collaborating with eleven different actor types identified from the literature from both a structural as well as relational network perspective. We performed the investigation for a group of 19 SMEs based in Gauteng and surrounding areas in South Africa. From a structural perspective, the results show that having more direct connections to firms from other sectors, science partners, and government increases a firm's innovation performance with regards to the novelty of innovation. The performance with regards to the novelty of innovation increases even more if some of the aforementioned collaborators are international organisations. From a relational perspective, interacting with these types of collaborators more frequently improved the sample firm's innovation performance with regards to novelty.

**Project and program management / 89**

## Barriers to Post Project Learning: A Study of Project-Based Organisations in the Construction Industry of South Africa.

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The South African construction industry is on a decline since the global recession that preceded the 2010 FIFA world cup infrastructure developments in South Africa. Although the post project review is a common process of identifying areas of improvement on projects for project-based organisations to become or remain sustainable, the temporary nature of projects most often restricts the assimilation of knowledge learned to be used on future projects. This research seeks to identify barriers to effective post project learning in project based organisation. Although much research already exists on barriers to effective post project learning in the construction industry of developed and developing countries, it has not been done in an emerging country like South Africa. A framework was developed to investigate the barriers, linking them to the different stages of post project learning and to identify and suggest critical success factors that could mitigate the identified barriers. Fourteen barriers and eight success factors for mitigating these barriers were identified from the literature and empirically tested through a survey questionnaire involving respondents in different project roles. The inferences drawn from this study are in line with the results from several other developing and developed countries.

**Management of technology in developing countries / 91**

## Knowledge spillovers in labor demand induced by innovation

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The promotion of innovation in services is essential to improve the productivity of this sector and that of the economy as a whole, not only because it has been a means to encourage growth and equity in developed economies (OCDE, 2010) but also because it represents around of 60% of both total employment and total aggregated value, in Latin America and the Caribbean (Rubalcaba, 2015). The innovation policies in Latin America have paid little attention to this sector, although some subsectors have a great capacity to generate new knowledge and to spread it to the rest of the productive system, for example the intensive services in knowledge and the creative industries. There is previous evidence of agglomeration patterns between businesses belonging to intensive innovation industries, particularly in intensive knowledge services, high technology manufacture and creative industries, in developed countries (Chapain, et al., 2010). This investigation sets on trial a labor demand model deriving from innovation in order to analyze how important are knowledge intensive business services (KIBS), high-medium technology manufacture (HMT) and creative industries (CI) knowledge spillovers in the generation of employment in a developing country. The proposed model uses cross-section data and analyzes in odds ratio terms the labor demand generated due to innovation (endogenous variable) and two groups of explicative variables: innovation capabilities (IC) and agglomeration economies, as proxy of knowledge spillovers (KS). A first group of estimations is performed by three innovation types: technological, new products and mixed (adding the two prior ones). A second group of estimations is also performed for the labor demand derived from mixed innovation corresponding to one of the three sectors of intensive innovation mentioned previously, i, to analyze the influence of the other sectors h, j upon it, and it is successively repeated to complete the inter-sectoral effects of the KIBS, HMT, and CI, among themselves. The results at all levels of the sample indicate that the KIBS concentration always has a higher probability to generate labor demand derived from innovation, followed by HMT and CI companies, no matter the type of innovation analyzed; also personnel training is the most important IC in the probability to demand labor due to mixed innovations and new products. However, in the labor demand by technological innovation, the most important IC is the ratio of higher educated employees. At a cross-sectoral level, human capital (measured as the ratio of employees with higher education) is the most important IC for the KIBS and CI companies, for the HMT it is the training, while the KS shows a clear pattern of dominance of HMT over KIBS and CI, in turn CI only dominates over KIBS and also has a bigger influence than it over the HMT companies.

The findings show that KIBS and CI companies are an important sub group of the service sector in terms of capacity to promote innovation in the economy as a whole, this is the reason why it is worth being paid attention to by the innovation policy makers in developing countries. Future investigations have to deepen into which specific businesses inter-relate the most with other strategic sectors such as the HMT and in which concrete ways are the KS performed.

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## **The policy framework of ICT innovations development in Iran regions**

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The different studies have been done by researchers about regional innovation models. The research objective is the identifying of the effective factors for developing information and communication technology in Iran regions. Based on the literature review, 6 dimensions and 26 factors were identified as the preliminary theoretical pattern. ICT as the main case were analyzed by theoretical pattern in Iran regions. Also three technology (Bio, Nano, Aero) were compared with ICT based on the theoretical pattern. For investigating each technology, the documents, the believes of interviewers and statistical methods were used by researchers. The Cross-case analysis and Whithin-case analysis were done in selected technology and the differentiations and common points were analyzed by real and theoretical repetition. The 16 factors of theoretical pattern have

real repetitive for analytical extension. The national and international collaboration policies as a transregional dimension has 3 factors. Also the regional dimensions in the final framework are the social and cultural properties of the region, the level of economical and industrial development in the region, the locational advantages and properties of the region and the learning and knowledge flows in the region. The level of economical and industrial development in the region is the most important dimension for developing ICT innovations in the regions of Iran. In the paper, we analyze the importance of different factors for ICT development in Iran regions.

## Industrial and manufacturing technologies / 97

### The impact of autonomous maintenance on the performance of pumps in refineries

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Reliability and availability are important maintenance indicators for most physical assets. Availability is also an important indicator for the business enterprise since it directly affects the output of the production assets and therefore the profits for the company. Various maintenance concepts like Reliability-centred Maintenance (RCM) and Total Productive Maintenance (TPM) emphasize the achievement of high reliability through preventive maintenance technologies linked to condition monitoring in particular. One of the basic principles of TPM is operator maintenance, also known as autonomous maintenance. Manufacturing companies aim to increase profitability by decreasing production costs through higher reliability and availability. However, one of the major petrochemical plants in South Africa have experienced high maintenance costs due to high failure rates of rotating equipment and pumps in particular. This situation initiated the research project discussed in this paper. The main objective of this research study was to establish the extent of autonomous maintenance for centrifugal pumps at a number of petrochemical refineries in South Africa and to determine whether the application of autonomous maintenance has a positive effect on the reliability of these pumps. A secondary objective of this study was to establish the barriers to implementation of autonomous maintenance for centrifugal pumps at petrochemical refineries. Data was obtained by means of a survey amongst maintenance and asset managers from four of the six refineries in operation in South Africa. A web-based questionnaire with 56 statements and questions was designed and 137 completed questionnaires were returned. An estimate of the reliability of centrifugal pumps was obtained by requesting an average of the mean-time-to-failure (MTTF) for pumps managed by the respondent. Information was acquired for a number of age categories of the pumps. A set of questions also established the respondent's knowledge of autonomous maintenance and the extent to which autonomous maintenance is applied in the plant. Another set of questions requested the respondent's opinion on barriers to the successful implementation of autonomous maintenance. Provisional findings don't indicate a strong correlation between the reliability of centrifugal pumps and the presence of autonomous maintenance. Further statistical analysis for different age groups and the four different plants is being performed. The survey also identified the most important barriers to implementation of autonomous maintenance. These barriers were linked to knowledge management, employee factors and people management. Employee factors comprised employee training, motivation and resistance to change. The findings of this research could assist maintenance and asset managers in petrochemical plants to implement and sustain operator maintenance in their plants which has the potential to improve the reliability of pumps in particular but also to improve the reliability of other physical assets. Autonomous maintenance is not feasible for all assets but certainly for a large number of assets. Operators can observe potential problems or failures at an early stage and report such incidents to the maintenance supervisors for action. The authors recommend that similar studies be performed for a broader range of assets, e.g. electric motors, valves and filters. Actual reliability data should then be obtained for such equipment if available and possible correlations with the extent of autonomous maintenance established.

## Technology transfer, marketing and commercialization / 99

### Morphological analysis of technology commercialization: A

## literature review

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Technologies have become the foremost differentiator for business excellence and growth. The conversion of invention into commercially viable new product or service based on the technology known as technology commercialization (TC) is critical for economic growth of a country. TC is a complex phenomenon involving various factors. Various TC models (linear and non-linear) and modes like - internal, quazi-internal, and externalization have been proposed by researchers in different industries and context to commercialize technologies. Literature indicates the TC process consists of imagination, incubation, demonstration, promotion, and sustenance. The product technology, process technology, market control, and support infrastructure related factors influencing the TC process. However the stages of TC and factors have been studied independently in the literature. Therefore the objective of the research is to critically examine the TC literature to identify the critical factors for each stage of TC. Morphological analysis helps in identifying the total set of possible relationships between the elements and factors contained in the problem. Importantly, morphological analysis encourages the identification and investigation of elements and boundary conditions, i.e. the limits and extremes of different contexts and factors. A structured literature review has been carried out using morphological analysis to identify the factors for each stage of TC. Identification of factors influencing particular stage of TC will help managers and entrepreneurs to derive at considered judgments as to which factors are critical for each stage of TC for enhancing the success of TC. This research can be used in designing and assessing the TC process.

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## A Review of Providing Technology Management Services by the University Start-up Companies around the World and Comparing it with Iran; A Case Study of Tehran University Science and Technology Park

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The distance between the research processes and production and technology market is one of the major challenges in technology development and innovation in Iran. In order to play a more effective role of universities in the development of knowledge, especially, technical knowledge and solving problems in the community, many countries have forced universities to increase commercialization of universities' research results. So Certain structural units such as technology transfer offices, incubators, entrepreneurship centers and science and technology parks has been formed in the universities to increase the commercialization of intellectual properties from universities and transfer developed technologies at academic institutions. In Iran, several academic centers have been established in recent years and in order to achieve their objectives, they need to follow integrated management to manage transformation of knowledge as the main asset to wealth. In this study, first we tried to examine academic centers of the world(MIT, Cambridge, TUM, Middle East university, Zhejiang University, KAUST, NU) from the perspective of technology management functions or tools and then compare them with integrated management model of university Science and Technology Park that was implemented in Tehran University Science and Technology Park. Finally, due to the lack of coverage of some technology management functions in an integrated management model of university Science and Technology Park, the suggestion of the addition of process / technology cluster development center to the model was presented.

**Small and medium sized enterprises and innovation / 101****Review of the patterns of cooperation between small or medium companies with big ones****Author(s):** Dr. NAGHIZADEH, Reza<sup>1</sup>**Co-author(s):** Mrs. SHAHIRI PARSA, Faeze<sup>2</sup> ; Mr. ASGHAR, Jebalbarez Sarbijan<sup>3</sup><sup>1</sup> *Faculty member of National Research Institute for Science Policy, Iran*<sup>2</sup> *Allameh Tabataba'i University, Iran*<sup>3</sup> *Qeshm Voltage Company(Chairman of the Board), Tehran, Iran***Corresponding Author(s):** naghizadeh@nrisp.ac.ir

Small and medium agencies are considered as one of the most effective reason in developing of society and economic in any country. This research is studying about the patterns of cooperation between small or medium companies with big companies. The object in this research is practical and the method is descriptive. All data are collected from the library and authoritative printed and digital resources. The result shows that a strong community between small or medium companies with a big company while the government strongly supports, cause to establish a consortium or multinational companies, that can help to solve a lot of issues in small, medium and big companies.

**Management of technology in developing countries / 102****Investigating causality on the path to Universal Health Coverage****Author(s):** Mr. DZAPASI, Mazwi<sup>1</sup>**Co-author(s):** Mrs. DE KOCK, Imke<sup>1</sup> ; Mrs. BAM, Louzanne<sup>1</sup><sup>1</sup> *Department of Industrial Engineering, Stellenbosch University***Corresponding Author(s):** imkedk@sun.ac.za

Universal Health Coverage (UHC) is one of the Sustainable Development Goals (SDGs). The SDGs comprise of 17 goals that integrate the three dimensions (economic, social and environmental) of sustainable development, with one of the key objectives being to ensure healthy lives and promote well-being for all. UHC forms part of the targets concerned with population health and well-being under SDG 3. The World Health Organisation (WHO) defines UHC as “ensuring that all people can use the promotive, preventive, curative, rehabilitative and palliative health services they need, of sufficient quality to be effective, while also ensuring that the use of these services does not expose the population to financial hardship”. This global call for UHC has led to a number of countries taking the initiative to transition towards UHC. However, numerous challenges are encountered during the planning and implementation of effective UHC, with one of the major challenges being the unavailability of adequate contextual evaluation tools to inform the mechanisms that a country should employ to successfully transition to UHC. Recent studies aimed at providing decision support to countries on the path to UHC mainly focused on factors that affect the shift towards UHC in isolation (monocausal), with a primary emphasis on the financial feasibility of such UHC concepts. The purpose of this paper is thus to investigate the possible contribution of complex causality methods towards gaining alternative or new insights into the factors, and causality between such factors, that influence UHC. The ultimate objective being to contribute to the quest for UHC by addressing the question, “Which factors, or combination of factors, affect which UHC outcomes?”.

In order to gain insights on the factors (and indicators) that shape the UHC landscape, the WHO's health financing diagnostics and guidance framework were used as an initial point of departure. The factors that contribute to, and influence, the success of UHC were divided into three distinct components namely; health financing arrangements, health system status and country contextual factors. A literature- and subsequent comparative analysis of complex causality methods resulted in Qualitative Comparative Analysis (QCA) being deemed the most appropriate method to assess causality linkages between factors that influence UHC. QCA focuses on the effects of combinations of causal conditions and multiple cases linked to an outcome, as compared to regression methods, that focus on isolated net-effects of causal conditions and probabilistic models that only examine

the incremental influence of independent variables on an outcome. To confirm these findings, the properties of UHC and QCA were then studied with the purpose of finding the concord between the two, aimed at unearthing the possible contributions of complex causality methodologies to informing UHC policy. The paper subsequently proposes an approach, through the application of QCA, that contributes towards priority setting when moving towards UHC. The research is relevant to the “resilience through differentiation in the age of globalization” theme of the conference as it will contribute to the world transformation goals.

## New business and investment models in the digital world / 103

### An investigation into the wearable technology landscape

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Over the past several decades the capability of m-Health technologies, and more specifically wearable technologies, to improve access to primary, secondary and tertiary healthcare services has been clearly demonstrated. Recently, there has been a growing use of sensors for remote monitoring of medical parameters and lifestyle applications. Sensors are commonly used for detecting, transmitting and/or storing vital signs and physiological data, as well as for measuring and detecting levels of activity. The availability of technologies at lower cost, access to high-capacity telecommunication networks and increasing levels of computer literacy contributed towards the advancement of the development of wearable technologies.

This paper provides an overview of the current state of wearable technologies, including those that are commercially available and those that are in the advanced stages of development. Aspects that are considered in the overview include: 1) the key enabling technologies such as sensing hardware and data collection, communication software and hardware, and data analysis and decision support systems; 2) the technology maturity; 3) the intended user(s) of the output from such technologies, i.e. data, namely healthcare workers or patients; and 4) the application area(s), including the disease that the technology is developed for and the stage of healthcare provision, i.e. preventative, monitoring, etc. that the technology is intended for.

The research approach involves a comprehensive literature- and structured comparative analysis of the wearable technologies mentioned above, with a specific focus on their application areas within the healthcare environment. The key focus being to comprehensively map out the current landscape of wearable technologies with a healthcare application.

This research provides insight on the status quo of the developing field of wearable technology including an indication of the maturity of this technology. The research output can be used to provide developers of wearable technologies with a comprehensive overview of the key enabling technologies that are currently commercially available as well as those that are likely to become available in the near future. The output can be used by researchers to identify gaps in the development and application of wearable technologies. Finally, the research can be used by healthcare system managers to identify opportunities to incorporate wearable technology into healthcare provision. The research is relevant to the “economic and societal impact of technology” track of the conference, as it will contribute towards a better understanding of the role that wearable technology has to play when population health is considered.

## R&D Management / 105

### R&D investment, synergy innovation and innovation performance

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Innovation and technological progress are deemed basic determinants of regional economic growth. Industry-university research synergy innovation is considered to be an important strategy of regional development and economic growth in China. Enterprises, universities and scientific research institutions enhance their independent Research & Development (R&D) ability, at the same time the innovation actors strengthen the synergy innovation with others, which makes the regional innovation performance improved. Moreover, R&D capital and human resource investment of actor is demonstrated the important manifestation to the independent innovation. Nevertheless, together with the serious economic and technological regional difference in China, it has been increasingly recognised in the literature that spillovers of innovation performance from different areas may have an important impact on innovation processes and economic growth. An area's innovation performance may well be affected by the R&D investment and synergy innovation of other area. Given the nature of knowledge creating activities and the existence of localized knowledge externalities, it might be expected that innovation performance in one area could be affected by innovation performance of other areas. In this context, the spatial dimension becomes a relevant question in determining the effectiveness of such spillovers in the regional innovation performance. In this paper, we use the model of composite system coordinating degree to measure synergy innovation of innovation actors which are enterprises, universities and scientific research institutions, and reveal the relationship between three types of actors. Then we empirically investigate the effects of local R&D investment and synergy innovation on regional innovation performance with spatial econometric analysis technique from evidence of Chinese provincial panel data during 2005-2014. The study finds that not only innovation performance is relevant in determining local R&D investment, but also synergy innovation, which measured by model of composite system coordinating degree. Moreover, with regional innovation performance's significant spatial correlation, eastern developed regions formed H-H (high-high) collective modality with benign development. A level of regional innovation performance development is required to improve the effectiveness of R&D capital investment and synergy innovation, but R&D human resource investment has little effectiveness on the innovation performance development. Therefore, it is necessary for R&D policies to act in combination with other policies focused on the improvement of socio-economic and structural determinants of regional innovative performance. Thus, this paper developed theoretical concepts and discussed empirical results in order to determine the effective reference for realizing China's regional economic growth and improving China's synergy innovation system. And it will have some important theoretical value and practical significance for the China's future policy development. Keywords: R&D investment; synergy innovation; innovation performance; spatial correlation

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## **A System Dynamics model for Adoption of Multi-Use Health Technology in Healthcare Facilities**

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System Dynamics models have previously been used to describe the adoption of new technology in Healthcare. JB Homer and later KL Knoll developed such models based on case studies involving implantable devices and antibiotic pharmaceutical product. In both cases the technologies studied were of a therapeutic nature and the use-event was linked to an individual patient (single use). The process involved in the adoption of new technology which is diagnostic in nature and where the same device is used in many patient use-events, is significantly different. In such cases, the initial decision to acquire the technology is normally dependent on the availability of substantial capital but once the device is installed, the subsequent use requires little or no additional funds. The differences brought about by the application; namely diagnostic versus therapeutic, introduces a further variance form the aforementioned scenarios, resulting in unique dynamic characteristics. The model, discussed in this paper was developed to simulate the multi-use diagnostic device adoption process and is structurally based on the five-stage Adoption Decision process described by Rogers. The well-known process describes the propagation of potential adopters through the

stages of adoption or rejection of a new idea. Stocks and flows which constitutes the key elements of a System Dynamics model is utilised to represent the population of adopters (stocks) and how they move(flows) through the stages of the Adoption Decision process.

In developing the model, a specific case of adoption of a novel full body x-ray scanner is used. Data for development and verification of the model was collected from the adoption of the innovation in two distinct applications, namely Trauma and Forensic Medicine. The two applications were further studied in two different geographic areas; South Africa and the United States of America. This lead to the simulation of the adoption process of the same innovation in four distinct cases. The paper will present the initial results from the simulation.

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## **Building the Hydrogen Economy through Niche Experimentation and Digitalisation**

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It is widely acknowledged that the current patterns of energy supply and consumption are not sustainable (COP21). As a result, the global community has adopted an ambitious programme, known as the Two Degrees Scenario (2DS), to decarbonise energy supply and reduce substantially its dependence on fossil fuels. This programme has many social and technological challenges. For instance, although renewable energy (RE) technologies such as wind and solar are competitive against gas, coal and nuclear, the intermittent nature of RE presents major difficulties with respect to load balancing and supply security. This challenge has led to the emergence of the energy storage systems and smart grid technologies, including hydrogen storage and the dynamic management of energy supply in response to rapid changes in solar or wind energy. The integration of various technologies through smart grid approaches is fundamentally an application of digitisation. Such techniques are still under development, however, and have not been widely implemented. Moreover the new technologies are being developed within a context of rigid techno-economic systems which have little interest in facilitating sustainability transitions. In this paper, the development of hydrogen fuel cells in South Africa is reviewed as a case study in order to understand how countries can act to support new technological innovation systems (TIS) that will be essential to meet the goals of 2DS. The hydrogen programme in South Africa, referred to as HySA, is mostly a research initiative driven by the Department of Science and Technology with some support from the private sector. All of the HySA research centres and many of the relevant role players have been interviewed in order to profile HySA's activities within a TIS framework. The work shows that the hydrogen TIS in South Africa is still at a pre-competitive level. It is important that the principles of niche experimentation, a proven strategy in respect of proven sustainability transitions, are further pursued if the country is to make a meaningful contribution to hydrogen generation/storage and its integration with fuel cells. Importantly, the costs of energy derived from RE via electrolysis, storage and generation, which are presently several times larger than the use of natural gas, must be reduced. Furthermore the country needs to focus more heavily on the development of digital technologies to manage supply fluctuations. The article concludes with a set of clear steps which will need to be taken in order to allow the future development of a viable zero emissions energy sector based on the integration of the hydrogen and the electron economies.

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## **DEVELOPING NORMALISED METRICS FOR COMPARING THE ENERGY USE OF HOSPITALS**

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Energy and water consumptions are major cost points for large buildings, such as manufacturing plants, hospitals and office complexes. The drive for sustainability and efficiency, when considering energy and water usage in the building management sector, has resulted in the increased importance of the effective management of such resources. Hospitals are complex, resource intensive facilities, resulting in increased complexities when managing energy and water usage. In addition, there is a significant difference in the energy and water usage between hospitals. These differences are due to factors such as the demand, environmental characteristics, and capacity of a hospital, which greatly influence its energy and water usage. However, investigations suggest that comparisons of water and energy efficiency between hospitals are deficient without normalising for differences between hospitals. Normalisation of performance measures or benchmarks would enable more accurate comparison, and subsequently management, of resources in hospitals. Normalising the energy and water utilisation provides a means of determining a hospital's current consumption efficiency, as well as identifying potential opportunities for efficiency improvement. The need for a management tool to normalise the energy and water usage across hospitals, and to subsequently determine the actual performance potential of a hospital's energy and water consumption, is thus evident.

This research follows a literature-based approach to i) identify the variables that contribute towards water and energy usage in hospitals, ii) establish the factors that contribute towards the differences between various hospitals' energy and water use, and iii) to ultimately propose an approach for normalising the energy and water usage of hospitals. The approach will enable hospital management to determine the true energy and water performance potential of hospitals. A hospital is modelled as an aggregate of its functional units, the macro departments that make-up a hospital. A literature analysis was conducted to understand how energy and water are consumed within these functional units, and to identify methodologies for normalising the energy and water consumption of a hospital. Studying the factors affecting the energy and water consumption within the individual functional units, and analysing their overall effect on the consumption of the hospital, provides a means of comparing the energy and water consumption of hospitals that specialize in different activities. The proposed approach assesses the individual performance of functional units that form part of a hospital; and subsequently assesses the performance of the hospital as a whole,, namely all functional units.

**This paper engages the technology management in developing countries theme of the conferences with emphasis on facility management.**

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## Prioritization of R & D lines in Biotechnology

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Perez (2010) claims that the future development strategies of countries of Latin American region should contemplate changes associated with the massive application of advanced biology, to the sustainable transformation of renewable resources. The UNCTAD in the Report on Policy Review in Science, Technology and Innovation for Peru (UN, 2011) recounts the importance of the application of biotechnology and indicates that given the magnitude of its transformative impact, the development of biotechnology "could allow Peru to enhance its competitive advantage in abundance and diversity of natural resources by integrating its multiple traditional primary activities into more complex value chains". Hence the innovation project "Laboratory of Digital Manufacturing (Fab Lab) in the Amazon" of the Fab Lab Association of Peru, takes those recommendations and includes among its lines of action the biotechnology. Therefore, the present research aimed to identify and prioritize research and development (R & D) lines in biotechnology for the Amazon within the framework of this project.

The exploratory and qualitative methodology includes a literature review for the identification of current and potential R & D lines, as well as the development of 10 semistructured interviews

with biotechnology specialists. For the stage of prioritization of research lines, a literature review was carried out on "capacity for technological innovation", which is one of the criteria chosen for the evaluation of each R & D line. Based on this review, related variables were selected and used in a survey to 19 researchers from different institutions, including universities, public and private, non-university research centers, public research institutes and companies. This survey allowed to gather the opinion of these experts on the level of capacity to develop research and development of the research line, as well as the level of importance to address the 3 challenges posed by the Fab Lab Amazon Project: Biodiversity Conservation, Food Safety and Sustainable Industry Development. In order to process data from the survey, a statistical multicriteria method and a matrix of importance Vs Prioritization capacity were applied.

As a result, it was possible to identify 13 R & D lines in Biotechnology to be developed in the Amazon. Those R&D lines was prioritized based on two criteria: technological capacity and the importance for conservation, food security and sustainable development. From the 13 identified lines, 5 were prioritized, on which it is possible to develop one or more R & D Agenda with specific roadmaps. In addition, a qualitative methodological process was developed, through consulting expert researchers to prioritize these R & D lines. This process can be replicated for prioritization of R & D lines in other required sectors, including required changes due to the particularities of each sector or subsector.

Finally, this work seeks to contribute through the proposal of a participatory methodology for the process of prioritizing R & D lines. This is important when managing resources adequately to generate the greatest social and economic impacts in a society. And, on the other hand, addressing the Biotechnology sector and knowing the priorities raised by researchers represents an opportunity to deepen these lines and gives rise to the elaboration of R & D & I Agendas.

#### Small and medium sized enterprises and innovation / 113

### Dynamic capabilities and SMEs performance: a synthesis of researches

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Although the themes of dynamic capabilities and performance are abundant in literature of large firms, there is still a research gap regarding the understanding of dynamic capabilities in the context of Small and Medium Sized Enterprises - SMEs, representing a potential subject to be explored. Several researches had already explored dynamic capabilities by the combination with different abilities or capacities, identifying influence models or performance moderators (Macher & Mowery, 2009; Hung, 2010; Drnevich & Kriauciunas, 2011; Hsu & Wang, 2012) in different types of organizations and under the most different contexts (Drnevich & Kriauciunas, 2011; Chien & Tsai, 2012). Although the principles and concepts of dynamic capabilities originate from large firms or multinationals (Prange & Verdier, 2011), we underline that SMEs can also present dynamic capabilities, although at an early stage (Eriksson, Nummela & Saarenketo, 2014). As they develop, SMEs tend to adopt more complex organizational forms and, after the first challenges, can consider innovation and change, such as large firms or even multinationals (Eriksson, Nummela & Saarenketo, 2014). The main objective of this article is to explore the relationship among dynamic capabilities, operational capabilities and SMEs performance, and proposes a theoretical research scheme based on researches synthesis. We used bibliographical research method as a representation of state of evidence from scientific indexed researches regarding terms, pursuing research synthesis precepts (Cooper, 2010). To demonstrate the graphical presentation of relations among terms, we used an analytical display (Miles, Huberman & Saldaña, 2014) that allowed the proposition of a research agenda. Publications quality (Cooper, 2010) was ensured through Boolean searches in international scientific databases (Web of Science, SCOPUS, Science Direct, Brazilian Periodical CAPES and SPELL). As searches result, 126 articles were selected and, among these, six were identified containing the themes 'dynamic capabilities' and 'operational capabilities'. Among the main contributions of selected papers are those directly related to innovation management: a) the relationship among higher level of absorption capacity; b) the development of a learning environment and acquisition of more complex technologies; and c) the consequent creation of a more profitable environment for development of dynamic learning abilities. In general, research papers highlight the importance of interactions among dynamic and

operational capabilities and creation of a 'proactive entrepreneurial logic'. The researches synthesis allowed the identification of constituent elements of dynamic capabilities, operational capacities and performance in a context of SMEs, shedding light on a research agenda that considers the specificities of SMEs that can be used as an analytical parameter for future researches. From observing this theory gap, the contribution of this research to dynamic capabilities research field is: a) the identification of current state of the art of literature, b) the identification of themes and approaches on dynamic and operational capabilities themes in SMEs, and c) the proposition of a theoretical schema of dynamic capabilities in SMEs. We underline that this phase is necessary to understand this phenomenon in SMEs to later understand how innovation is given through this concept in this context.

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## **The Effect of Startup Weekend Event in Entrepreneurial Education: Experiential Learning and Practical Intelligence Perspective**

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For nations' economic development and fortune creation, entrepreneurship has an important role. Under this situation, the government introduces regulatory reform and open more entrepreneurial courses to boost entrepreneurship. Recently, an event called "startup weekend" is popular in the global entrepreneurial area. The government divisions, private organizations and universities recently hold many startup weekend events in order to promote entrepreneurship under the government's policies supporting and encouraging. But, this type of entrepreneurial education is really effective in practice? Therefore, this study explores the two research questions. First, comparing the academic entrepreneurial education in the universities, the action-based training and experiential education is a better way to promote entrepreneurial performance? Second, why and how an action-based entrepreneurship and experiential education has a positive effect on entrepreneurial performance? This study uses the perspective of experiential learning theory and practical intelligence to investigate the answers of above research questions. It postulates and examines the startup weekend event training has an effect on entrepreneurial opportunity identification and entrepreneurial performance through experiential learning and practical intelligence. Theoretically, this study shows another theoretical perspective, experiential learning theory and practical intelligence, to explain the effects on why and how startup weekend event training works, in spite of action theory, action regulation theories, and perceived behavior control theory. In practically, this study evaluates the training of startup weekend event after the training is finished and investigates the training having influence on promoting entrepreneurship. It may offer to the government, universities, and entrepreneurial incubators another alternative in entrepreneurship training designing.

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## **INTEGRATED TECHNOLOGY TRANSFER CONCEPT FOR FOSTERING INNOVATION IN SMEs**

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The digital transformation affects all parts of industrial value creation. Major levers are the collection and usage of digital data, the interlinking of formerly independent systems and a transition from traditional products to integrated product-service systems. It is characterized by significant changes of established business processes resulting in dynamic value creation networks. More than ever, innovations are a key factor for ensuring competitiveness within the global market.

Small and medium-sized enterprises (SMEs) with their characteristics are particularly affected. With very limited resources, they rely on needs-based innovations that are directly related to their core products. Because of this practice, they may overlook strategically important trends or even lose track of entire technological advancements.

In this context, the transfer of technology and knowledge is a critical success factor. New technologies or methods developed by research institutions could provide long-term market advantages for SMEs. But despite a tremendous diversity of research results, the possibilities for tapping this source of valuable knowledge often remains unused. This mainly results from a gap between research and its commercialization in industrial applications – a phenomenon called “the valley of death”. Typical barriers are insufficient knowledge of available technologies, a lack of creativity within the identification of application potentials or simply missing resources. The digitalization even increases these barriers due to a growing interdisciplinarity of technologies. Furthermore, interconnected business processes and the demand for product service systems cause additional challenges. At present, there is no approach to solve this challenge sufficiently.

Therefore, we present an integrated technology transfer concept, focusing the increase of the digital maturity of SMEs. The approach merges a (1) technology platform concept and a (2) multi-stage process model for the entire transfer process. It includes the initiation phase, the strategic planning and the implementation of a project-based transfer. We present (3) formats for the different stages in a structured manner. Our approach is verified by a case study: the leading-edge cluster “it’s OWL” which is funded by the German Federal Ministry for Education and Research. By transferring technologies and methods for advanced mechatronic systems within the scope of tailored transfer projects, the cluster follows an innovative path. The case study provides 170 projects established since 2014. Based on the platform with its bundled technologies, specific demands of SMEs are tackled. Furthermore, we present an (4) evaluation method which allows to validate the impact. To ensure an optimal effectiveness, the maturity level of SMEs should be developed in manageable steps. Thus, we present (5) methods to assess the current state. The findings serve as an input for the planning of the transfer process.

The main result of our research is an innovative technology transfer concept, integrating the (1) active principle of a technology platform and a (2) multi-stage model to successfully overcome the valley of death. Apart from that, we developed (3), (4), (5) methods for the strategic managing of transfer activities. A key factor to support SMEs to exploit the technological opportunities is a high adaptability of the concept to the company-specific demands.

## Economic and societal impact of technology / 118

### ICT Impact on Economic Growth: The cases of Egypt and India

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Egypt and India are both developing countries where ICT industry is a driver for economic growth. The World Bank outlines requirements necessary to adopt a knowledge economy which include (Rizk et al, 2015): A sound institutional and economic regime, An effective educational system, necessary to produce a qualified workforce, Telecommunications Infrastructure. These requirements, in addition to others such as governmental policies and initiatives, and available workforce would be the main pillars for evaluating ICT for economy growth approach for the following study. Egypt Ministry of Communication and Information Technology MCIT has defined seven major tracks of the national ICT plan paving the way for Egypt’s Information Society Initiative (EISI) (MCIT ICT Indicators, 2016). Tracks related to promoting ICT skills are eHealth for providing training to doctors, eLearning for a community where using ICT is a part of daily life, and eBusiness to improve workforce skills. Egypt’s Internet penetration rate grew from less than one percent in 2000, to 5% in 2004, 24% in 2009, (ITU, 2011) and 54.6% in 2014 ([www.internetworldstats.com](http://www.internetworldstats.com)). ICT’s expenditures represent 6% of GDP (Egypt ICT Indicators Portal). However, in most cases, graduates, once entering the employment market, they face the inadequacy between what they have learned academically and the tools that the

professional life requires. This has been overcome by several programs by MCIT. With an average rate of growth of close to 6 percent a year since 1980, there is some evidence that India's growth is accelerating and can be sustained at 8 percent a year in the coming decades (Mani S., 2014). Cheap and skilled labour is an important factor attracting FDI to India seeking pools of talent at competitive costs, especially in those countries that have actively helped to create this (incl. Singapore, Malaysia, China and India). Quantitative expansion of Indian higher education hinders raising the standards of higher education (Stella A., 2015). E-commerce and internet marketing in India and has got tremendously bright future in terms of the increase in number of customers and internet users increasing interactivity among businesses and their customers (Kalia P., 2015). Indian software exports are huge – roughly US\$75bn in 2014/15 (and US\$100bn if BPO services are included) – and continuously registering double digit annual growth. IT software/services' share of total exports remains roughly static: it was just under 14% in 2003/04 and just under 15% in 2013/14 (Time Series Data). For India, the IT sector which is currently valued at US\$143 billion is expected to grow at a Compound Annual Growth Rate (CAGR) of 8.3 percent year-on-year to US\$143 billion for 2015-16. The sector is expected to contribute 9.5 per cent of India's Gross Domestic Product (GDP) and more than 45 per cent in total services export in 2015-16 (www.ibef.org). ICT goods exports and imports as percentage of total goods exports and imports in Egypt over the period from 2008 to 2014 shows that ICT exports have increased significantly in 2014 compared to past years to reach 2.75% of total goods exports in Egypt in this year (STIIB, 2016). ICT has become a main contributor to the economy of these two countries with Egypt's ICT's GDP contribution is expected to reach from EGP 65 billion (USD 8 billion) in FY 2014-2015 to EGP 195 billion (USD 25 billion) in FY 2020-2021, while the ICT sector in India is expected to contribute 9.5 per cent of India's Gross Domestic Product (GDP) in 2015-2016.

**Technology management and competitiveness in the globalized world / 119**

## Trajectory data mining in R

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Spatiotemporal data is everywhere, being gathered from different devices such as Earth Observation and GPS satellites, sensor networks and mobile gadgets. Data collected from those devices might contain valuable information about different subjects, such as weather monitoring or mobility. Among these themes, moving object trajectory data has a particular interest in this work. Moving object trajectory is an example of Big Spatial Data (BSD). It meets the classical three features of Big Data: Volume, Velocity and Variety. Trajectory data sets are quickly becoming available for a larger collection of vehicles due to rapid proliferation of cell phones, in-vehicle navigation devices and other GPS data-logging tools. Such data sets are collected from different kinds of sensors with distinct spatial and temporal resolutions. In order to process this kind of data, there is a need for high-level programming environments that allow users to access big trajectory data sets and to develop new algorithms to analyze them. R is a software tool widely used for data analysis. It provides a broad variety of statistical methods (time-series analysis, classification and clustering) and a high-level programming environment and language suitable for fast developing of new algorithms. Although there are many packages for spatial and spatiotemporal data analysis, there are few R packages that work with trajectory data. In this work, we propose a framework that extends the R environment for big trajectory data handling. We present an R package that can access big trajectory data from different types of sources. In this work, we present existing tools for trajectory analysis, highlight their advantages and disadvantages and point out the need for a high-level programming environment that allows users to access big trajectory data sets and develop new algorithms over them. We implemented an R package for accessing big trajectory data by parts from different types of sources, as a solution to work in memory limited environments. Finally, we demonstrate this framework in a case study.

**Knowledge management / 120**

## Regional High-tech Industry Knowledge Transfer Ability Evaluation and Influencing Factors Study in China

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**Abstract:** High-tech industries, which are based on intellectually-intensive technologies and integrate multidisciplinary technological achievements, are the strategic leading industries of the Chinese national economy. The statistical range of the Chinese high-tech industry includes five categories: aerospace manufacture, electronics and communications equipment manufacture, computer and office equipment manufacture, pharmaceuticals and medical equipment manufacture, as well as instrument and meter manufacture. High-tech industries are important because they drive the world's economic layout, political affairs, and military competition. With the arrival of the era of knowledge economy, the contribution rate of knowledge economy to traditional industrial economy growth has changed obviously. However, it is the result to absorb the experiences of success to get the industrialized successes for any industrialized country. High-tech industries which established on the basis of the high-tech are the production and service sectors relying on high-tech research and development of high-tech achievements. High technology and industrialization became the important ways and directions for every country to get higher economic competitiveness. Knowledge economy reveals the importance of the knowledge for economic development, and the development of high-tech industry is the core of the knowledge economy. Furthermore, along with the further progress of the knowledge-based economy and globalization, previous studies show that development of high-tech industry has become a concrete expression of the strength of a nation or region. However, in china, the market has an increasingly higher requirement for innovation and technology innovation, with a series of problems, such as unreasonable allocation of resources, the flow is not smooth, irrational industrial structure. The study of knowledge transfer on high-tech industrial development is important because agglomeration is a process of gathering knowledge transfer. In this paper, we based on the data of 27 provinces in China during the years 2009-2014 by using the entropy TOPSIS model, which is to determine the knowledge transfer ability of high-tech industry. Then we regards the prior evaluation index as the dependent variable, the influencing factor as the independent variable by using the panel Tobit model, in order to process high-tech industrial. The research shows that the regional high-tech industry knowledge transfer ability exists some fluctuations and differences in the time dimension and the regional dimension. The Tobit model regression results show that the effect of government support and ownership structure is not remarkable, industrial structure, opening degree and market competition degree respectively plays a positive role. Thus, this paper can provide the effective reference for realizing China's sustained rapid economic development and improving China's high-tech industries innovation ecosystem, which undoubtedly has important theoretical value and practical significance in the China's present national conditions. **Keywords:** high-tech industries; knowledge transfer ability; Entropy-TOPSIS model; panel Tobit model; influencing factors

**Management of technology in developing countries / 123**

## **The performance Impact of Servitization on Capital Good Companies**

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Servitization is a business model that started in the 1980s and has quickly been used in corporate strategy, peaking with the advent of the Internet of Things (IoT). By the way, there is a crossover with information and communication technologies which treat them as a synonymy (Baines et al., 2016). Manufacturers have been shifting their focus in order to offer services jointly with their products as a way to create value to the customers (Neely, 2014; Baines e Lightfoot, 2013). Recent studies (Datta e Rajkumar, 2010; Benedettini et al., 2015; Kohtamaki et al., 2015) point that the servitization leads to a potential decline in economic performance, called "servitization paradox". Therefore, Neely (2009) shows that servitization has a positive effect on the profit margin of the companies. Similarly, Canton (1984) highlights a positive revenue correlation between products and services. This positive feedback is significantly strengthened by more sophisticated service

offerings, in which closer connections between the supplier and the customer present opportunities to identify new businesses. This paper aims to analyze the financial performance impact of servitization in Brazilian capital goods companies. A survey was conducted with 50 companies associated with the Brazilian Machinery Builders' Association (ABIMAQ). The data collected from each company were P&L and Net Income of 2013. Besides, Cost of Goods Sold, Net Revenue and Profit Margin completed the analysis. The companies' performance was compared according to their Profit Margin, Net Revenue and Cost of Goods Sold. A manual tabulation of the services offered by the companies was conducted, which was based on the 12 pragmatic types of service highlighted by Neely (2009). A classification was utilized to calculate the extension of servitization. The number of different services supplied by the companies was measured from 0 to 12 with weight 1. The data were processed by SPSS and Excel. Linear regression was used following the same method conducted by Neely (2009) in order to get the same comparison basis. The study reveals that the companies which have more services offerings raise more Net Revenue and increase Cost of Goods Sold. However, it is not possible to assume that the extension of servitization can increase Profit. The paper also contributes to identify the servitization stage of the publicly held Brazilian capital goods companies'. Thereby, it is possible to plan actions out at each stage to reach a better financial result. Data accessible to the public are granted only by publicly traded companies. For that reason, other types of companies were not included, which in turn reduced the sample, causing a limitation in the study. In spite of this limitation, the results open discussion about the implementation strategy to be adopted by the companies with regard to the extension of servitization. It is important to obtain a deep understanding through studies of multiple cases about the process of extension of the servitization and the stages the companies are in to create some managerial implications, especially regarding the maximization of profitability.

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## **Electronic Health Record Adoption in Brazilian Hospitals**

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The economic and social importance of technology used in industrial operations and services requires the process of choice of technology to be done carefully. In the health area - as it is indicated by frequent OECD reports, the US government and private companies that provide health services - the concern of public and private managers with the quality and costs of services provided to patients is increasingly evident. The literature in the area of industrial operations suggests that technological choice has to meet criteria that go beyond the simple maximization of economic returns. Such choice is influenced by environmental, organizational and individual factors. Many variables can impact the various stages of this process, as for example, acquisition and maintenance costs, efficiency of the production process and brand improvement. In the service area, however, and particularly in the medical and hospital sector, technology choice has been little studied. In previous work we proposed a theoretical model of choice of technology in healthcare organizations. The model includes the analysis of the various stages of the selection process, as well as the different factors that seem to influence decisions at each stage. The next step would be to evaluate if such model could represent well the Brazilian reality. As such, the objective of the present study is to evaluate the adequacy of this theoretical model in Brazilian hospitals. Given the large variety of technologies used in hospitals, we decided to focus on only one type of digital innovation: the Electronic Health Record (EHR). The EHR provides several improvements in the routine of a hospital, not only from the point of view of management but also in the exercise of medical activity. It's possible to have a better grasp of costs, profits and losses as well as to provide a better monitoring of material and human resources used. It can also increase the quality of the doctor-patient relationship, focusing on the humanization of care, increased attention paid to patient safety and the information gathered. To this end, in depth interviews were conducted with hospital administrators, doctors, nurses and technicians in 6 Brazilian hospitals. Previous conversations with specialists indicated that our case studies should be conducted with three pairs of hospitals according to the degree of implementation of EHR: two hospitals at an advanced stage, two at an intermediate stage and two with incipient implementation. Results indicate that although our model seems to represent well the process of choice of technology in the health area, (i) there are some stages that receive little formal

attention from hospitals (needs analysis, alternative analysis); and (ii) there are some factors (notably, medical culture and culture of other health professionals) that have such a strong impact on this process that can lead to inappropriate choices or prevent the achievement of the full potential of the innovation. We suggest that there is a need for significant cultural change as well as for the implementation of a more structured process of choice (as initially proposed by us). Our next steps will include (i) a survey study to evaluate propositions obtained in the analysis of the present cases; and (ii) comparative studies with hospitals in different stages of adoption of EHR, trying to relate the degree of adoption with results associated with quality of care and hospital costs.

**Product and service development / 131**

### **Selection criteria for technology alliance partners: conceptual model and application at a food industry company**

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Product and process innovation is essential to maintain competitiveness and companies have been creating an increasing number of strategic partnerships to pursue it. A correct assessment of partners' complementary areas is likely to lead to faster and higher quality innovation, while reducing and sharing risks among the partners. However, studies have also shown that many partnerships fail for a variety of reasons. There is a dearth of studies looking at the factors that determine success or failure in developing countries, mainly in the food industry and particularly related to partner selection criteria. The purpose of study is to: a) identify criteria for selecting the most appropriate partner in order to develop a technological innovation; b) identify the relative importance of these criteria. Initially, the study will review the literature on this issue and identify the factors involved. The model will then be applied to a Brazilian company that is currently selecting a partner for a strategic technology alliance. This company is JBS, a Brazilian company global leader in animal protein production with 340 plants in several countries, 230.000 employees and the ability to produce over 20 million tons of various types of food products including meat and meat products. Given the geographic breadth and wide range of new business opportunities in the animal protein sector, JBS aims to create a technology partnership that will leverage biomass and establish a foothold in the pharmaceutical inputs sector through biotechnology. It is currently looking at several Indian, Korean and Brazilian multinationals to select a strategic partner. Survey respondents will be employees from the company's new business area who are based in a wide range of countries and are responsible for selecting strategic alliance partners. The conclusions cannot be applied more generally given the case methodology limitations.

**R&D Management / 132**

### **Pathology of R&D management in subsidiary companies of Iran's Energy ministry and planning for the establishment of regional and sectorial innovation system in Khuzestan Water and Power Industry (Case study: Khuzestan Water and Power Authority Co. (KWPA))**

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This article has been deduced from the results of research activities of Khuzestan Water and Power Authority Company (KWPA). The first issue is the non-functionality of many research projects being done in KWPA during these twenty years. Given that this company has always had the first rank among the subsidiary companies of Energy ministry from the perspective of research analysis, the above mentioned issue exists in most of them. The second issue, is that the outcomes of most of research works are only booklets. This means that the results were not raw materials and technological products or services. The third issue is that many of the research projects being contracted with the local universities were eventually the share of within-capital (Ahvaz) universities. Thus, the universities located out of the capital had only one percent of the research contracts to be signed for themselves. In this paper these issues are explained and a solution will be offered to fix them. The applied technologies in Water & Power industry can be divided into six categories: 1-the technology of human sciences and soft technology, 2-the technology of monitoring, control and instrumentation, 3- simulator technology and co-decision making support of water resources, 4-the technology of water manufacturing and engineering, 5-hydraulic structures technology, 6-hydro power plants and renewable technology. These issues have caused that the needed technologies in the water industry are not taught at universities in the province or don't have applicable aspects. For example, Khuzestan produces more than 95 percent of the country's hydropower, but even one master's degree or doctorate in the field of hydroelectric plants is not graduated in the universities of the province. In other technologies such as law and economics of water, instrumentation and control, automation, water supply, etc. the situation is the same too. To solve these problems, we are trying to implement regional and sectorial innovation systems during the sixth five-year of Iran's development program. Considering this purpose, Khuzestan has been divided into six areas: 1-central, 2-north, 3-north east, 4-north west, 5-south west, and 6-south east. At the moment, memorandums of cooperation have been signed with provincial universities so that each university, according to its ability, works out in a certain research area. In addition, the center of technology development and commercialization exhibition have been set up. The three questions being mentioned at the beginning of the paper are answered by this solution. Firstly, it has been tried that the research projects be more various and include all six required sciences and technologies for subsidiaries. Also, there are a lot of attempts to pursue achieving these technologies and their commercialization until 1404 (2025). Secondly, the universities out of the capital have the same opportunity as the universities within the capital to carry out research activities. This situation has created an effective competition between the universities. Also, the cooperation with the universities located outside the province or outside the country will be gained by the discretion of the employer or university.

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## Consumer Demand Analysis Based on Text Mining Methods

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A large amount of data produced in the Internet every day has attributed to the rapid development of mobile Internet technology, the wide application of E-commerce, the popularity of intelligent mobile equipment and so on. Meanwhile, these data involve a mess of unstructured data, such as text data and multimedia data. However, the problem to be solved at the present is how to acquire potential and valuable information by making full use of unstructured data analysis based on Internet technology. This paper targets consumer demand and finds several problems existing in current demand analysis methods, which include inaccurate demand expression, belated demand source, high demand analysis cost and limited demand-acquisition approach. In the digital environment, consumers can express their comments on products and hopes for product quality. Therefore, those existing problems can be solved by discovering consumer demand from those online comments. At the same time, in terms of the rapid development of text mining methods like crawler, natural language processing, text categorization and cluster. Based on the above information, this paper makes an analysis of consumer demand by adopting text mining methods. First and foremost, this paper starts with theory of consumer demand analysis, analyzing source of consumer demand and its five characteristics which consist of dynamics, complexity, hiding property, affective reaction and fuzzification. It combines cyber-expressions of consumer demand and characteristics of text mining, thus discovering several advantages

that text mining has when used in the field of consumer demand analysis. Those advantages include reliability, rapidity, low cost, durative and real-time. Based on specific process of text mining, namely, data acquisition, processing and visualization, it also put forward that consumer demand analysis can be divided into demand acquisition, identification and expression, thus reaching hierarchical structure model of consumer demand analysis based on text mining. Then by compares and studies of text mining as well as hierarchical structure mode of consumer demand analysis, it considers that the acquisition of consumer demand information facing online comments can be finished by crawler, and vector space model and clustering analysis algorithm can be better used to identify and express consumer demand, thus putting forward double-spiral structure of consumer demand analysis. At last, this paper recounts the specific flow of consumer demand analysis based on text mining. Research findings of this paper consist in the conclusion of common steps of consumer demand analysis and division into demand acquisition, identification and expression, thus promoting hierarchical structure model of consumer demand analysis and double-spiral structure of consumer demand analysis. Besides, it also analyzes empirically and proves validity and feasibility of consumer demand analysis based on text mining. By means of deep analysis of consumer demand and research of text mining, research significance of this paper lies in providing a new consumer demand analysis method for enterprises, therefore, in the digital era, enterprises can increase acquisition rate of consumer demand in virtue of text mining methods, so that enterprises can rapidly identify consumer demand and help enterprises accurately target the real demand of consumer, discover potential demand of target consumer and promote more suitable products for consumer demand.

### Small and medium sized enterprises and innovation / 137

## Analyzing research fields related to design thinking

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Design Thinking (DT) is becoming a more important concept in both innovative major companies and growing startups. They are daily struggling on whiteboards putting on and off sticky notes, while they are also analyzing big data by the cutting-edge computing algorithm. DT and Data Analysis (DA) are coming to essential skill to their innovation. On the other hand, in research fields, we acknowledge a lot of valuable papers on DA but know less papers on DT. Actually we checked the papers related to DA and DT in the database of the Web of Science (WoS) provided by Thomson Reuter's. Consequently, we exacted 101,874 papers including the words "data analysis", but we sought only 975 papers including the words "design thinking" in the title, abstract, and keywords from WoS. We also found that the two clusters are almost completely separate. Next, we specified five main clusters which include over 30 papers through citation network analysis on the papers including the words "data thinking", and drew networking maps which express citation relationship among papers in each cluster. As a result, we found that each cluster was drawn as a form like a star, which means main "hub" paper was centered and cited directly from most of the rest papers.

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## CO-ADAPTATION IN COOPERATION FOR TECHNOLOGY DEVELOPMENT

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With consensus objectives, organizations established cooperation to optimize benefits, minimize replicated services, reduce costs, and enlarge professional networks. Cooperation optimizes capabilities and generates scale's economies. Therefore, organizations develop relational capabilities, which are, according to Alves (2015) the creation and the combination, of common resources,

intra and inter-structures, to manage conflicts, to promote trust, to transfer knowledge and information, to generate value and learning and to achieve process improvements, adaptations and/or innovations in interorganizational relationships. According to Alves, De-Carli and Segatto (2016a), coadaptation dimensions is part of the relational capabilities. It reflects the organizations' ability to proactively adapt to create new and effective product and process solutions. This research aimed to compare the coadaptation dimension of relational capabilities in cooperations for the development of non-profit and for-profit technologies. This research was proposed a qualitative, descriptive and exploratory research with analysis of ten organizations that cooperated for technology's development, divided between for-profit (Group P) and non-profit (group N). The data were collected through a semi-structured questionnaire and in-depth interviews, and they were analyzed by content analysis with case description and counting frequency of the factors' presence in the coadaptation dimension and its components. The results showed that the analyzed organizations identified in their coadaptation's dimension and its components twenty proposed factors. Aspects such partners' adaptation, focus on common goals and solutions for improvement process were most mentioned for group P. But for social organizations, communication between partners and focus on generated results in partnerships to increase social credibility were more cited. In addition, only group P prioritized the need for experience in the partnerships' realization, while group N emphasized the need to disseminate the created knowledge to warrant strategic dependence on knowledge and avoid disadvantage to partnerships. It was also realized that the results generated in the partnership were related to the capacity to evaluate them. The processes' improvements had affinity with previous experiences. The search for common solutions was integrated with proposed changes and solutions and to maintain close relationships, communication between partners was necessary. The research allowed to identify which of the twenty-two factors are considered more relevant in coadaptation dimension of relational capabilities for cooperations that develop different types of technology. Thus, the organizations that make up these alliances may seek to develop these items to maintain and advance their partnerships. In addition, the study expands the knowledge about relational capabilities, which it is a theme previously studied, but still has aspects to be approached and discussed. Another relevance of this research was the focus on cooperations that carried out for the development of non-profit technologies, because it is a topic of a few theoretical-empirical discussion. Recommended future research are related alliances' success and maintain based on the existence of the factors established in the dimensions of relational capabilities. It is possible to discuss similar researches, but addressing the other four dimensions (coordination, cultural, knowledge and technological).

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## **COOPERATION FOR PROFITABLE TECHNOLOGY'S DEVELOPMENT AND RELATIONAL CAPABILITIES**

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Cooperations are an agreement of two or more organizations, for resources and knowledge sharing, with mutual benefit. Partnerships can also solve complex problems and transfer technology, bringing yield and competitive advantage to firms. However, building and maintaining them is not an easy activity. Therefore, they need to be properly managed, structured and understood. By properly managing partnerships, relational capabilities are developed. They can be understood as creations and combinations of common resources, routines, procedures and policies within and between firms, to manage conflicts, promote trust, transfer knowledge, generate value, achieve improvements, adaptations and / or innovations in interorganizational cooperation. The objective of this research was to analyse the relational capabilities of cooperations for profitable technology's development. This research was based on Alves, De-Carli and Segatto (2016), and delineated a qualitative, descriptive and exploratory research, with the analysis of five cooperations for profitable technology's development. Data were collected through a semi-structured questionnaire and in-depth interviews. Data analysis included content analysis for the case description and frequency counting of the factors' presence in the dimensions and their components. The results demonstrated that twenty-two factors can explain the components and dimensions of relational capabilities in the studied organizations. In coordination dimension, the communication among the partners and the strengthening of the partnerships were highlighted. In cultural dimension, the organizations pointed out the need for partnerships to be formed with organizations with

very close values and culture, to generate more results and improve the partnership's processes. In knowledge dimension, the most cited factor was the adaptation to the partners. But the knowledge's strategic dependence and the partnerships' strengthening were also cited as important. In technological dimension, the highlight was the need to avoid losses at partnerships. In addition, it sought to improve processes and strengthen partnerships to achieve better results. Finally, in coadaptation dimension, it had the highest number of cited factors. Among them are the adaptation to the partners looking for common solutions, processes' improvements and common goals. The research identified which of the twenty-two factors are considered more relevant for the development of component and dimensions of relational capabilities. From this analysis, it was possible to understand how to improve the alliance's performance, setting effectiveness in partnerships management. Thus, among the management implications, organizations that develop profitable technologies could improve or deepen the influencing factors of partnerships' success. Thus, they could have successful partnerships, by creating, maintaining and publicizing their work, and guaranteeing faster and more efficiently access to resources. Among the academic implications, it is the greater discussion about: relational capabilities, cooperations and technology development. They have been little discussed and deepened, both individually and collectively. However, this research indicated that future studies to assess whether there are differences among the cited factors in different types of cooperation, as well as a more detailed analysis of each dimension of relational capabilities to understand them individually.

### **Economic and societal impact of technology / 140**

## **University-Industry Cooperation and Social Innovation: searching for a unifying model**

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The innovative capacity of a country or region is conditioned by the result of the relations between economic, political and social actors, with local cultural and institutional conditions (CASSIOLATO, LASTRES, 2008). In Brazil, such capacity depends on which region occurs and how the National Innovation Systems (NIS) policies are managed. Interrelated institutions that contribute to the development of innovations (ALBUQUERQUE, 1996; PLONSKI, 2005; STAL, 2006) compose the NIS. The parties interconnection provides the development of mutual skills. When there is a relationship between industry, universities and government, the innovation is strengthened (PORTO et al., 2011). This kind of relationship is based on resources allocation and infrastructure development, from the government to other parties (TOLEDO, 2015, p.337), what is the fundamental state of NIS constitution (CASSIOLATO, LASTRES, 2005). The use of knowledge and its incorporation into new production systems depends on this stimulus. Although the developing economies NIS, such as Brazil, occurs from developed economies practices, their actions can be elaborated to encourage the creation of new markets and to take advantage from technological innovation aimed at social change. In this context, the Social Innovation (SI) can be inserted comprehended as innovative activities and services that are motivated by social need and are predominantly diffused through organizations with social objectives (MULGAN, 2006). A technological focus and a future orientation may lead to the development of technologies for social and business application, because scientifically and technologically developed countries transform the society, in search of welfare, quality of life and progress. In this sense, this study emphasizes that university-industry (U-I) cooperation can allow integration of social, environmental and technological factors to the development of SI to the benefits of society. This way, U-I cooperation could allow the SI promotion and diffusion, making improvements in the social conditions of developing economies population. The study has a conceptual approach. Studies about U-I cooperation, SI and their relationship were searched. A single study (Benneworth and Cunha, 2015), connecting the themes, has been identified. It discusses that universities contribute to social process of social innovations by identifying and looking for ways to solve social problems. In the NIS, U-I cooperation is an instrument for social change, because of its innovations and technologies. This change comes from high social impact innovations which can improve quality of life: the Social Innovation. If innovation is a social process, that involves people communicating and sharing ideas (TIDD; BESSANT; PAVITT, 2008), the development of social innovations is allied to this perspective. People can interact to transform their reality to promote quality of life and social insertion. This way, it was identified a gap in the literature: the studies focus on

the characteristics, barriers, instruments and mechanisms about U-I cooperation, but it does not include the SI perspective. This type of study could be researched to propose specific and proper structures to promote SI. A profitable field of research in this area was observed.

**Technology transfer, marketing and commercialization / 141**

## **Technology Transfer and Public-Private Partnerships for Technological Development**

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Understanding the path for technological development and innovation is a longstanding matter of interest for economic and organizational researchers (Bozeman & Link, 2015). However, contemporary technological dynamism and global economic integration brought this interest back (Audretsch et al., 2014). Thus, frontier technology is an important source of competitive advantage for organizations and nations (Leischnig et al., 2014). Notwithstanding, technological innovation and development are not the only access to frontier technology. A viable option is technology and knowledge transfer (TKT), where an already established technology and the knowledge inherent to it that were developed in a given social, economic, cultural and technological context are adapted, transferred, and implemented elsewhere (Rosenberg, 2013). On developing countries, only transferring technology may not be sufficient for reaching frontier technology levels, since public research institutions and universities are the usual locus for technology development and innovation (Rausser et al., 2000). Thus, incentive mechanisms for bringing private actors back into technology development have been recently adopted, which is known as Public-Private Partnerships (PPPs), especially regarding biotechnology, biomedicine, and health care fields (e.g. Woodson, 2016). In Brazil, the efforts to develop frontier technology in a strategic area (public health) aligned technology transfer and PPPs in the program called Productive Development Partnerships (PDPs). In this paper, we aim to comprehend the path for the development of frontier technology in an emerging market context through the lens of TKT and PPPs. We investigated the PDP National Institute for Science and Technology in Diagnosis for Public Health (INDI-Saúde) in the field of molecular biology. Thus, we conducted a qualitative exploratory case study, gathering data through two stages in-depth interviews. The first was an exploratory interview for identifying the institutional context and the history of the arrangement, which led to the creation of a semi-structured guide for conducting second-stage interviews. Then, we conducted in-depth interviews with actors with strategic relevance for the PDP formation and evolution from 1999 to 2014. We analyzed data through thematic content analysis. We triangulated interview data with secondary sources, such as documents and archival data. We found that the arrangement was crucial for developing frontier technology in molecular biology in Brazil. The INDI-Saúde actors were brokers or gatekeepers of such technology, since they were able to gather frontier technology through TKT from abroad, applying, adapting, and developing such technology in order to transfer it to private biotechnology industries in Brazil. Our results showed that this process allowed the technological catching-up of the Brazilian biotechnological industry (Kim & Nelson, 2000), reducing technology distance from developed economies in the field of molecular biology diagnosis applied to public health. Our research contributes to extant literature on TKT and PPPs, since it shows how they may reduce technology distance and induce frontier technological development, especially on emerging economies. Considering innovation systems and strategic thinking debates, our research may contribute for discussions regarding economic and societal impacts of technology developed through initiatives alike PDPs.

**Future demands for work skills in the digital world / 143**

## **ROADMAP INDUSTRIE 4.0 – IMPLEMENTATION GUIDELINE FOR ENTERPRISES**

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Due to volatile and fast moving markets, increasing competition as well as more complex products and production, industrial companies are facing increasingly intricate challenges. Experts are talking about the fourth industrial (r)evolution, also called Industry 4.0 (I4.0). I4.0 focuses on an intelligent and transdisciplinary world in which smart factories represent the connection between digital and physical production networks. According to the DESI Index (Digital Economy and Society Index), Austria is ranked in the midfield of the EU member states concerning the degree of digitization. This development confronts Austrian companies with various challenges, in particular the pressure to strongly increase the level of digitization or to define the role of humans within new processes. Due to these demands there is a great need for a systematic approach to introduce I4.0 in enterprises respectively for a tool indicating the maturity level. Recently, there have already been presented some approaches existing in the literature or research projects (e.g. I4.0 Readiness Model from VDMA, Procedure Model for I4.0 Migration according to Fraunhofer). However, a general approach is not applicable for the implementation of I4.0, since an individual transformation process is required in order to identify, evaluate and utilize the specific I4.0 potentials of the respective company. In this paper an Industry 4.0 Roadmap developed in cooperation with a renowned Austrian company is introduced aiming at a structured and individual application of Industry 4.0 actions in industrial companies. Special focus is put on the relevance of employees, additionally required competences and their role within new processes. For the development of the 6-step I4.0 Roadmap a “top down - bottom up - approach” has been used. The core of the roadmap consists of maturity models covering the fields of purchasing, production, intra-logistics, sales and employees. The maturity assessment is carried out by evaluating the different maturity levels within MS Excel and is therefore easy to apply from the technical point of view. The 6 steps include general I4.0 analysis, a maturity analysis, the determination of the target state, development and evaluation of measures as well as the application domain and the determination of the specific roadmap. However, the I4.0 strategy must be defined and supported by the management, which is responsible for the initiation of I4.0 activities.

Within this paper the results for the field of employees are given. The introduced model has already been successfully applied at a company. The results of the internal evaluation are presented in the form of a network graph. This visualizes the current degree of digitization in the company and shows clearly where action is required. In addition, this paper presents exemplary measures for increasing the degree of digitization in that specific company.

With the development of a structured Roadmap for the systematic increase of digitization, a framework has been created which allows companies to evaluate main areas of activity concerning their I4.0 maturity and to derive desired target conditions. The maturity model targeting employees is comprehensive across all fields of activity and covers necessary competences and organizational requirements. In order to give deeper insight in the model, this paper deals with results of the self-evaluation in the field of employees regarding their I4.0 maturity.

**Complexity of innovation systems in the future digital world / 147**

## **Adapting National Innovation Systems in a Digital World**

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The rapid adoption of e-commerce and digital technologies to disrupt brick and mortar businesses and transform industries is under way with far-reaching consequences. The globalization of industries has connected once isolated national innovation systems (NISs; Nelson, 1993; Lundvall, 2007) heightening both similarities and differences between countries. Digital technologies have allowed industrialized economy firms to take advantage of low-cost locations around the world to outsource manufacturing while retaining the research and development and other skill-intensive tasks in high-cost locations. This innovation strategy has focused attention on new and emerging high-technology industries to take the place of traditional industries for innovation systems to remain competitive in the global economic system and to provide employment to those disrupted

by the globalization of supply chains and outsourcing. At the same time, the rise of China, India and other emerging economies and entry of emerging market firms as new players in the global economic system has increased competition. While rising income has reduced poverty in many emerging economies, NISs in emerging economies are concerned with raising the competitiveness of firms and industries while ensuring social and economic inclusion. Additionally, governments of both industrialized and emerging economies have focused on upgrading NISs to facilitate innovation, widely recognized as critical for competitiveness (Baumol, 2002). For example, India and China have focused on adapting their respective innovation systems (Fan, 2011). The interconnection of NISs suggests some level of integration at a global level (Meuer et al., 2015). Linkages with the global innovation system can be forged through: (1) institutional adaptation; (2) mechanisms for stimulating growth; (3) commercialization of innovations, locally and globally. This paper examines the research question: How do NISs adapt to remain competitive in a digital world? The paper uses two theoretical frameworks – NISs and complexity - to develop a conceptual model of NIS adaptation to promote innovation and competitiveness in global markets. Complexity theory (Holland, 1995; Iansiti and Richards, 2006) is relevant as it highlights the importance of diversity of interactions and linkages in a system. Case examples of selected NISs are provided to support the model and yield insights on innovation strategies. These insights can help to modify and develop other innovation systems and provide guidance on strengthening linkages in the global innovation system.

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#### Project and program management / 149

### Quality aimed Proposal of a Software development process

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Nowadays, technology has become an integral part of the daily routine. As a result of the phenomenon, the demand for quality and speed in regarding software production has been increasing, it is understood that generally preventing problems is far less resource requiring than solving problems. Failures in the software development cycle or software maintenance can be costly. Those costs may come in the form of financial damage or even as lost lives. Given this scenario, we developed a process applicable in software development quality. Allowing software to be developed in an Agile way, meeting all the demands declared by the clients, through studied frameworks and tools in synergy with Quality Assurance and related subjects, in which we collected our theoretical basis. We intended to optimize the development process, considering all the software cycle, providing a prototype of a robust tool that enhances the handling of information and the interpretation of final results by providing to all involved teams easy ways to follow the process. By all involved, we mean from technicians to project managers, offering decision making support, according to the established process.

**Knowledge management / 150****Social CODE**

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Communication is one the cornerstones of humanity. We can communicate orally or with gestures and more recently we started communicating via writing. This written communication evolved with our technology. We came to a point where it is difficult to imagine our lives without social networks, in which written messages are core. Such fact is interconnected with the always increasing need and desire for productivity. And with the advances of technology there is an increasing need for productivity, quality and minimum cost. To achieve such goals there is demand for people with specific skills, the need for people who understand how to program or at least who actually understand how programming works. In order to teach people those pressing abilities and making use of the need to communicate, we propose in this paper a social network for the teaching of programming languages. This social network should allow people to post tutorials, links, videos anything regarding programming. People interested in learning will have easy access to the content posted by more experienced users. The actual effect of such network is still being evaluated.

**Technology management and competitiveness in the globalized world / 153****Realizing core technological portfolio change through technological M&A**

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In high tech industries, the constant threat of technological obsolescence forces companies to renew their core technological portfolio in order to build up and maintain competitive advantages. Due to limitations of internal R&D, many firms employ external knowledge sourcing strategies to facilitate changes of their technological portfolio. Among the various external knowledge sourcing modes, technological M&As are a proper strategy for such a change as they allow the acquirer firm to assimilate the target firm's complete bundle of knowledge and expertise. While previous research extensively focused on the relationship between technological M&As and post-M&A innovation performance, it overlooked the role of technological M&As as a firm's core technology portfolio change strategy. The purpose of this research is to examine this role and identify factors which influence the degree of core portfolio change the firm can achieve through technological M&As. To this end, the research examines the direct effect of two key firm-specific factors, i.e., path dependency and combinative capabilities. Further, it also investigates the moderating effect of post-M&A target firm inventor retention which disrupts path dependency and enhances combinative capabilities. The hypotheses are tested on a dataset of 287 technological M&As conducted by firms in the biopharmaceutical industry from 2001 to 2008. Information on the M&A deals was collected from the Thomson Reuters SDC Platinum database. The research also collected data from DataStream and the United States Patent and Trademark Office database to measure firm's financial and innovation characteristics. Patents are also employed to identify the target firms' inventors and track their retention after the M&A deal. The results of the analysis show that the path dependency of the acquirer firm hinders the firm's core technological portfolio change. At the same time, the combinative capabilities of the acquirer firm can enhance such a change. The results also confirm that the target firm's inventor retention should be seen as a key success factor for core technology change through technological M&A as it reduces the negative direct effects of the acquirer firm's path dependency. This study contributes to the literature on



technological M&As by examining the effects of technological M&A as a core technology change strategy. Also, by highlighting the importance of post M&A target firm inventor retention, the study provides contributions to the literature on organizational learning and the evolutionary theory of the firm. The findings of this study provide direct implications for managers of firms who consider using technological M&A not simply as a tool for improving the overall innovation performance of the firm, but as a strategy for renewing the firm's core technological portfolio. In this case, the post-M&A integration process should be carefully managed to increase the retention of the target firm's inventors.

Key words: technological M&A, core technological portfolio change, path dependency, combinative capabilities, inventor retention, technology management

## Product and service development / 154

### How a firm without a fundamental technology gains advantages

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The purpose of this study is to examine how a firm without a fundamental technology gain competitive advantages. This research uses the fundamental technology as a key word. The fundamental technology is the technology that satisfies two requirements. One requirement is a technology for working the "basic function" provided by a product. Secondary, when each firm enters the market, its fundamental technology is recognized as the technology composing the primary part of the product, and fundamental technology decided by the overall industry. The recognition subject is the set of manufacturers, and the timing for recognizing the fundamental technology is an introduction stage in the industry. It is the technology that is developed continually and improves the function level. In contrast, the peripheral technology is defined as the technology concerning all devices except the fundamental device.

In order to solve research question, this research adopts qualitative research approach (Yin, 1984; Eisenhardt, 1989) as research method. It picked up 3 cases, such as Sony in the flat display TV industry, Casio in the digital camera industry and Nintendo in the home game machine industry. I had interview with product managers of Sony and Casio, competitors and device makers. I also used the secondary data, such as websites, newspaper, several journals and statistical data.

From 3 case studies, this research extracted the two advantage of the firm without fundamental technology. First, those firms have a flexibility to respond quickly to environmental changes at low costs. In this research, we call its advantage an economic advantage. This advantage was known as strategic flexibility in existing researches. In addition, this study then found that wide selection in procurement means that such firms can choose the highest-performance center technology product from several options and switch easily among manufacturers for low-cost and flexible response to both technical and market demand changes in a highly competitive environment.

Second, this study also found another advantage of firms without fundamental technology—an organizational advantage. The economic advantage on the financial side of the firm brings advantages from building relationships with external sources in order to reduce the firm's costs. In addition to cost reduction, such firms enjoy an organizational advantage in decision making and organizational behavior. The organizational advantage consists of an activation of converting the product strength and an organizational sense of crisis. The activation of converting the product strength means exploration of new competitive factor and exploitation of accumulated technology, and the organizational sense of crisis does psychological energy supports the development of a product that is different. The firm without center technology makes the best use of these two advantages and develops innovative product which has new competitive factor in its industry.

In conclusion, this paper points out the firm gains the two advantages, economic advantage and organizational advantage. The economic advantage points that the firm without fundamental technology can gain flexibility by wide selection and switch easiness in device procurement. Moreover, the firm without fundamental technology think out a new competitive factor and produce a real product which is supported by organizational sense of crisis.

## Management of technology in developing countries / 155

**Identifying monitoring indicators for emerging technological opportunities****Author(s):** Ms. OH, Eunkyeong<sup>1</sup> ; Prof. SHIN, Juneseuk<sup>2</sup>**Co-author(s):** Mr. LEE, Yongseung<sup>1</sup><sup>1</sup> *Department of Graduate School of Management of Technology (MOT), Sungkyunkwan University*<sup>2</sup> *Department of Systems Management Engineering & Graduate School of Management of Technology (MOT), Sungkyunkwan University***Corresponding Author(s):** oheun1115@gmail.com

Monitoring of emerging technologies needs indicators which are more sensitive to changes in context and time (Porter, 1991). To this purpose, organizations have depended on qualitative expert judgment, but it has increasingly suffered from reduced sensitivity and accuracy (Ranjbar and Tavakoli, 2015). A better way of monitoring is needed. As either alternative or supplement to expert judgment, some researchers suggested various quantitative indicators including number of patents, number of new products and others (Valk et al., 2009). However, it is not clear what indicators are good for monitoring of emerging technologies, and how we can identify such indicators because each indicator has advantages as well as disadvantages. Therefore, in this paper, we suggest a method of identifying appropriate quantitative indicators for emerging technology monitoring. In the existing literature, appropriateness of monitoring indicators can be evaluated from three perspectives: 1) sensitivity to technological changes, 2) sensitivity to changes in external context, and 3) robustness to noises. In other words, good monitoring indicators send signals when important changes occur, but move little according to noises and accidental events. Through literature review, we collect monitoring indicators and their time-series data of four emerging technologies over last five years. Selected technologies consist of building-integrated photovoltaics system, lumber support, 3D animation platform, Probiotics and automatic insulin pump. We define changes in technology, context and noise through document analysis of papers, patents and news, and measure sensitivity of each monitoring indicators to three factors by using the first-order sensitivity index. The index measures the contribution of each change alone to the variance in monitoring indicators. For five emerging technologies, we find some indicators that are sensitive to more than 70% of changes in technology and external context, but are sensitive to less than 10% of noises. These are good general indicators. However, some indicators are sensitive to more than 90% of changes in either technology or external context, and therefore are useful to monitor a certain kind of changes. By using these results, we can create a sequential use of indicators to identify a specific change in either technology or external context, and then to identify a clear shift in both aspects. Our finding can be useful to monitor emerging technologies on both public and private sides, and help policymakers as well as managers make good decisions for science and technology policy, R&D and further business.

**R&D Management / 156****Bayesian MCMC Analysis on Growing Biotech Start-ups under Lehman Shock [U+FF1A] Focused on Signaling Function for Democratic Innovation**Prof. FUJIWARA, Takao<sup>1</sup><sup>1</sup> *Toyohashi University of Technology***Corresponding Author(s):** fujiwara@las.tut.ac.jp

NASDAQ Biotechnology Index (NBI) has been more steady than Dow Jones Industrial Average. And digital technology is promoting democratic innovation.

Start-ups are more excellent in speed, cost, and flexible management than large market-oriented pharmaceutical companies to integrate the innovative technology with the niche market. However, most start-ups are in negative profits except dozens of companies in the US 1500 biotech start-ups, because of 'Death-valley' as negative profits period for the drug development in the average 12 years, US Dollars 3 billion, and success probability one millionth.

On the other side, the Crowdfunding in FinTech which has developed in digitization, is superior to collect constant funds from a large number of investors even if each small financial amount,

and can function as the mediation between angel investors and venture capital (VC) by signaling, based on a virtual marketing research.

As research questions, is it possible to reduce the waste of high birth and high death rate type innovation at start-ups ecosystem, by applying Bayesian Markov chain Monte Carlo (MCMC) analysis as one of artificial intelligence (AI) methods? Is there what kind of R & D investment decision difference between the present Growth type and the Stagnant type biotech start-ups, for overcoming past 'Death-valley' just after the financial crisis as Bankruptcy of Lehman Brothers? As a key concept, biotech start-up is defined as a portfolio of real options which assume the commercialization ideas of life science as the underlying assets. Among the NBI components, this paper selected 72 companies of which data in both FY 2009 and 2015 are available from the U.S. Securities and Exchange Commission (SEC)'s EDGAR database, classified into the Growth and the Stagnant biotech start-ups based on the increase ratio of their stock prices between FY2009 and 2015, and compared the characteristics of the research and development (R&D) investment of both type start-ups with the net income (loss), R&D expenses, and stockholders' equity values by applying Bayesian MCMC hierarchy model.

While the growth rates of stock prices in the Growth group are higher in the six years towards FY 2015 if the lower the stock prices of FY 2009, the higher the stock price of FY 2009 is, the higher the stock price of FY 2015 is, compared to the Stagnant group. In FY 2009 83% of the Stagnant group and 66% of the Growth group are, and in FY2015 72% of the Stagnant group and 52% of the Growth group are respectively deficit companies. In the 6-year net income (loss) fluctuation, there is a positive correlation between both fiscal years in the Growth group, but in the Stagnant group the correlation is weak and chaotic.

There is a negative influence in the Stagnant group between the net income and R & D expenses in both fiscal years, and FY 2015 is more influential than FY 2009. On the other hand, in the Growth group, there is a positive contribution to net income by R & D expenses, and FY 2015 is more influential than FY 2009. Between net income and shareholders' equity value, the correlation is weak and chaotic in the Stagnant group. However, in the Growth group, there is a positive and clear relationship. Thus it is possible to evaluate the potential value of even a deficit company.

If FinTech can leverage the market mechanism through the Internet and the Cloud-funding management companies can adopt the screening method for the business plan by experts, a signaling function of FinTech can be expected especially for VC investment in neglected diseases.

**Small and medium sized enterprises and innovation / 157**

## **Innovation in products based on agrobiodiversity produced by Peruvian PYMES (SMEs)**

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Peru is renowned as one of the seventeen megadiverse countries in the world (Conservation International, 1998). It is estimated to hold 25,000 flora species, 30% of which are endemic. This extraordinary biological diversity offers endless possibilities for its sustainable use which can be enhanced even more through the generation of added value coming from the investigation to generate knowledge. (Proambiente, 2015). The main objective of this investigation is to determine the level of innovation in selected products from the Peruvian agrobiodiversity as well as the sectoral characteristics and conditions of the PYMES crucial to succeed in sustainable bio-businesses. Therefore, structured personal interviews were executed during September 2016 in the Expoalimentaria Fair premises, the main Latin American beverage and food fair. 57 out of 65 companies whose offer included derivatives from the four products from the Peruvian biodiversity analysed: maca, yacon, camu camu and sachu inchi were interviewed. This sample ensures 95% reliability and 5% margin of error. Based on the literature (Jong and Vermeulen, 2006; Montoro-Sánchez, M. Á. et al, 2012), questions oriented to know: business characteristics, specialized investigation connection and level of innovation were selected. Regarding the first

topic, the role in the value chain, crop types (organic and conventional) and international sale importance highlighted. Dealing with scientific investigation, questions about the main investigation objectives, economic sources and academia-company cooperation level were asked. Finally, regarding the innovation level, an approximation to the number of products offered, types of presentation and target market was made. The main results show that only 40 out of the 252 products, less than 16%, could be considered innovative mainly because they come in presentations not generally offered by the competitors. Although more than 90% are exporting companies, these products are oriented to the local market in small volumes while the exported products are mainly intermediate products: powders, gelatinized and dehydrated products and extracts. On the other hand, although 100% considers that investigation is Indispensable for the product development, only 51% was involved with investigation processes at that moment. Only 35% stated to have been involved in the last two years with laboratories and/or university researchers or institutions of the like because their products are developed mainly by their quality assurance personnel. Also 74% identified limited economic resources as the main restriction for investigation, although 77% had not applied for the non-contestable funds offered by the government since 2014, due mainly to not knowing they existed. The first conclusions indicate that within the framework of the interviewed PYMES (MSEs) about products selected from biodiversity and although resources such as specialized researchers and funds for their development are available, there are no organizational strategies of collaborative work for adding value to these products through scientific investigation which hinder the link between science, technology and innovation.

**Technology management and competitiveness in the globalized world / 158**

## **Preadaptation strategy in technology management**

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Technological evolution brings big change in business and in many cases, just few companies can survive such situation. Digitalization drove out photographic film from the market and most of film makers including Eastman Kodak failed to change its business portfolio and survive. One of the exceptions is Fuji Film. There are many comparing analysis of management aspect of Kodak and Fuji after crisis. Previous studies have shown that after a long period of film business success, Kodaks core competencies became core rigidities and making change was difficult. Also, it is shown that organizations culture change was very difficult, especially in Kodaks bureaucratic organization staffed by risk-averse managers. Malfunction of Kodaks top management is also pointed out. Meanwhile, it is discussed that Fuji achieved proper business change under the strong leadership of CEO Komori, and succeeded business diversification in a short time. New business fields of Fuji include pharmaceuticals, cosmetics, diagnostic digital imaging, LCD film and so on. Technological diversification should be ahead of business diversification, especially in case of the business with high technology. However, technological diversification takes long time, so it is difficult to take an opportunity of business diversification in a timely manner. This is critical issue to survive the era of technological drastic change. Purpose of this study is to analyze how a firm responds to a big change, and clarify the conditions that make a firm possible to create diversified business in appropriate time period. We focused in the process of technological diversification that is needed to create diversified new business. We analyzed patent data of Fuji and Kodak to visualize the range of technology by a time series. International patent classification (IPC) code was used to distinguish field of technology. Number of variety of IPC subclass code and its Herfindahl-Hirschman Index (HHI) of each year were calculated. Interviews to senior managers of Fuji Film and other companies were done. It became clear that Fuji was extending its technology field between 1994 and 2000. The number of IPC code variety was increasing and HHI was decreasing in the period significantly. Market decline of photographic color film started 2000 and Fujis mid-term strategic plan "Vision 75" started in 2004. This means that Fuji Film had started its technology diversification in advance of business big change. On the other hand, Kodak did not show such clear strategic activity in this period. Kodaks IPC code HHI started to decrease only after 2000. This new findings may help to understand why Fuji could survive big change caused by digitalization and Kodak could not. Technology diversification takes long time and business organization should prepare long time before business change is expected, so precise and visionary technology management is needed to make it possible. We named this kind

of maneuver as a “Preadaptation Strategy” of technology management in the era of big change. Preadaption is a term of evolutionary biology and describes a situation where a living creature uses a preexisting anatomical structure inherited from an ancestor for a potentially unrelated purpose and function. By extension, preadaptation strategy of technology management means a process that company diversifies its technology in preparation for big business change in advance. As technological singularity is approaching, this concept may provide important suggestions to the management of technology in high-tech industry.

**Green technologies and sustainability / 160**

## CONCEPT FOR ENHANCING MACHINE ELEMENTS BY RESIDUAL STRESSES AND TAILORED FORMING

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Due to the current demand to reduce the power consumption particularly in the transportation sector intensive research is carried out to reach resource efficiency. To fulfill future trends in resource efficiency machine elements offer possibilities to enhance the surface and part properties and to reduce the components weight and costs. By applying residual stresses to bearing surfaces it could be proven, that the bearing fatigue life can be increased by a factor of 2.5. For this purpose manufacturing processes have to be adopted. With an enhanced surface the machine dimension can be reduced to fulfill the required function. In a next step hybrid machine elements with tailored material properties are designed and manufactured. Concerning this, a shaft with an integrated raceway made out of a higher strength material than the shaft itself was developed. The raceway of the shaft acts as the inner ring of a bearing. This complex machine element combines various requirements in one part like resistance against elongation, stiffness and a surface under cyclic rolling contact fatigue. For the hybrid shaft the raceway should resist the rolling contact fatigue and mechanical wear, while the main material for the shaft consists of a more lightweight and cheaper material. In order to manufacture said shaft, intensive research on the whole product engineering process is done.

Simulations were performed proving the reliability of the concept. Doing so, the resulting stress field from the superimposition of load stresses and residual stresses is computed based on the model of Ioannides, Bergling and Gabelli [1]. The approach consists of a FE model of a bearing inner ring that has been developed in order to calculate the three dimensional stress state. As input variables the Hertzian pressure as external load and residual stress depth profiles, which are defined as initial stresses in the model, are used. The maximum of the applied Hertzian pressure is  $p_{max}=2500$  MPa. A result of the numerical calculation is the orthogonal shear stress beneath the surface. The size and location of the maximum is required for the fatigue life model of Ioannides, Bergling and Gabelli. It is based on the model of Lundberg and Palmgren [2] and is expanded with a stress fatigue limit. A proper fatigue stress criterion has to be used, which in this case is the criterion of Dang-Van [3]. This includes the maximum orthogonal shear stress and the local hydrostatic pressure  $p_{hyd}$ , corrected for residual and hoop stress. The hydrostatic pressure can also be calculated with the FE model.

The concept was evaluated with bearings manufactured by various machining processes to achieve subsurface residual stresses. A significant increase in bearing fatigue life could be proven. Current work is done to evaluate hybrid machine elements. Doing so a test rig was set up and tests on first tailored formed machine elements were conducted. These first results and the feasibility of the concept are presented. With the presented findings machine elements with tailored properties can be designed whereby resources can be saved due to components lower weight and costs.

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**Small and medium sized enterprises and innovation / 162**

## **Front End of Innovation in Start-up Companies: An exploratory study regarding innovation framing and desired outputs**

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Innovation Front End is an important topic in Innovation Management, especially when considering Start-up companies where most of the company success is derived from a well developed idea and business plan. Digitalization and digital transformation are fields where Start-ups are very present and have a key role in the innovation processes of many industries.

Although a topic with increasing interest, the literature regarding Start-ups is yet scarce and research considering the Fuzzy Front End actives in these companies are even more rare.

Fuzzy Front End in large companies is normally composed by three major steps: Idea Generation, Product (Service) definition, Project Evaluation (Kim & Wilemon, 2002). In Start-up Companies, innovation project and company is tied together as almost a single entity. In other hand, big corporations uses mechanisms such Innovation Awards, partnerships and Merger & Acquisition processes to practice the so called Open Innovation (Chesbrough, 2004).

This article aims to reduce the scientific gap in this area studying 222 Start-up companies that participate in a Innovation Award promoted by German-Brazilian Commerce Chamber and sponsored by five major German organizations: Bayer, Basf, Siemens, Volkswagen and Club Transatlantico.

In this paper, the proposal is to use primary and secondary data sources. The primary data source is the interviews with organizers of the Innovation Award of the Brazil-Germany Chamber of Commerce (AHK) to understand the criteria used in the selection of start-ups to be awarded, the motivations behind the project and The interest of the sponsoring companies in relation to the categories to be awarded that were Sciences of Life, Culture, Cities of the Future, Digitization and Mobility.

The secondary data source is the AHK Innovation Award database on the Start-ups platform known as Fundacity.com. Fundacity.com is a platform that has until the present moment more than 72 thousand active users, 42 thousand Start-ups, 1,600 groups of investors in 175 countries. From this universe, we will study the 222 Start-ups that have applied to participate in the AHK Innovation Award. For that two different multivariate data analysis were implemented: Association Analysis and Text Mining.

The association analysis is to identify correlation between being well succeeded in the selection process composed by five phases (desclassified, 1st Round, 2nd Round, Finalists, Winners) and five structural factors: comprehension of Problem & Solution, Proposed Innovation & Applied Technology, Market, Business Model and profile of Team & Entrepreneur.

The text mining analysis is to identify concepts among the data provided by the Start-up to their evaluators that could improve the chances of being well evaluated in the classification processes. The data gathering and preparation processes are over and the research is ending the phase of data analysis and final discussions. Final results are expected for early January 2017.

**Technology transfer, marketing and commercialization / 164**

## **Europe's first certified training on Knowledge & Technology Transfer**

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This talk will give a comprehensive overview about the first fundamental and holistic training for knowledge & technology transfer experts (brokers) and institutional intermediaries. It will describe in detail the new ISO 17024 certified training program and the reflections (and evaluations) of the trainees from five Austrian Universities. The training program was carried out for the first time as a pilot at Montanuniversität Leoben, Austria. The qualified education program was developed to cover the needs of experts to deepen the knowledge and expertise in technology transfer, since there haven't been any adequate vocational training opportunities before. The program is structured in 15 different modules comprising basic and in-depth knowledge of professional technology transfer. The training program foresees a studying period of about one year with 21 training days. The program includes methods and know-how for knowledge- and innovation management. Also trained are methods and tools for project work as well as for the management of events. Further, a closer consideration is done on the management of co-operations, on methods of problem analysis as well as on communication. Deep insights and workshops are given to futurology and its methods, to the evaluation of knowledge and technology. Searching methods are taught to be able to make technology monitoring as well as searching the state-of-the art (prior art) or the freedom-to-operate within web based patent- and literature databases. The dealing of the knowledge and technology (especially within academic publications or by protecting via patents) and the "cooperation model" are further issues that are considered in the training program, beyond methods for national and international development of transfer strategies. Last but not least, principles for entrepreneurship in sight of a university (potential. Start-ups and Spin-offs, advantages of incubator centres) are taught. The participants taking part in the training program have to demonstrate their improved competences by performing a project work. The results of that project have to be presented to an examination committee which is authorized by the certification. The vocational characteristic of the program allows the combination and interaction of daily required application and learning. Trainees of this program get the basics and improve their competences, skills and expertise for the transfer or exploitation of scientific results. These competences enhance the dissemination of knowledge to the market or into the society and increase the speed of transfer of technology to new and fascinating social compliant and environmental compatible products or processes. Main tasks of Knowledge & Technology Brokers are the institutional support of tasks connected with the exploitation and expansion of commercial opportunities, particularly with regard to university-based inventions, and the dissemination of knowledge in order to facilitate the transfer of knowledge to industry and society. The program will be reflected and regularly improved according to the needs of the market players and the scientific institutions. The certificated program will be offered by Montanuniversität Leoben on a regular basis. The development during 2015/2016 and the pilot training program Q1/2016 till Q1/2017 was supported by funding of the Federal Ministry of Science, Research and Economy within the co-operative projects Knowledge Transfer Centres, IPR exploitation and by the aws Austria Wirtschaftsservice(1). (1)See <http://www.awsg.at/Content.Node/innovation-investition/patentservice/foerderungen/98017.php>

**Product and service development / 165**

## Mapping Product Portfolio of Energy Service companies in the USA

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**Abstract** Following a sequence of oil price hikes in the 1970s, the USA needed to address the challenges of high-energy costs and inefficiencies in its use. Since the USA was by far the largest energy consumer As in the World and reliant on imported energy, the policy makers realized that in addition to the increasingly serious environmental pollution related to energy consumption, energy inefficiency directly threatened the country's energy security. In the 1980s, a market-oriented mechanism to implement, promote and improve energy efficiency emerged

and the energy service sector and companies (ESCOs) appeared. Through a nearly 30-year development process, US energy service sector is widely seen as a successful model for private sector delivery of energy-efficiency technologies and services (Goldman et al, 2005). The study of the energy service sector and ESCOs in the USA have attracted many researchers. Goldman and Dayton (1996) conducted a study to identify market trends in the sector. Vine et al (1999) evaluated the US ESCO industry. Goldman et al, (2005) analysed market trends in the sector with empirical analysis of project data. While the existing literature on the sector and ESCOs is scarce, it is still extremely informative (Okay, 2008). This paper reports on a study of a sample of 112 US ESCOs which are qualified by the US Department of Energy through the perspective of their product portfolios. Our main source is based on secondary data from the companies' official websites and the Department of Energy. The product portfolio of an ESCO not only helps it to achieve its strategic objectives, but also to improve its competence and competitiveness in an increasingly fiercely competitive market. In this paper, we show where the companies are located, whether they operate in multiple locations and draw a map of the range of products and services they offer which constitutes their product portfolio. This paper makes a contribution to the academic literature by expanding research of the ESCOs sector in the U.S from perspectives of locations and product portfolio. It also makes a contribution to business practice as it benchmarks product portfolios and helps to identifying new products and technologies which could assist with new innovation and improvement of positioning within the sector. Further research on product portfolio management, qualitative data collection and analysis are needed in developing countries to enhance their energy efficiency strategies. The focus of this study makes our findings very relevant for ESCOs, investors in the energy and energy services sectors and policy makers in developing countries.

**Management of technology in developing countries / 166**

## **Corporate Acceleration: analysis of three programs in Brazil**

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The competitiveness is closely related to the companies' capacity to generate, transfer and apply technological innovation. However, established organizations face a great challenge to incorporate external technologies and innovative practices, in part due to their organizational inertia and internal pressures for operational excellence. Recent literature proposes that establishing relationship with startups is a promising way for those companies to learn, since startups act as a source of new ideas and business opportunities. In addition, companies can benefit from the interaction with the startups' ecosystem, as an environment that favors the fast absorption of new practices and technologies. On the other hand, startups can also benefit from the direct interaction with companies, since they can use the knowledge of the company's employees and its network to catalyze the growth of the nascent business. In this context, a Corporate Acceleration Program (CAP) is a formal organizational initiative to invest in and support a number of startups leading to a fast growth of ventures. This study aims at analyzing CAPs and identify the key parameters, similarities and challenges to design and manage them.

The experience of three large companies in Brazil is studied through semi-structured interviews with the managers directly involved in such programs. The case-selection was based on the following criteria: companies that work with corporate acceleration, and that have a program set with initial results available. The variables analyzed include: program structure, its investments, people involved, forms of startup integration, program time and general targets.

Finally, the paper discusses the similarities, challenges and initial results of these initiatives, comparing them with the literature recommendations in the light of local contingencies. Moreover, it identifies gaps and propose complementary recommendations for both theory and practice.



The article brings to the discussion a form of building innovation capability in large companies that merges non-organic and organic perspectives. The corporate acceleration is non-organic when capturing opportunities from attracting and interacting with startups, and it is organic at the time that an internal program is designed to nurture the approach with startups and such a program promotes interactions between startup teams and people associated with current operations. By doing so, the study contributes to the congress by fostering questions as follows: Which concepts can be developed to manage the complexity of innovation systems?; Which novel organizational processes are required?; Which models will support the investment in corporate acceleration initiatives?; How can new business models enhance the success of SMEs and large companies?. The article is best associated with the following event themes: project and program management, technology management and competitiveness in the globalized world, technology transfer, management of technology in developing countries and new business and investment models in the digital world.

**Management of technology in developing countries / 167**

## Assessing the impact of new healthcare facilities

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As populations in developing countries continue to grow, and the demand for healthcare services increase, questions frequently arise regarding the allocation of resources towards the development of new healthcare infrastructure. In order to balance resources between the tiers of the healthcare facility hierarchy<sup>1</sup> in a way that ensures optimal healthcare provision, it is paramount that decisions concerning the expansion of the healthcare service provision network should align with a clearly defined strategy.

At a strategic level, it is often difficult to evaluate alternative healthcare infrastructure expansion options and to select the optimal solution (given the current healthcare system) without the use of a decision-making tool. An example of such a tool is impact assessment. In this paper, an impact assessment methodology is developed that can be used to inform the healthcare infrastructure expansion strategy of regional healthcare authorities through the holistic evaluation of the (future) impact of new healthcare infrastructure, with a specific focus on healthcare facilities.

Perspectives from which the provision of a new healthcare facility are evaluated include: (i) the impact of the facility on the healthcare provision network as a whole; (ii) the impact of the facility on the total healthcare provision cost for the population that the facility serves; and (iii) the impact of the facility on healthcare outcomes amongst the population that it serves.

While a multitude of impact assessment frameworks and applications are available in literature, the suite of existing impact assessment frameworks does not fit the need of the assessment required by the healthcare authorities in South Africa, as no available applications consider the specific perspectives relevant to the study. This lack of literary support confirms the need for a framework created with the specific aim of evaluating the impact of new healthcare infrastructure from the mentioned perspectives. Such a framework is thus developed through a thorough evaluation and juxtaposition of the various impact assessment frameworks and applications in literature, leading to a method suitable for the specific application.

In future research, the methodology will be applied to a newly constructed district hospital to compare the relevant data metrics before and after construction. This will enable a prediction of the impact of this kind of facility on the three perspectives mentioned above. While the accuracy of the prediction may be limited initially, the methodology is constructed in a generic enough way that it will can be applied to a number of facilities in the future, leading to increased predictive capabilities.

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<sup>1</sup>Possible facilities in the hierarchy include clinics, district/provincially aided hospitals, midwife obstetrics units, mobile services, psychiatric hospitals, regional hospitals, reproductive health facilities, specialised healthcare facilities, Tuberculosis (TB) hospitals and tertiary hospitals.

**Small and medium sized enterprises and innovation / 169****Integration of technology management, prospective and innovation strategy: the case of a luminaire manufacturer****Author(s):** Ms. MARCHE, Brunelle<sup>1</sup>**Co-author(s):** Mr. BOLY, Vincent <sup>2</sup> ; Mr. CAMARGO, Mauricio <sup>2</sup><sup>1</sup> *Equipe de Recherche sur les Processus Innovatifs*<sup>2</sup> *Equipe de Recherche sur les Processus Innovatifs / Université de Lorraine***Corresponding Author(s):** vincent.boly@univ-lorraine.fr

Technology management is a major concern for IAMOT community, it deals among other with observing company strategies and developing management approaches to help top managers in the definition and valorization of technologies allowing the development of the company. In this research technology is considered as a complex system of knowledge and know-how supported by equipment (Yanez and Kahlil, 2010). This includes scientific and technical knowledge as well as business abilities (knowledge mobilized for the economical exploitation of technic: supply chain management, sales and other businesses). Literature attests of decision aided approaches to strengthen the elaboration of the technological strategy of companies (Cooper, 2000; Kaplan and Jarzabkowski, 2006; Kim and Mauborgne, 2010). These approaches are always evolving as the context of companies is changing. In this research on the identification of scenario about the company's profession and knowledge of tomorrow and the corresponding tomorrow business ecosystem outside the company, the following concepts are studied and combined: - The theory of evaluation applied to the field of knowledge. Attention is directed toward the data collection and treatment approaches required considering some theoretical aspects: the existence or not of standards, the influence of the evaluator on the system to be evaluated, the importance of the scale and context (does a particular knowledge have the same interest and value according to the targeted markets?) and the knowledge dynamic (considering employees mobility and the effects of experience among others), - The concept of Value. The evaluation of Value is a major concern when choosing the technology to adopt in the company (Kumar and Reinartz, 2016). Value is considered as multi-criterial with the integration of financial, marketing, reputational, sustainable and strategic criteria (Boly, 2016). One problem is the temporal dimension: Value is unstable if considering short or long term, - The notion of innovation. On many markets, innovation becomes an asset for competitors. Then, the newness degree of the potential products that can be produced with a candidate technology is important in the decision process (Garcia and Calantone, 2002). Moreover, as being the first to launch a product on the market may be crucial, the newness degree of the knowledge to be valorized itself may be an element to focus on, - The notion of prospective scenario. Technology is moving, hence some authors consider digitalization as a world revolution (Lindstone, 2011). Then, uncertainty remains high on the future context of companies and consequently the elaboration of different scenarios modeling different potential future environments of the company is applied. Moreover, technology may require heavy investments and then a long term exploitation, as consequence the long term impact of a technologic choice has to be studied.

In this research, to contribute to the scientific production about technology identification and evaluation in a context of innovation, the previous concepts are studied and their combination is analyzed thanks a literature review. As one objective is to elaborate a decision-making aid approach, a data collection and treatment approach is suggested including: an internal census of the core competencies, data about the environment, scenarios about the emergence of some technologies, the elaboration of a global strategy and the identification of a plan of progress including the in-house process of development of the technology or out-sourcing scenarios. Finally an experiment of the approach is described within SME manufacturing luminaires.

**Future demands for work skills in the digital world / 171****Telecommunication Infrastructure for the digital inclusion in schools****Author(s):** Dr. TOSTES VIEIRA, Marta Lucia<sup>1</sup>

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According to the Global Information Technology Report 2016 from the World Economic Forum, Peru, based on the networked readiness index, is in the 90th position out of 139 countries (World Economic Forum, 2016). Regarding education, the schools are to connect to the optical fiber network by means of a wireless access net thus enabling the inclusion to the worldwide Internet and the access to online educational material. This infrastructure will enable access to public services such as tele-education, telehealth and electronic government in order to improve the country competitiveness and make basic services available to the citizens (Ministry of Transport and Communication, 2016). This investigation aims at analyzing the current infrastructure available in the schools to make use of the broadband advantages. For analysis purposes, the San Martin region was chosen as a study case due to its low academic achievement and high cultural and environmental diversity. The methodology used consists of two parts. The first one focuses on the infrastructure of the educational institutions in the context of the national optical fiber backbone network of Peru installation. This infrastructure implementation will allow schools in the San Martin region to have access to new educational possibilities coming from digital databases, TIC platforms, several kinds of educational material with multimedia support, video conferences among others. This first part of the study assesses the connectivity infrastructure and the equipment with which the schools count on to make the most of this connectivity. Regarding the connectivity, key aspects such as the transmission medium and speed, service coverage and continuity are analyzed. Regarding the school equipment, the recent transfers of access points, solar panels, servers, workstation, stabilizers, multimedia projectors, notebooks, laptop, tablets and PC are considered. As part of this analysis, the incoming and outgoing data traffic matrix is presented in order to know, at a regional level, the demand that the Optical Fiber Backbone Network installation faces.

The second part of the methodology focuses strictly speaking on the correlational analysis between the teaching access to computers with internet at a national level and the teachers' participation in development processes such as academic level improvement and trainings. In order to do so, the data base of the National Survey of Public and Private Teaching Institutions (National Council of Education, 2014) is used. The results confirm the hypothesis of a high relation between teaching development and accessibility which is supposed to have a great impact on the academic experience of Peruvian students who need new mechanisms to surpass the digital inclusion and the academic achievement gaps when compared to similar international experiences.

**Management of technology in developing countries / 172**

## **Development in construction companies in Gauteng, South Africa – An investigation into small contractors**

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Small construction companies in Gauteng, South Africa, have experienced many obstacles in their attempts to successfully complete construction projects. The general failure rate of construction companies, in South Africa, is historically high. This research focuses on investigating reasons as to why construction companies fail in South Africa, specifically Gauteng Province. The South African government has focused resources on contractor development, however only a minority have advanced and developed.

Literature indicates that contractors experience challenges from financial, managerial and political barriers. Research indicates the lack of development of Small, Medium and Micro Sized Enterprises (SMMEs) have been viewed as being at globally problematical. This dissertation identifies

existing relevant literature reporting on problems relating to the lack contractor development and construction project failure. Furthermore, the research investigates local and international best practices for contractors that have resulted in the success of construction companies.

The researcher conducted an analysis of the construction industry focusing on a group of contractors involved in a contractor development program. The participants were subjected to a one-on-one interview, as well as the completion of a detailed questionnaire. All participants involved are part of the First National Bank (FNB) Incubator program. The questionnaire focuses on establishing the financial status, management skills, appropriate staffing, and assessment of technical and contractual skills. The data analysis would benefit the construction industry in providing insight into the contractor's deficiencies and challenges. The results indicate that the failure of many small construction companies has been due to many factors including certain factors working in combination. Furthermore, the research focuses on revealing key factors resulting in the collapse of construction companies as well as how these factors should be addressed, with the aim of providing a solution to the lack of contractor development and the failure of construction companies. This dissertation compares best practices, for contractors globally, together with details as to potential implementation strategies.

The development of contractors is vital to the South African economy [5]. The inability of various parties and the contractors themselves to address key factors has resulted in contractors struggling to develop or sustain their businesses' long term plans. These plans need to be successfully created and implemented, if there is to be a change in current circumstances.

**Technology management and competitiveness in the globalized world / 173**

## **STEEL MANUFACTURING OPTIMIZATION, AN ENGINEERING MANAGEMENT APPROACH**

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Optimization of the steel industry in order to deliver on competitiveness includes many factors ranging from process improvements to strategic initiatives. This research focuses on a strategic approach with a focus on process specific initiatives. The strategic initiative relates to the two models of operations, Make-To-Stock (MTS) and Make-To-Order (MTO). This research focuses on investigating the two options for optimizing the plant and reducing the production costs of making steel in South Africa. Local companies have to constantly improve production efficiency levels and evolve at the same rate as the ever changing international manufacturing trends. The research conducted on the utilization of coke, electricity, production volume, product quality index, logistics and Mean-Time-Between-Failure (MTBF) at a steel plant illustrated that MTS results in better optimization of plants through improved MTBF and product quality than MTO. Process improvement under MTS results in improved utilization of coke and electrical energy which have a direct effect on the cost of steel production. Cost reduction through capacity utilization and improved product quality are the primary factors that are required to drive down the price of steel in the market, therefore improving competitiveness of the company.

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## **Generic Logistics modeling with systems Engineering**

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The ability to predict the supply and demand of global energy, water and resources is a challenge. Specific models have been researched for individual logistics. This research focuses on the application of system engineering together with agent based models, developing country specific

supply and demand networks. These networks are adopted as multi-variable conduit with the ability to predict demand of various resources. The country specific network is classified so as to deliver logistics based on demand. Various scenarios together with optimization propositions are developed. A forward prediction model is also delivered.

Key research considerations include the ability to link supply and demand and country specific networks. The network classification together with the input and output models are key to resolution of the challenge.

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## **DIGITAL TRANSFORMATION OF PRODUCT PORTFOLIOS – FUTURE-ORIENTED CONSOLIDATION AS KEY ENABLER**

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Nowadays, companies face rapidly increasing numbers of product variants. Among new developments or facelifts the current product portfolio is rarely revised. In addition, there is often no continuous reduction of the part master. Over time this leads to an excessive product portfolio and a disproportionate increase in complexity costs, because old products often require intensive support. Resources are tied and not available for innovation. According to KERSTEN, 27% of all product variants and 37% of all component variants are superfluous – the consolidation of product portfolios is hence inevitable [1]. To obtain an optimal distribution of resources and maximize innovation strength, the consolidation must include the elimination of unprofitable and fostering of promising products. This requires a systematic anticipation of future developments. Especially companies confronted with disruptive changes such as digitalization, have to reconsider their product portfolio. Due to the strong networking of products an isolated consideration of individual products is not effective. It threatens negative impacts on profitable products. Especially in historically grown product portfolios dependencies are not obvious. Companies face the question: How can we reconfigure our portfolio in the light of digitalization under the condition maximal turnover increase and cost savings? In this paper, we present a methodology for the future-oriented consolidation of product portfolios simplifying analysis and digital transformation of product portfolios. Starting point of the methodology is the aggregation of information. This comprises a characterization of the current product portfolio, the identification of possible product gaps and the grouping of similar products to a manageable number of product groups. For them an automated cross-linking-analysis from a market and a technical perspective is conducted. The cross-linking analysis allows the quantification of the leverage of individual products. The third step is a systematic anticipation of the future relevance and uniqueness of product groups. Among other things, this enables the verification product gaps. In light of the impact of digitalization and the cross-linking of product groups critical product groups are determined. For them fadeout and ramp-up measures are determined. The result is a future-oriented consolidation-roadmap, which allows for the elimination of unprofitable products in favor of promising innovations. The main result of our research is a methodology that enables a systematic digital transformation of product portfolios. Apart from that, we achieved several sub-outcomes: (1) By coordination of product development and product elimination an ideal allocation of resources is reached. (2) The impact of digital technologies on the product portfolio varies and must be anticipated systematically. (3) Success factors for consolidation are usage of reliable, relevant data and decoupling of the elimination decision from the product lifecycle. The introduced methodology provides tangible benefits for companies when it comes to the digital transformation of their product portfolio: (1) it supports the efficient analysis of relevant data, (2) enables the quantification of the leverage of individual products, (3) ensures an early identification and evaluation of future success potentials for product gaps in the light of digitalization, and (4) it reduces planning complexity and quickly leads to a sustainable product portfolio. Literature: [1] Kersten, W (2002): Vielfaltsmanagement. TCW Transfer-Centrum, München

**Technology management and competitiveness in the globalized world / 179****A multiple case study of technology management in metal processing cluster companies****Author(s):** Prof. URBAN, Wieslaw<sup>1</sup>**Co-author(s):** Mrs. KRAWCZYK-DEMBICKA, Elzbieta <sup>1</sup><sup>1</sup> *Bialystok University of Technology***Corresponding Author(s):** e.dembicka@pb.edu.pl

Technology management is a crucial issue for any company; a technology applied to the company determines its competitiveness and long-term development. At the same time this is a field with many dilemmas and hard decisions for managers. An ability to operate effectively in this area eventually gives a company many advantages. The literature from this field proposes models and approaches, which explain how technology management is carried out by companies as well as tips and guidance how to perform effectively in this field. The literature's models of technology management identify its significant components and the links between them. The most widely known model of technology management by Gregory (1995) identifies five generic processes: identification of potential technologies, selection, acquisition, exploitation of technologies and finally protection of knowledge. This model, developed over 20 years ago, provides a general framework of technology management, but it leaves many ambiguities and gaps, mostly because its generality. Modifications of Gregory's model by other authors do not fully encompass the complexity of the highly variable environment of business and R&D institutions. From the point of view of business entities, needs such as effective cooperation within particular triple helix ecosystems, make more detailed empirical studies highly desirable.

This study aims to investigate the technology management in several companies operating in the metal processing industry in Poland, which are associated in a business cluster. The qualitative methodology of a multiple case study is employed. In the selected five companies, study visits were carried out. During these visits direct interviews with the production and technology managers, as well as with selected employees were conducted. Visits were carried out according to a previously developed scheme, consisting of items referring to identification of technology families, detailed process course identification including activities, links between them, and decisions taken, and identification of the factors influencing the technology management process. Each case was meticulously written down immediately after the visits.

The investigation in companies makes it possible to see and analyze whole technology management process cycles, including the early decisions, through exploitation, development and modifications, replacement with others forecasts/plans of liquidation. From the in-depth analysis emerges the view of a model approach in a company engaged in a cluster structure and operating in the metal processing field. This qualitative descriptive model of the technology management process includes a number of activities at different organizational levels, feedback and decision points. It enriches technology management models described in the literature by providing many more details such as new loops and connections. The case studies allow identification of series of factors and activities specific to the conditions of cooperation within the technology management process. The identified model provides the framework for wider investigation in metal cluster companies based on a quantitative approach. The research results are indeed a new point of view in the development of technology in a company and its influence on company competitiveness. The association in a cluster structure is a very important determinant shaping the technology management process.

**Technology management and competitiveness in the globalized world / 180****Technology support for capability based acquisition****Mr. THABA, James**<sup>1</sup><sup>1</sup> *CSIR***Corresponding Author(s):** jamesthaba@yahoo.com

The evolution of warfare, and its increasing complexity has made planning for future deployments more difficult. The need to plan for more eventualities makes it more complex. The need for decision support tools and technologies to assist capability planners make more sound decisions has become more critical. Many defence forces have made a conscious decision to ditch threat based planning approach for the capability based planning (CBP).

This paper will focus on the implementation of CBP in the military. the envisaged process to be following, including the stakeholders involved to ensure the successful implementation. The paper will further discuss the Capability Lifecycle (CLC) defined in the South African National Defence Force context, and the link of this proposed life cycle to the system life cycle as define in Defence Acquisition Publication 100.

The implementation of the Capability Life Cycle approach will be investigated in terms of the tools and technology support require to facilitate successful implementation of the CLC. There are various tools to be dealt with supporting the implementation of the CLC approach, for example Enterprise Architecture modelling, Model-based systems engineering, capability engineering and interoperability support.

The paper will conclude by focussing on the requirements for successful implementation of the CLC process. The benefits of this implementation and envisaged improvements in efficiency will be emphasised. Verification and validation of requirements will be addressed through concept development and experimentation discussion

### Management of technology in developing countries / 181

## COMPETITIVE INTELLIGENCE TO SUPPORT STRATEGIC PLANNING IN SCIENCE, TECHNOLOGY AND INNOVATION IN ARGENTINA

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The Ministry of Science, Technology and Productive Innovation of Argentina MINCYT, with the aim of creating inputs to facilitate strategic planning processes at the national, territorial and sectorial levels, set itself the objective of establishing Competitive Intelligence as a National Policy for Science, Technology and Innovation. The Ministry recognizes the strategic value of technical literature and digital information for the generation and development of strategies for knowledge management and innovation in the territory.

The National Program of Technological Scanning and Competitive Intelligence - VINTEC Program - of the National Studies Department, with the purpose of promoting the generation of a National System of TS&CI, develops among its lines of work, Panoramic Studies of Technological Scanning and Competitive Intelligence. Studies that present and analyze scientific, technological and market information in such a way as to be able to visualize the evolution of scientific production and patent applications, identify relevant actors, countries and areas of technological research and development and leading players in the market. Documents elaborated with the technical support of the industry experts and the knowledge of the context by the business chambers. The information is obtained by consulting and analyzing the information provided by international databases of publications, technical articles, patent documents and R+D+I projects. Data mining software tools were used to analyze the information in search results on patent bases and scientific literature.

The purpose of the paper is to present how the Competitive Intelligence is a strategy for the incorporation of the digitized information in the processes of research, innovation and technological transference in the productive sectors, thereby, the paper describes the methodological steps and the software tools that support the data mining process: (I) selection of the data set, (ii) analysis of the properties of the data, (iii) transformation of the data set, (iv) selection and application of the data mining technique, (v) extraction of knowledge, and (vi) interpretation and evaluation of data, to generate new information, which will be submitted to the expert opinion.

As an example, will be presented the Panoramic Study on Composite Materials technologies in the automotive parts sector, which was carried out collaboratively with the Association of Argentine Component Manufacturers - AFAC with the following content structure: characteristics of the automotive complex, importance and incorporation of composite materials in the automotive sector, analysis of information from scientific publications and patent documents, and perspectives and challenges of composite materials in the automotive industry.

It is the experience acquired by the Ministry of Science Technology and Productive Innovation - Argentina, as an institution of the State, in the search for the positioning of Competitive Intelligence as a strategy for the collective generation of inputs to support strategic plans of STI in the Argentine industry.

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## Technology Disruption as a Driver for Business Model Innovation

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Technological innovations increasingly influence the transformation of business models. Disruptive technological developments significantly influence business environments and alter the way how businesses are operated. These technologies replace existing technologies of incumbents by sacrificing features that are important to current customers and offering different attributes (Bower & Christensen, 1995), and change the performance metrics along which firms compete (Danneels, 2004). As technological innovations are influencing business model's development (Baden-Fuller & Haefliger, 2013), it is important to understand how disruptive technologies drive business model innovation. This workshop aims to summarize the process and mechanisms of disruptive technological change and to discuss the impact on business model innovation. Considering the specific characteristics of disruptive technologies, their influence on different elements of business models and especially on the process of business model innovation will be examined.

The workshop will start with two theoretical presentations (each 20 min.), summarizing the current knowledge on disruptive technologies and business model innovation. First, the features of disruptive technologies will be reviewed, discussing technology development, the characteristics of disruptions and suitable methods to determine disruptive technological developments. Second, different perspectives on business models and the process of business model innovation will be analysed.

Subsequently participants will work in smaller groups: Based on a specific example of a disruptive technology the teams will discuss how a certain elements of the business model might be influenced by the new technology and what the process of business model innovation is like. In addition, experiences by practitioners on this topic should be collected and discussed. The workshop links the main aspects of disruptive technologies with the process of business model innovation. By discussing these theoretical perspectives using a practical example of a disruptive technology, participants will elaborate how technological developments impact business models and how this innovation process takes place.

The workshop aims to better understand the impact of disruptive technologies on the process of business model innovation. Participants have a better understanding of the impact of technologies on business models.

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**Project and program management / 184****On the Combination of Strategy and Innovation Tools with Roadmapping: Exploring Taxonomies and Sequences****Author(s):** Ms. MUDRIK, Julia<sup>1</sup> ; Dr. FREITAS, Jonathan<sup>1</sup>**Co-author(s):** Ms. MELO, Júlio<sup>1</sup> ; Dr. BAGNO, Raoni<sup>1</sup> ; Dr. OLIVEIRA, Maicon<sup>2</sup><sup>1</sup> *Federal University of Minas Gerais*<sup>2</sup> *Federal University of Alfenas (UNIFAL)***Corresponding Author(s):** juliatiso@gmail.com

Roadmapping frameworks are said to provide a common reference point for linking strategy and innovation (S&I) tools. It has been argued that there is no incompatibility between these tools and roadmapping. Therefore, combining the development of roadmaps with S&I tools would support an integrated approach to S&I processes. However, it is not clear how diverse S&I tools can be meaningfully classified into basic types that are fundamentally different in the way they relate to roadmapping. Moreover, discussions on how these tools may be sequenced in an integrated approach are seemingly absent in literature. Thus, this paper proposes taxonomies and sequences for combining S&I tools with roadmapping.

In order to achieve this goal, this essay explores, through a thought experiment, potentially useful variations on how S&I tools could be grouped and arranged over time, based on their main characteristics pointed by the literature. Both the multi-layered time-based general structure of roadmaps and the main S&I processes related to roadmapping are characterized in order to derive the criteria on which proposals are based. The tools' level of analysis and whether or not temporality and information of multiple layers are explicitly taken into account exemplify the types of criteria that are adopted in this paper.

Results highlight the usefulness of identifying possible patterns in the combination of S&I tools and roadmapping for creating relevant guidelines for practitioners. Four main types of tools are proposed based on their contribution to fill the roadmap structure with relevant content: (i) intra-layer and current situation; (ii) intra-layer and medium/long-term vision; (iii) inter-layer and current situation; and (iv) inter-layer and medium/long-term vision. Using a corresponding two-by-two matrix (layers x time horizon), well-known examples of each kind of tool are given and their classification is explained. Moreover, using this taxonomy and a model of a typical S&I management system, a comprehensive four-step sequence of tool application is suggested. It is argued how more than ten different tools could be used over time in order to build a robust S&I planning system, centered on the roadmap structure. Each of the four steps is related to a macro S&I process (strategic, portfolio or project management) and its contribution is graphically illustrated using the roadmap architecture. Emphasis is given to the possibilities of synergistic effects of the parallel combined application of tools inside each step.

Future work is encouraged to test, in real-world practice, the usefulness of this taxonomy and sequence. Indeed, we expect that new proposals to distinguish S&I tools in ways that are relevant to roadmapping-guided management should be inspired by the suggestions made in this paper. After all, although many interesting work has been done on S&I tools and roadmapping separately, it is still poorly discussed how this toolbox could be usefully applied in practice in order to help building a robust S&I management system. We hope this paper will trigger this much needed integrative discussion in the management of technology field, by extending traditional issues of mixed-methods research – such as taxonomy and sequence – to the technology management tools' debate.

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**Innovation at voestalpine**Dr. ANDROSCH, Franz<sup>1</sup><sup>1</sup> *voestalpine Stahl GmbH***Corresponding Author(s):** ulrike.redl@voestalpine.com

A successful innovation starts with an idea and ends up as a product on the market. Sounds simple, but turns out to be very complex when implemented. A few important principles are basic

for our innovation process. We keep to our strategy. Company management stands fully behind R\&D. We have a clear plan, road maps, where all R\&D-topics are recorded and monitored. We have a stage-gate-process for innovation, beginning in the preliminary area which is rather fuzzy and then becoming more and more precise towards market implementation. Especially in the preliminary research phase, we put an emphasis on creativity. New ideas need enough time and space to grow, requiring a company culture of team spirit and openness. With our decentralized R\&D and with strong interactions to our own processes and products, selected customers and long-term cooperation with scientific partners, we recognize new possibilities and developments bottom-up at an early stage. Success occurs when all relevant business functions are considered and integrated in the innovation process.

## Management of technology in developing countries / 195

### Egypt Investment Map

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Egypt Investment Map Egypt Atlas of economic complexity will be a modified and customised version of Harvard atlas online complexity index. Harvard atlas online complexity index is a powerful interactive tool that enables users to visualise a country's total trade, track how these dynamics change over time and explore growth opportunities for more than a hundred countries worldwide. Egypt Atlas will measure and representing current products in map with 7 axes ( Value added , innovation , Complex index , Industrial usage and infrastructure , politics , location ,time ) .

The Atlas will use by investors, entrepreneurs, policymakers, students and the general public to better understand the competitive landscape of Egypt The Atlas will shows which products are produced and exported; The Atlas can then use this information to suggest products a country could begin manufacturing in order to fuel economic growth. As a dynamic resource, The Atlas is continually evolving with new data and features to help analyse economic growth and development.

In this paper we will introduce a model for The Egypt Atlas of economic growth and complexity that shows where Egypt will be in 10 years . and also where it's rank .It's not a crystal ball, but it could very well be a map for investment over the next decade.

We will using big data analytics techniques to get the Atlas Insights from The collected data .The collected data will be a list of current products , the existing production technologies , Government strategy up to 2052 ,S curve for those Products , Potential producers ,Services Industries , Users Segments For those products .

The investing map care about the structure of the product space because it affects the ability of country to move into new products. Products that are tightly connected share most of the requisite capabilities. If this is the case, then country that already have what it takes to make one product will find it relatively easy to move to the next ones. A highly connected product space, therefore, makes the problem of growing the complexity of an economy easier. Conversely, a sparsely connected product space makes it harder.

Also this research will show that the probability that a country will make a new product is strongly related to how close that product is to other products the country already makes.

We Will Achieve a Clear Investment Map that could use by investors, students , entrepreneurs, policymakers and the general public to better understand the competitive landscape of Egypt .And raise Egypt growth within 8 % / Year and raise The GDP within 5% / year ,Also this new map will raise the Quality of life in Egypt.

Egypt full of opportunities but to achieve this we should connect every component in product and service value chain to start from current product to new and innovative products . Egypt Has large market but the major of it non formal one .and this research will help conference attendees whose concern with The effect of Management of technology in developing countries.And know how can this Atlas starts with the idea that the wealth and potential of nations is derived from productive knowledge. And To maximise collective knowledge, a nation needs to Connect its individual citizens , each of whom can benefit the whole. The more complex and interconnected

a nation, the greater its economic productivity and potential, And Know Also Formal education alone won't necessarily bridge the gap between poor and rich countries.

### Project and program management / 197

## Integration of eco-products' criteria in project management

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Environmental consciousness has drastically evolved over the last few decades. The consequences of pollution, raw material depletion, global warming... are now widespread throughout society. Numerous tools and guides have been developed to help or strongly encourage companies to deal with sustainable development principles, including International Policy Frameworks, Codes of Conduct, Sustainability or Social Responsibility Reports, Auditing, Monitoring and Evaluation Frameworks. In this paper, we will try to show to what extent the concept of EcoDesign can participate in this purpose, due to the fact that Eco Design is a process in which the products or services are designed in order to reduce their environmental impact in each step of their life cycle. As a result, it is important to take environmental characteristics into account in the development process as soon as possible in order to obtain greener products and services. However, the environmental concerns are so broad (water, air, waste, noise, raw material depletion ...) that we can wonder how to apply the practices of EcoDesign. Are there specific steps to take environmental criteria into account in the design of the product? Can each company use the same process to have an eco-design approach? This paper aims to answer both questions. An initial paragraph highlights the context of the research and defines the EcoDesign concept on the basis of the theories, processes, tools and methods we can find in the literature. Several examples of companies designing eco-products are also taken into consideration.

Based on the previous search, we introduce, in a second paragraph, a proposal for a generic process of implementing an eco-design project (EPDP – Eco-Product Development Process). Indeed, some common points were identified, among which was the necessary implication of multi-expertise in the process and the assessment of environmental impacts in order to identify possible improvements, considering the whole life cycle of the product.

The third part is more practical. In order to validate our proposal, we tested it in a firm that manufactures and sells small domestic appliances. A gap analysis between our theoretical proposal and what is realized in the tested company is set up to allow a critical review of the process before concluding about its direct applicability to firms. As a result, our major contribution is in the confirmation, by means of a real industrial case, that our proposal is feasible and directly applicable in the industrial sector. We will also discuss the expansions of the study based on a limitation we have already found: the necessity to take into account the characteristics of the industrial sector in order to specify our proposal for each type. This aspect will be very interesting both for academics and practitioners interested in green processes and sustainability.

### New business and investment models in the digital world / 200

## Creative community, uses and Fab Lab: the example of the Lorraine Fab Living Lab

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Connecting people" is a common expression nowadays, often repeated in digital companies' communication strategies. Beyond the catchy slogan, however, connecting people and connecting things has become a real challenge for companies wanting to stay competitive. The fact is, we are seeing the end of the "mad", isolated inventor, replaced by collective and collaborative creation. In this context the concept of the FabLab has emerged to meet new expectations for the design of the products of tomorrow. Born in the hallways of Massachusetts Institute of Technology (MIT) in the United States at the end of the 1990s, FabLabs are growing fast today, with over 300 worldwide, including in developing countries. FabLabs are defined as fabrication laboratories in which several technologies are gathered together: software, small equipment and, usually, machine tools. Their association and the democratisation of knowledge and skills related to their use make it possible to design and make objects or micro-robots, to repair devices... and to manufacture at the prototype or small production run level. To put it simply, a FabLab is a fitted-out physical space that enables communities of practice to design and manufacture their own objects, particularly using digital tools. People come to these places, which could be thought of as communities of skills, to exchange views, get trained, find solutions and produce things. Mobilising shared and collaborative forms of innovation, FabLabs are involved in the development of new models of innovation, strengthening 'open innovation' even further. Nevertheless, from the point of view of innovative design, the process would not be complete were we not to reintroduce the notion of use. Indeed, if this passage from problem to solution seems relatively simple and, in fact, widely accessible, we must not neglect the power of the end user to refuse or accept the solution. In this respect, from the point of view of design research, the association of FabLabs and Living Labs (a type of project involving users and particularly using behaviour observation tools and methodologies) may strengthen the development of knowledge of design practice and user feedback so that, right from the upstream phase of the innovation process, improvements can be made to the acceptability of the future product or service by having multiple by/for tests and with use. That is what we are going to show in this paper. In the first paragraph we shall give an overview and then define the notions of FabLab and Living Lab, collaborative design, open innovation and creative community. Then, in the second paragraph and using the example of the Lorraine Fab Living Lab® space designed to foster both collective creativity and design by use, we shall show how the principle of "connecting people" is given life today in the ability of territories to promote the development of spaces conducive to hosting these new creative communities that are revolutionising our relationship with the status of knowledge and intellectual property. It is these very last two points that will allow us to set certain limits and to open research opportunities because it is undeniable that collaborative design and open innovation, intrinsically linked to the FabLab and Living Lab model, cannot go on without asking the question of intellectual property rights and how to value them. The free use of projects (shelved and, in fact, potentially accessible to all with or without payment obligation) has little compatibility with the definition of intellectual property rights and demands reflection on the new business models to be designed.

For academics and practitioners

**Small and medium sized enterprises and innovation / 202**

## **Industry 4.0 - Integration strategies for small and medium-sized enterprises**

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Many industrial countries worldwide are confronted with multiple challenges such as globalization, increased volatility of markets, abbreviated innovation cycles, intensified competition and augmented complexity. As a result, the German government has initiated Industry 4.0, the German program for the introduction of the Industrial Internet of Things to respond to these challenges and maintain future competitiveness for the German industry. It integrates current technological trends into industrial production, assisting to improve complex systems of value

creation. Main elements include horizontal and vertical interconnection within value chains of people, products and machines, using intelligent and self-regulating technologies. Alongside with technical challenges, organizational conversions will be undergone. In contrast to research in technical fields, economical sciences have investigated the topic of Industry 4.0 less so far. Especially the interconnection of the entire value-added chain, also across enterprises, has to be considered in this context.

We claim that small and medium-sized enterprises are especially important for investigating the introduction of Industry 4.0 in the industrial value-added chain, as small and medium-sized enterprises represent high importance for the German industry, encompassing 99.6 per cent of enterprises, 59.4 of employees, 54.8 per cent of value added and 35.9 per cent of annual turnover. However, research in the field of small and medium-sized enterprises and Industry 4.0 remains scarce. For the investigation within multiple case studies, small and medium-sized enterprises are especially suitable, as leading personnel has a holistic view on the entire enterprise. Furthermore, small and medium-sized enterprises have distinct characteristics, such as limited resources, that influence the integration of innovations and technologies.

Conclusively, this study addresses the following research question:

*Which specific characteristics regarding the introduction of Industry 4.0 exist in small and medium-sized enterprises and how can those be addressed with accordingly designed integration strategies?*

In response to rare research in this field, we use an exploratory and qualitative case study research design based on 68 in-depth expert interviews within the three most important German industry sectors, mechanical and plant engineering, electrical engineering and automotive suppliers. Interviews were conducted with leading personnel of the respective enterprises, including 41 CEOs. We find that small and medium-sized enterprises have several limiting factors concerning the integration of Industry 4.0, such as a low degree of standardization, lack of personnel and financial resources and low levels of trust in digitization. We assign these challenges for the respective business models of the regarded enterprises. Here, we find distinct characteristics between suppliers of Industry 4.0-based solutions, generally more affected, and enterprises applying Industry 4.0 in production. Thereupon, we find integration strategies, such as the cooperation with other small and medium-sized enterprises along the value-added chain in order to find economies of scope and turning to services rather than production, to strengthen one core competency of small and medium-sized enterprises, individual solutions and personal contact.

**Key words:** Industry 4.0, Industrial Internet of Things, small and medium-sized enterprises, multiple case study

## Economic and societal impact of technology / 206

### Open Innovation and Business Model: Embrapa Case Study

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The open innovation practice as proposed by (CHESBROUGH, 2003; 2013) is directly related to the organization's business model. Although the themes of open innovation and business model are discussed in the international literature with assorted characteristics, there is a research gap involving empirical studies in the context of public companies, since the literature focuses on investigating private companies. A number of studies aim to explore how organizations benefit from this activity (YUN et al., 2016, SAMADI, 2014, WEST, 2014, ADES et al., 2013, CHESBROUGH, 2012, FOSS et al., 2011, GIANODIS et al. ., 2010; CHESBROUGH, 2007). Thus, this article seeks to study the business model from the approach of the concept of open innovation, within the scope of public enterprise, a theme still little discussed in the sphere of technological management (FELLER, 2011). Inasmuch as, the present work is structured based on the following question: "How does the Brazilian Forest Research Corporation (EMBRAPA) - Forest Unit structure its business model to better manage the inherent issues of open innovation?" In this sense, the main objective of the study is to evaluate how a public company manages

its business model in open innovation. Specifically, it is intended to analyze: i) the elements of the business model and their roles in performing open innovation; ii) internal and external relationships inherent in open innovation; iii) examine aspects related to the governance of the transactions, as well as the mechanisms used to manage open innovation (SAEBI, FOSS, 2015, ZOTT, AMIT, 2011). As far as the company's choice is concerned, it is worth mentioning that it is one of the main players in the world of tropical agroforestry research (BARBOSA, MACHADO, 2014, RADA, BUCCOLA, 2012). Therefore, the research strategy is qualitative, combined with the proposal to investigate a solid case in multiple dimensions, which are: social, economic, technological and scientific. The study involves large companies, covering the public and private spheres, whose structures allow the application of open innovation. As far as data collection is concerned, a set of semi-structured interviews with directors, managers and researchers of the company, are involved in R & D & I projects, as well as direct observation and documentary analysis, as guaranteed by (YIN, 2015; EISENHARDT, GRAEBNER, 2007). The corpus of the research is relevant because it is the main Brazilian company responsible for R & D & I in the national tropical agricultural sector. The contribution of this work will be in the following aspects: a) theoretical construction involving the themes business models and open innovation in public organizations; B) unpublished research that simultaneously analyzes the business model the practice of open innovation in a relevant research company in the agricultural sector, being this influential in a global context. We emphasize that it is of fundamental importance to understand how public companies seek to interact with private sector organizations, through the practice of open innovation. It is worth mentioning also that the present study is relevant to understand how the governments in their various spheres and, through their companies, disseminate innovations and knowledge society, both nationally and internationally. Keywords: Open Innovation; Business model; Public Organization; Agribusiness.

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## **SMEs facing the challenge of innovation and export: Proposal for a joint assessment tool, the Potential Export and Innovation Index (PE2I)**

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Innovation and Export are generally considered as two different activities, but being in relation to each other. Indeed, a link between innovation and export was identified both within the scientific literature as with the bodies specialized in the support for companies. The research works studying this link are plentiful and the advantages of a coupling of the support services concerning innovation and export was detected. Yet, although this link is identified in a theoretical way, in practice the support services integrating a joint vision of innovation and export are rare. They represent nevertheless an interesting way to manage the complexity of companies and they take all their importance in the particular context of SMEs, for whom the mobilizable resources are limited. Encouraging SME to consider innovation and export in a joint way allows them to favor actions having a simultaneous impact on these two activities and thus to decrease the effort associated with the improvement of their performance. The objective of this contribution is to propose a support tool for SME putting into practice this joint vision. This tool of diagnosis, called PE2I (Potential Exportation and Innovation Index), relies on a joint methodology of evaluation of the innovation and exportation capability of SME. Thus the main specificity of this tool is that it concentrates on the activities/resources/skills which a SME has to mobilize first and foremost to improve in a simultaneous way its performances concerning innovation and export, while reducing the effort associated with its performance improvement. This index measures the maturity of the joint activities innovation/export realized within companies. It makes it possible to propose a diagnosis of the situation of a company by identifying its strengths and its weak points, and gives an indication to its potential domain of preference (innovation and/or export). The PE2I indeed relies on the principle of "Measuring to better Manage". So as to support SMEs on the long term and in a relevant way, it is so necessary to know the current situation of companies through an evaluation of their potential innovation and exportation capability. Then, from this current situation, it is then possible to propose them customized ways of improvement,

adapted to the particular situation of the company, as well as to its strategy of development. The company wishes to favor its development in the foreign markets? The PE2I will identify the main levers so that it reaches this goal. On the contrary, the company wishes to turn more significantly to the innovation? The PE2I will propose then potentially different levers of action. The company wishes to set up a common strategy for innovation and export? Even there, adapted levers of action will be identified. Thus this communication will be structured in the following way. First, the context of innovation and export in SME will be presented, in order to put forward the contributions of a coupling innovation/export for the SMEs' support. Then, the methodology of conception of the PE2I will be detailed and a case study will be finally proposed.

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## **INFORMATION TECHNOLOGY (IT) PROJECT PORTFOLIO MANAGEMENT PRACTICES IN SOUTH AFRICA**

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Many organisations have adopted Project Portfolio Management (PPM) processes to improve the implementation of their strategies, however few organisations have achieved tangible returns on investment (ROI) from PPM. Although PPM stakeholders are aware and understand that PPM enables the achievement of strategic objectives of the organisation, they admit to not fully being able to understand its value. This results in IT projects implementation and delivery not being aligned with the organisational business strategies. Moreover, the performance of IT initiatives indicates an increase in their failure rate, to an extent that it is becoming a threat to the very existence of organisations. The failure of IT initiatives is perceived as the reason many organisations are not achieving their strategic vision. The South African government spends more on IT initiatives, but effectiveness has not kept pace with other countries. The National Development Plan (Vision 2030) forecasts that South Africa is to spend more on IT initiatives. This study aimed to assess the effectiveness of PPM practices in South African public organisations, in ensuring efficient return on IT investments. The methodology that grounded this research is quantitative analysis, using survey consisted of closed questions. The survey was distributed to project, programme, and portfolio management professionals as well as PPM stakeholders who takes part in portfolio management activities in their organisations. The survey requested PPM practitioners to evaluate the maturity of their PPM practices and the overall performance experienced in their IT Portfolio. It further enabled them to establishes what has been the focus of governance mechanisms in PPM and unpacks the challenges and benefits experienced over PPM in the industry. The study finds that majority of organisations in the public sector achieved a level 2 maturity, which implies that IT portfolios are managed for value at an individual project basis, which doesn't support their business strategies a contrast to having IT portfolio being managed enterprise wide and integrated with business to guaranty strategic alignment. The study indicates that PPM practices are not aligned to the expected strategic vision and benefits of South African entities. Furthermore, PPM doesn't reflect sensible investment and balanced portfolio priorities. Contrary to PPM standards, organisations experience difficulties in ensuring that resource allocation is effective and efficient. The study suggests that there is a need for governance on PPM initiatives, as opportunities for risk to impede against portfolio success across the project portfolio lifecycle exists. This is evidenced by the poor performance noticed across organisations. The research indicates that Portfolio governance is mostly focused on monitoring of expenditure rather than focusing on the management of processes and prioritization of programmes and project resources throughout the portfolio lifecycle components. The study provides, beside the benefits of IT portfolio management, critical challenges that impede on PPM success. With the identified limitations it is therefore possible for both researchers and practitioners to relook at theories and practices with the aim of improving effectiveness. Considerable improvement needs to be made to PPM maturity, performance and governance of South African entities, where emphasis should be made on among others, portfolio planning, review and tracking with involvement of executives which would result in the achievement of ROI on IT initiatives and business goals.

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## Potentials and Pitfalls of Open Innovation and Open Science Projects between Industry, Science, and Society

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The European Union is heavily emphasizing the importance of open innovation and open science to leverage the potential and creativity of European citizens and finally unleash a plethora of novel ideas, cutting-edge improvements and commercially successful innovations. The overall goal is to increase the competitiveness of the European industries. In one of their latest publications, the European Commission has coined this paradigm shift towards more openness as the ‘three O’s’ - Open Innovation, Open Science, and Open to the World . Digital technologies are making both innovation and science more collaborative, international – and open to the society.

Science2Society is an EU-funded project kicked-off in 2015. It aims to understand and improve the efficiency of the European innovation system and the ways it creates new businesses, turns technology into products and services, attracts financing and generally creates value from academic research. Science2Society combines methodological frameworks with ‘real life’ experience from practitioners in science and industry, making the transition from promising blueprints to actual change within some 3000 actors in Europe by 2020. The aim of the proposed workshop is to engage participants from the IAMOT 2017 conference to discuss and share their experiences on open innovation practices with the Science2Society project and beyond.

Science2Society applies “fast prototyping” in seven pilots to explore ideas and get direct experience with how things work in practice. It creates a Learning and Implementation Alliance to continue experimenting and learning in an open community of practitioners, transforming organizations across Europe in a second step. The project focuses a huge share of project resources on seven concrete University-Industry-Society Interface Schemes, namely Co-creation, Co-location, Collaborative R&D&I projects between universities, industries, and the society, Inter-sectoral staff mobility, Collaboration through big data and science 2.0, Direct university coaching and training to SMEs, Online knowledge marketplaces.

After a short introduction into the motivation and goals of these seven pilots, the organizers will engage all workshop participants to share their experiences with (one or more of) those 7 schemes in a structured way. Depending on the number of workshop participants, each scheme will be worked on by one group. The focus of the workshop is then on communicating real-life experiences and best practices on how to make open innovation and open science projects more successful. Many of the known best practices could be effectively and efficiently taken up by other stakeholders to increase the knowledge on open innovation and open science. Each group will then document their experiences, best practices, success factors, and lessons learned and share them with all other groups at the end of the workshop, e.g. by using flipcharts.

Findings and benefits for workshop participants are e.g. networking & engaging with a community of open innovation and open science practitioners and sharing own experiences and knowledge in a structured way, comparing the international perspective to European Union’s three O’s and providing feedback to the strategy pursued by the European Commission, receiving feedback from others and learning how to make own open innovation and open science projects more successful, conducting an active information exchange with consortium members of the H2020 Coordinating and Support Action CSA on the topic INSO-4-2015 - Innovative schemes for open innovation and science 2.0.

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## The Effects of Cross-Channel Service Integration on Consumers’ Purchase Intention

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Nowadays, there are lots of Clicks and Mortar models. Brands can earn benefits through cross-channel integration, so they develop cross-channel model from online to offline to meet consumers' requirements. According to MIC's report, consumers prefer to search online to compare the goods and shop in a physical store. The reason is that consumers can get goods immediately, save shipping fee, confirm product quality, and experience the atmosphere. In order to increase consumers' willingness to shop online, brands have started to build cross-channel service integration. But consumers have different characteristics and they have distinctive purchase behaviors. This research combines Technology Acceptance Model (TAM), experience of shopping online, risk acceptance, and knowledge of product to build our research framework to discuss the effect of cross-channel service integration on consumers' purchase intention. The research collected 358 data and all respondents were female. After analysis, the result showed: (1) integration of distribution, integration of transaction and integration of customer service have positive influence on perceived usefulness, perceived ease of use, perceived playfulness, brand attitude and purchase intention; (2) consumers' perceived ease of use has positive influence on perceived usefulness; (3) consumers' perceived usefulness, perceived ease of use, perceived playfulness have positive influence on brand attitude; (4) consumers' brand attitude and objective norms have positive influence on purchase intention.

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## **The Business Model in a Cage (The business model design challenge of transport system innovation)**

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Business model (BM) design is essential to accommodate new technologies to reach full commercial scale. However, BM design is difficult (Teece 2010; Chesbrough 2010). The state of the art literature on business models scrutinized BM design sources of difficulty from an intra-organizational perspective (Sund et al. 2016; Chesbrough 2010; Teece 2010; Osterwalder et al. 2005; Amit & Zott 2001). BM design issues surface when firms try to create a new business model or reconfigure current BM.

Introducing new business models often instigate organizational challenges manifested in tensions with current organizational structure (Sund et al. 2016). The choices incurred in BM design significantly affect the business architecture translated to the deeply seated internal functions in the organization. Thus, changing the business model or even refining the current BM components will encounter organizational hurdles (Teece 2010). While designing new BMs, general managers who work on reconfiguration are attached to their old BMs resulting in a cognitive challenge (Zott & Amit 2010). The design challenge is also manifested in a resource competition between new and old business models (Sund et al. 2016; Chesbrough 2010). The major line in the business models literature provided a base to understand the BM design challenges from an intra-organizational perspective. This paper focuses on BM design challenges of incumbent firms while re-designing their BMs in a demonstration project that introduces a new charging technology to a Bus transportation system. thus we extend the understanding of BM design in a technological change setting by exploring specific challenges incurred by incumbents.

RQ: What Business Model design challenges incumbents face while adopting a technological change?

To achieve the objectives, this study recovers multiple stakeholders' views with a specific focus on two incumbents, a bus manufacturer and a public transportation operator (PTO). The stakeholders are testing an emerging technology providing stop inductive charging to E-buses. The research design is based on a single case study (Yin, 2009). Our case inspires a new perspective motivated

by a case study finding (Siggelkow, 2007). The data has been collected from multiple sources: 20 semi-structured interviews, participant observation, and document analysis.

This study has three main findings. While the first one confirms literature review, the last two speak to our contribution: First, while PTO is considering to reconfigure its BM, managers witness operational tension between a potential bus reliant on specific charging infrastructure, and current combustion engine bus that could be rotated around leading to less operational flexibility. This confirms tensions between old and current BMs (Sund et al. 2016; Chesbrough 2010). Second, the Public transportation authority (PTA) sets environmental targets for the PTO. The operators need to deliver the service with a bus solution that abides by the PTA targets. The manufacturer (who supplies the operator with buses) also adapts to PTO needs and by that will have to deliver a value proposition choice that fulfills targets. Third, the terms set by PTA doesn't allow money to flow to operator directly but it comes in portions by the PTA. Thus the revenue architecture of the operator is heavily affected by the PTA terms.

Our study enhances the understanding of emerging technologies management by probing BMs redesign challenge triggered by a technological change. We contribute to BM literature by showing that value proposition and capture choices can't be made in isolation as they are deeply seated in the context.

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## **DIGITAL COMMUNICATION NETWORKS DURING CONFERENCES ON BIOBASED ECONOMY**

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This contribution presents a study of recent communication in the emerging issue “bio-economy”. We introduce a topic specific analysis of social media communication during selected conferences. In recent years the emergence and rapid spread of social media has led to a paradigm shift in the way how people communicate, exchange and store information. For quite some time, the emergence of the microblogging service Twitter enables to obtain fundamentally new insights about individuals, their behaviour and their relationships. Meanwhile, the social media application rose as a popular communication medium also at conferences. In this regard, an analysis of the Twitter communications shows a great potential, where new issues like the bio-based economy could benefit from. In the absence of any previous analysis on this subject, the objective of this study was to find out what kind of information could be obtained from the Twitter communication and to what extent the data is good for displaying and understanding networks of communication. For this purpose short messages sent during three different conferences (ECO-BIO 2016, #EcoBio2016; BIO World Congress on Industrial Biotechnology, #BIOWC16 and European Biomass Conference and Exhibition 2016, #EUBCE2016) were analysed. We selected these meetings because the participants and research topics were international in scope, Twitter was widely used by, and the official conference hashtags were well promoted and are readily searchable with the Twitter search tool. Based on the mentioned conference-specific Hashtags (the language operator) all messages were downloaded before, during and after the conferences. We used methods of social network analysis, visualization of networks and cluster analysis for Twitter users, to draw semantic maps of hashtags and to identify network components of thematically different structured groups. In order to figure out more precisely types of users for each conference hubs and authorities of the network were identified. In order to examine the content shared via Twitter we performed a hashtag network analysis. The keywords exemplified different issues of bio-economy thus offering access to complex, lively discussion contributions and much more. Overall, 722 users participated in the conversations, creating 3294 connections. In the Twitter networks of each conference 3 to 5 large groups of users could be documented. Each network contained a small number of core participants. In general the community consisted of individuals and representatives of

organisations that actively participated in the conferences and thus were directly related to the events, whereas outside participants did not occur. We identified companies, scientists, research organisations, editors of journals as well as conference organisers as hubs and authorities in the communication networks. Also some current and future applications and research areas in bio-based economy like biorefinery, biofuels, biodiesel, jet fuels, biochemicals, biomass production, reutilisation of waste and biofuels from microalgae but also economic, social, ecological and political issues like ethics, circular economy, land use, emissions as well as the promotion of products like biocement could be identified. A thematic focus on basis of the microblogging data, however, was not always possible. Overall, the exchange of specific information on Twitter during the conferences was limited.

Keywords: social media, conference communication, bio-based economy, microblogging

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## **THE IMPACT OF COMMUNICATION ON PROJECT PERFORMANCE: AN EMPIRICAL STUDY**

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The role of communication in project management has been intensively debated for decades. It has been investigated from various perspectives and has enjoyed a substantial coverage in project management literature. Communication has been identified as key to success and poor communication as the reason for many project failures. While some researchers have considered communication as just a success factor in project management and others have identified communication as an important skill and a required competency for project managers, there is still a need to establish contextual and empirical evidences on how communication impact project performance. With the use of social medias as communications tool emerging within the literature, it is equally important to identify the best set of tools and techniques to be used for successful management of communication. This paper aims to evaluate and uncover the relationship between communication and project management. It uncovers tools needed for successful management of communication and the extent to which communication impacts project outcomes through an empirical study. A quantitative research approach was used to shed light on current practices of communication in the project management industry. A survey questionnaire was distributed to a population a purposive sample consisted of professionals who are involved in project management The responses of 70,7% participants were received and analysed using the e-surveycreator on-line tool and statistical analysis using SPSS. The purpose of the survey questionnaire was to test the evidence in the literature in order to answer the research objectives. The results indicated tha there is a strong positive relationship between communication and project outcomes. Communication increase success rate and improve the overall performance of projects. The vital role of communication is clearly recognised as indicated by the empirical evidence gathered. The tools and techniques required to successfully manage communication are identified together with the Information Communication technology (ICT) support tools. Moreover, the results also established that project managers who regards communication as one of the most important factors contributing to the success of projects achieved higher success rate in their projects than the other participants. The high success rate seen on their projects is a direct result of effective communication. This paper contributes to the body of knowledge by producing empirical evidence on how communication impact the performance of a project and provides the best set of tools and techniques that are required to successfully manage communication. It further singles out social media tools that can be used to improve project communication. This work forms the basis of further development into how should the social media identified be used and to what extend can they be relied on as a means of project communication, and what the impact thereof would be. These tools have the potential transform communication in the project management field. The use of social media in projects is still a highly debatable issue and the exploration of the extent to which social medias should be used to improve communication in project management would be a great contribution to the body of knowledge as their use embodies considerable risks and controversies. Key words Social Media, Project Management, Project communication, Project Performance

**Technology management and competitiveness in the globalized world / 217****What do we know about “Industry 4.0” so far?**Mr. KIEL, Daniel<sup>1</sup><sup>1</sup> *Friedrich-Alexander University Erlangen-Nürnberg, Chair of Industrial Management***Corresponding Author(s):** daniel.kiel@fau.de

“Industry 4.0” or the “Industrial Internet of Things” (IIoT) refers to a new paradigm of digitized and connected industrial manufacturing. Its core is based on Internet of Things technologies, which enable real-time capable, smart, horizontal and vertical interconnectedness of people, machines, objects as well as information and communication systems for the dynamic management of complex systems. It is assumed to yield extensive industry-spanning opportunities, e.g. efficiency and quality increases and novel business models. Being officially defined and mentioned not until 2011, the IIoT represents a comparably young research field. Due to its technical core, recent academic works primarily focused on fundamentals and challenges from a technology perspective. By contrast, the economic and management perspective is still underrepresented, slowly starting to catch up. In order to accelerate the scientific discussion from an economic perspective, a systematic synthesis and overview of the extant body of literature is essential. Accordingly, our paper aims at displaying the current state of management research as well as at identifying research gaps in order to enable a reasoned development of future management research in the context of the IIoT.

A systematic literature review is chosen as research method since it is elaborate, transparent and replicable for the identification, evaluation, synthesis and discussion of existing academic works. It revealed 234 articles in leading business journals, reference books, collected editions as well as studies of research institutions published between 2011 and 2016. Further selections with regard to contents and quality criteria identified a final sample of 82 relevant articles to be examined in detail by applying an inductive synthesis and analysis procedure.

In doing so, the literature review identifies five topical areas: Human Resources, Implementation, Strategy & Business models, Supply Chain Management as well as Law & Ethics. Most of the articles (n=25) are assigned to the area Human Resources which addresses implications of digitized value chains for ways of working, job design as well as the need for IIoT-specific workforce qualifications. Literature dealing with the Implementation (n=23) of the IIoT provides not only general recommendations but also concrete change management tools to drive the digitized connection of production processes. The area Strategy & Business Models (n=17) emphasizes the need for a future-oriented organizational transformation as well as for innovative business models based on data and cloud computing. Regarding Supply Chain Management (n=16), academia discusses the optimization of data-driven value chains in order to increase e.g. resource and energy efficiency. Last, Law & Ethics (n=3) refers to legal and ethical issues like data handling, ownership and transparency as well as their potential misuse.

By providing a comprehensive and clearly displayed current state of research as well as showing respective research gaps, our findings are highly relevant for future research aiming at further elaborating on the economic perspective of the IIoT. The paper is e.g. recommended for technology management and competitiveness in the globalized world, new business and investment models in the digital world as well as for future demands for work skills in the digital world. Moreover, our paper supports managerial practitioners in understanding the IIoT and its inevitable effects on industrial companies by presenting insights into strategic management in the era of digitized and connected industrial value creation and capture.

**Economic and societal impact of technology / 218****Scenarios on economic and environmental impact of new fishing technologies****Author(s):** Dr. CARIOLA, Monica<sup>1</sup>**Co-author(s):** Dr. PAGLIARINO, Elena<sup>2</sup> ; Dr. PRONTI, Andrea<sup>2</sup><sup>1</sup> *IRCRES-CNR National Research Council of Italy*<sup>2</sup> *IRCRES-CNR*

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**Introduction and purpose** - Italian fishing fleet is second in Europe for number of vessels and total power and fourth for gross tonnage (Cariola et al., 2014). The bottom trawling fishing with otter boards represents the 19% of the Italian fishing fleets and is the most impacting for the environment because is both a high energy intensive, with important fuel costs, and a high environmental impact fishing method. For this reason, starting from the European Project “Benthis” (WP7, Task 7.4. - Subtask 7.4.4. - Innovative management scenario’s - partly to be presented in another track of IAMOT conference 2017) the present paper extends the results of the costs and benefits analysis (CBA) concerning the substitution of traditional otter boards with innovative ones, carried on a singular vessel, to all the Italian fleet, designing new scenarios where all the trawling vessels would implement the same more sustainable technology, namely a new kind of new otter boards. They could bring both low environmental impacts and fuel efficient fishing activities, and their performance can be further improved thanks to a digital technology, matching them to wireless innovative acoustic technologies for bottom trawling nets monitoring, to control fishing gears performance and the amount of fish caught. The main purpose of this paper is to implement and analyze new scenarios for fishing sector where some key factors, impacting on the introduction of the new otter board technology, will be appraised: i.e. the fuel saving per day at seas, the consequent saving as monetary cost, but also the value of the environmental benefits obtained for example in terms of CO2 reduction. **Methodology and findings** – Starting from the results of the CBA analysis carried on the new otter boards technology, through the use of foresight techniques, new scenarios have been implemented and analyzed. The identified scenarios are referred to the variables that will most influence the introduction and spread of new fishing technologies in the coming years. Considering that most of the trawling vessels in Italy have characteristics similar to the vessel where the new otter board technology has been tested, the scenarios have included all the trawling vessels which could implement the same technology in Italy. Besides no more only the impact of direct monetary costs and benefits has been considered, but also indirect environmental cost and effects, as impact of CO2 reduction, trend in oil price and in legislation. From the scenario analysis, the variables that mainly will influence the introduction and spread of new fishing technologies in the coming years, have resulted to be the reduction in fuel consumption and the introduction of constraints / incentives at legislative level. **Closing** Already the simple Cost Benefit Analysis on one vessel had showed as the introduction of the new sustainable technology was cost-effective for the fisherman and permitted a fuel cost reduction in the short term. The construction of future scenarios, considering also other key factors and including all the Italian fleet, provides new elements in support of the positive future economic and social impact of the introduction of this more sustainable fishing technology. Notwithstanding the good results of this analysis, many difficulties in implementing technological improvements in the fishing sector are still present and could be related to shortage of information and to a lack of management in new fishing technology, just because is still a rather traditional sector.

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## **New green technologies in fishery, a cost benefits analysis**

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**Introduction/purpose** - The study presented in this paper origins from the European Project “Benthis” (WP7, Task 7.4. - Subtask 7.4.4. - Innovative management scenario’s), and it is aimed to analyze costs and benefits of the substitution of otter boards built with traditional technology with innovative and more sustainable ones in bottom trawl fishery, in the Mediterranean Adriatic Sea, Italy. Italian fishing fleet is second in Europe for number of vessels and total power and fourth for gross tonnage (Cariola et al., 2014). The bottom trawling fishing with otter boards (19% of the Italian fishing fleets) is the most impacting on environment because is both a high energy intensive, with heavy fuel costs, and a high environmental impact fishing method. The growing public awareness on those two topics leads to the development of experimental technologies which can bring both low environmental impacts and fuel efficient fishing activities: in the case here analyzed, new otter boards. Their performance can be further improved matching them to digital acoustic technologies for bottom trawling nets monitoring, to control fishing gears performance

and the amount of fish caught. The purpose of the research was to assess whether innovative otter boards, which are able to reduce the impact on marine ecosystem, would also result economically sustainable for fishermen, in order to assess the possibility of implementation of such innovations in the fishing industry. **Methodology** – First, the data collected in technical test carried out on vessels, were re-elaborated in a statistical survey in order to obtain suitable information for the economic study of the assessment implementation cost-effectiveness of the innovative gear. The methodology used for this study is based on the construction of a Cost Benefit Analysis (CBA) often used to evaluate various options for investment in the fishery sector (Mokua et al., 2014; Crilly and Esteban, 2013). We used it to estimate the net present value of the hypothetical investment of the tested gears in a private investor view. The CBA has been used to assess whether the change in technology with the implementation of an innovative otter boards could be a feasible and profitable investment. It was considered the substitution of the old technology with the new one, and all its related costs and benefits, in terms of actual cash flows generated in a time period of 10 years. **Findings** The results of the CBA indicate that, standing at the data of the testing period with the hypothesis of no other factors occurred in the reduction of fuel purchasing per day at sea, the innovative otter boards are cost effective for the vessel studied. The benefit in swapping the technology are enough to exceed the cost of the investment operations. Based on the estimation of this study the whole cost in swapping the technology would be returned with a pay back after 100 days at seas, so already during the first year of the new technology implementation. **Closing** Notwithstanding the good results of tests and CBA, these new efficient technologies need to overcome “human behavior barriers” to be implemented massively in the sector. Difficulties in implementing technological improvements in the fishing sector could be related to some barriers; i.e. absence of information on technology themselves, such as lacks in gear performance results, fuel savings and environmental benefits (Suuronen et al., 2012), but also to a low capacity of managing these new technology. The present study intended to gather new information useful to overcome these kind of barriers.

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## THE ACTIONS SCHEDULING PROBLEM FOR IMPROVEMENT INNOVATION CAPABILITIES

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In literature, several works develop methodologies in order to evaluate the innovation capability (IC) of small and medium enterprises (SMEs) according to a set of actions performed by the firm, called innovations actions (Adams et al., 2006; Chiesa et al., 1996; Guan et al., 2016).

A good example is the methodology proposed by the ERPI research team of the University of Lorraine in France, which allows to characterize and diagnose the IC of the SMEs from the computation of its Potential Innovation Index (PII). This methodology has been validated both theoretical and empirical through the opinion of experts (Boly, 2008; Corona, 2005) with numerous cases of application (Boly et al., 2014; Galvez et al., 2013; Nemery et al., 2012; Sepúlveda et al., 2010)

Recent work linked to IIP seeks to determine recommendations for improving a company’s IC subject to some constraints such as a budget and/or resources (Galvez, 2015). However, these studies have not considered yet the optimal schedule of innovation actions to maximize the benefits or minimize the costs of the proposed improvements.

In this paper, we state the innovation actions scheduling problem for the improvement IC in SMEs, propose a binary linear programming (BLP) model for its formulation, evaluate the proposed model by performing several computation experiments based on French SMEs cases and analyze the obtained results.

Formally, we propose a BLP model based on the statement of problem, which is defined as follows: Given an initial IC levels for each innovation practice  $\{\hat{\ell}\}_{p \in \mathcal{P}}$ . We denote  $\sigma(j) := (\ell, p)$  the IC level  $\ell$  to obtain in the innovation practice  $p$  with an associated cost  $c_j$ . In addition, there exists a cost  $c_{i,j}$  by performing action  $i$  after action  $j$ . Let  $y_j$  and  $x_{i,j}$  binary variables that takes value

1 if the action  $j \in \mathcal{J}$  is performed and if the action  $j \in \mathcal{J}$  is performed after to perform the action  $i \in \mathcal{J} \setminus \{j\}$ , respectively; and 0 otherwise. We want to maximize

$$\sum_{j \in \mathcal{J}} y_j w_{\sigma(j)} \quad (1)$$

subject to

$$\sum_{i \in \mathcal{J} \setminus \{j\}} x_{i,j} + x_{j,i} = y_j \quad \forall i \in \mathcal{J} \quad (2)$$

$$x_{i,j} + x_{j,k} + x_{k,i} \leq 2 \quad \forall i, j, k \in \mathcal{J} \quad (3)$$

$$\sum_{j \in \mathcal{J}} \left( y_j c_j + \sum_{i \in \mathcal{J} \setminus \{j\}} c_{i,j} x_{i,j} \right) \leq b \quad (4)$$

$$y_j = 0 \quad \forall p \in \mathcal{P}, j \in \mathcal{J}_p, \sigma(j) := (\ell, p), \forall \ell < \hat{\ell} \quad (5)$$

$$x_{i,j}, y_j \in \{0, 1\} \quad \forall i, j \in \mathcal{J} \quad (6)$$

Objective (1) maximizes the PII of the firm. Constraint set (2) forces that if the action  $j \in \mathcal{J}$  is performed, then it is performed before or after some an action  $i \in \mathcal{J} \setminus \{j\}$ . Constraint set (3) imposes a specific order among three different possible actions  $i, j, k \in \mathcal{J}$  and constraint (4) defines the budget constraint. Constraints sets (5) fixed the binary variables  $y_j = 0$  for all action  $j \in \mathcal{J}_p$  which do not improve the initial IC level for each innovation practice  $p \in \mathcal{P}$  and constraints sets (6) states the domain of the variables.

BLP model is implemented in C++, using the BLP solver provided by IBM ILOG CPLEX library version 12.6 and the expected results correspond to the optimum schedules of innovation actions necessary for the construction of improvement recommendations adapted to the studied companies.

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## Innovative Business Models for the Industrial Internet of Things

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Today, manufacturing companies have to face multifaceted challenges like shortened technology and innovation cycles and the necessity to offer customized products at the cost of a large-scale production. One possible solution to address these challenges is represented by the Industrial Internet of Things (IIoT). This proceeding digitized connection of industrial manufacturing, also known as "Industry 4.0", comes along with extensive organizational consequences and opportunities for established manufacturers. Existing value chains will change providing opportunities for innovative business models (BM). Although academic literature agrees on the emergence of novel BMs, recent research mainly addressed technological challenges and benefits, whereas systematic and comprehensive examinations of IIoT-triggered BM types have a backlog. Consequently, we aim at systematically analyzing existing literature regarding novel BMs emerging due to the IIoT. Hence, we present a comprehensive overview of novel, innovative BMs relevant for the IIoT. Further, we assign these innovate BMs to three generic BM types. In doing so, we contribute to both academic literature and managerial practice.

A systematic literature review is chosen as research method since it is systematic, transparent and replicable for the synthesis, evaluation and discussion of relevant literature. It revealed 116 articles in leading business journals, reference books, collected editions as well as reports of research institutions published between January 2011 and April 2016. Further selections with regard to content relevant for our research purpose identified 58 articles to be analyzed in detail. They were analyzed in depth in order to develop topical categories inductively, which allows novel concepts to emerge from this process.

The results show that novel IIoT-triggered BMs can be grouped into three main categories: Cloud-based BMs, Service-oriented BMs and Process-oriented BMs. Cloud-based BMs provide an online platform, offer virtual infrastructure or grant access to software via the internet. Hence,

the cloud acts as a medium supplying customers with several values without being in need of physically possessing any hardware. Service-oriented BMs are primarily based on data, which are utilized in order to offer various services to customers, e.g. increased availability, availability on demand and predictive maintenance. Process-oriented BMs aim at optimizing processes, e.g. by bypassing intermediary actors. These BMs primarily target manufacturing companies helping them to address their end customers directly.

Our findings contribute to theory by systematically synthesizing previous works studying novel, IIoT-related BMs from several perspectives and with various objectives. Thereby, we provide three generic BM types, which put themselves forward for future BM research in the context of the IIoT. Hence, our paper is e.g. recommended for new business models in the digital world, technology management and competitiveness in the globalized world and management of specific emerging technologies. From a practical perspective, our findings are highly relevant as they facilitate companies' comprehension of innovative BMs emerging from the IIoT. By providing a comprehensive and illustrative overview of future business concepts, we enable managerial decision makers to oversee the range of different BM conceptualizations that can be put on the daily agenda in order to increase their respective companies' future competitiveness in the context of a digitized and connected industrial environment.

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## Developing a risk-adaptive technology roadmap (TRM) through bayesian network and conjoint analysis under deep uncertainty

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Developing a risk-adaptive technology roadmap (TRM) through bayesian network and association rule mining under deep uncertainty Yujin Jeong and Byungun Yoon Firms always face rapidly changing and complex environment, which is carefully dealt with because it is directly connected with success and failure in business. Under this circumstance, shorter technology life cycle and higher complexity of technology cause risk and uncertainty. Thus, it is necessary to forecast future changes and respond in time, and a diversity of studies has generated to identify risk and uncertainty as well as to planning under deep uncertainty. In particular, scenario-based technology roadmapping has received much attention because scenario planning is able to cope with uncertain events systematically. But it requires much times and efforts and the results are not highly concrete, which fails to establish more accurate and specific strategy. In short, there is a lack of communication with strategy and it reduces the advantage of TRM which is a tool communicating strategy with technology, product and market. They make it hard to update and complement TRM in contexts while reducing sustainability of planning. Therefore, this paper aims to develop a risk-adaptive TRM which makes possible to update and renew TRM at risk based on various risk factor affecting technology and market innovation. At first, risk factors are identified through text mining and opinion mining from relevant databases within the framework of STEPPER (Society, technology, environment, population, politics, economy and resource). Then, possible states for each node are defined in the pre-developed TRM through developing the event tree which consists of trigger events caused by risk factor serving as basic events. Second, probability and impact of each state are calculated by Bayesian network which is able to deal with uncertain knowledge by using probability information and conjoint analysis that provides partial value of each attribute level as well as utility of each profile with multiple attributes. Especially, the partial value is used as impact of each state, and the utility by each profile which is the combination of node in TRM and results in the path for achieving strategic goal will be one of elements for evaluating outcome. Third, the basic action plan is constructed by combining each nodes and arcs with consideration of all possible states. Fourth, outcome of action plan is evaluated through creating new indicator – feasibility based upon impact, importance, utility and strategic fit. It serves as the criteria to determine whether the state for node is adapted or perished. Finally, the risk-adaptive TRM is completed by adjusting and reconstructing paths based on feasibility and severity of risk event at each signpost when supposing that future events related to risk factor are occurred at the specific point. The basic action plan is adapted by re-selecting each node and arc with the goal of increasing strategic fitness and utility for users,



and it leads to transform basic action plans by reflecting risk factors and whether they occur or not. Consequently, the risk-adaptive TRM is able to overcome the limitations that traditional TRM underestimate complex environment surrounding innovations in technology and market. The proposed roadmap enables to increase success rate for implementing and commercializing new technology because it attempted to adapt or perish insignificant actions. In practice, the risk-adaptive TRM helps managers to recognize turbulent environment easily and make decisions by considering the results quantitatively measured on the basis of technological and market information.

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## **SERVICE ENGINEERING – DEVELOPMENT OF PRODUCT-RELATED SERVICES**

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Due to the global convergence of producers and consumers as well as of the consistency and homogeneity of product qualities and technologies, consumer products (hardware and software) are becoming increasingly similar and, thus, interchangeable. Differentiation merely by products has become highly complex and difficult. Additionally, producers from low-cost regions are increasingly able to produce at similar quality levels to Europe. Service Engineering is one solution for restoring or strengthening differentiation in the market by means of expanding existing products with specially tailored services (hybrid products) in order to achieve a sustainable competitive advantage.

The purpose of this paper is to clarify the topics of service engineering in theory and practice, as well as to underline the importance of digitization and Industry 4.0 for service engineering.

Therefore, a thorough discussion of the concept of service engineering is provided, focussing on the redesign and further development of services within the framework of interdisciplinary strategy and creative processes with the help of engineering principles and methods. Besides, it entails the model-based and practical implementation of existing and new service solutions. The necessary know-how concerning procedures and methods forms the basis for determining customer needs, such as finding ideas and developing new services. In a six-step-maturity-model, companies can classify their service portfolios and, thus, determine their current status quo. In a target setting, they can expand and derive their offers by developing services from the above levels. Due to the rapid rate of digitization, industrial machines and systems have become increasingly equipped with digital components and data connections to internal and external networks. Consequently, there are new possibilities to offer innovative services by making use of these new technological possibilities.

Based on this discussion a practical concept with concrete service applications is presented, which has been developed in close cooperation with industrial partners from the sectors of mechanical and plant engineering, as well as logistics service providers and universities. Additionally, the status of service development in Austrian companies is assessed, revealing that new services are often not developed as systematically as necessary and that companies often lack the required know-how (Richter et al. 2017).

Finally, a roadmap for offering hybrid products should represent a theoretical model to apply Service Engineering. It consists of different stages: firstly, starting or enlarging the branch of services which could be useful for customers; secondly, establishing a systematic process for identifying a customer's specific requirements and needs; thirdly, the fusion of products and specially geared services aligned as mentioned in the previous stage.

Consequently, the major benefit of this paper consists of providing a comprehensive view on Service Engineering including conceptual as well as practical approaches supported by empirical data.

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**Platforms of Science Crowdsourcing: The Canadian Case****Author(s):** Mrs. ZHEGU, Majlinda<sup>1</sup>**Co-author(s):** Mrs. KERTUSHA, Ada <sup>1</sup><sup>1</sup> *Université du Québec à Montréal***Corresponding Author(s):** zhegu.majlinda@uqam.ca

Digital age is on its way to upheaval the science system. Deep transformations are pushing toward the openness of the production and the dissemination of scientific knowledge. This paper provides an in-depth analysis of the transformations related to the multisided digital platforms. They have emerged as a driver of digital transformations. Multisided platforms function as intermediary devices that enable and, in many cases, coordinate the interactions among all the open science stakeholders.

Digital platforms are extensively being used in a large variety of crowd science projects. These new citizens science intermediaries meet the needs of scientists to communicate with the large public in ways that were not possible before (Franzoni & Sauermann, 2014). Our paper analyzes the Canadian citizen science practices. The data come from a large-scale observation of several crowd science platforms. We first map the typologies of crowdsourcing platforms. Then, we explore the scale and scope of transformations that platform-intermediated knowledge production models induce in the science ecosystem. The paper discusses the implication of these transformations on science policy.

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**Investigating the Development Process of Knowledge-based Product List in Iran****Author(s):** Mr. POURASGARI, Pedram<sup>1</sup>**Co-author(s):** Mr. FARTASH, Kiarash <sup>1</sup> ; Dr. SAHEBKAR KHORASANI, Seyyed Mohammad <sup>1</sup> ; Mr. SHOJAEE, Seyyed Mohammad Hossein <sup>1</sup> ; Mr. AHMADZADEH, Amirhasan <sup>1</sup> ; Mr. KHATIBI, Abdonabi <sup>1</sup><sup>1</sup> *Technology Studies Institute***Corresponding Author(s):** pedram.pourasgari@gmail.com

Knowledge-Based Companies Supporting Law is one of the main supporting programs in Iran for the purpose of accelerating development of technology and innovation in national level. In order to achieve best results in the process of implementation of the program, a product list including a classification of technology areas and products has been developed. After a while, the product list became one of the main characteristics of the Knowledge-Based Supporting program and its development represents the changes of the program's scope over time. We investigate the formation and development process of knowledge-based product list in Iran as well as its associated policy learning.

In this paper as a descriptive case study, after introducing similar classifications, the formation and development process of knowledge-based product list in Iran as well as its associated policy learning is investigated. In this regard we used related reports and documents and in order to obtain better information, interviews has been conducted with main players that were involved in development and modification process of knowledge-based product list.

Key findings include main experiences from developing Knowledge-based product list in Iran and implications for policy makers seeking to implement measures in support of technology and innovation development.

In developing countries, governments play a critical role in innovation, as many entrepreneurs and SMEs may face lack of financing for innovation activities. Representing experiences from a relatively mature program that's designed to support technology and innovation development in a developing country can help policy makers to develop better policies with the lessons we learned from these experiences.

**R&D Management / 230****Avoiding value destruction due to R&D portfolio changes****Author(s):** Mr. NGQULUNGA, Bonginkosi<sup>1</sup>**Co-author(s):** Prof. WALWYN, David <sup>2</sup><sup>1</sup> *University of Pretoria, PhD Candidate*<sup>2</sup> *University of Pretoria, GSTM***Corresponding Author(s):** bonginkosi.ngqulunga@gmail.com

Changes in the external and internal business environment may induce a redirection of company strategy, which can result in the destruction of a company's valuable intellectual assets (people and knowledge), generated through formal R&D investment. These intellectual assets may be of value to both the company and society, and their termination of projects as a consequence of the re-shaping of company R&D portfolios may result in the destruction of knowledge useful to society.

This study investigates four main aspects: 1) What is the likelihood of a change in business strategy that will impact negatively on an R&D project portfolio value? 2) What is the extent of the impact of changing business strategy on R&D portfolio value?, 3) What steps are being taken by companies to avoid destruction of shareholder value and maximize social return on investment in the event of R&D portfolio changes, and; 4) What portfolio management methodology can be used to mitigate the risk of portfolio value destruction as identified in questions above? This paper deals with steps being taken by companies to avoid destruction of shareholder value and maximize social return on investment in the event of R&D portfolio changes

Most company's patents are by no means used in any of the holders' businesses, or are used to deter potential competitors and most innovations and intellectual property sit on the shelf unexploited; from a public goods perspective, unexploited patents represent a large unexploited source of knowledge that could be used to construct new companies and economic growth if there were an efficient approach to 'activate' these unexploited patents in other companies. This waste of scarce resources is significant; from society's perspective, the loss is even worse; if organizations certainly do not use various technologies they are creating, or license-out these technologies to other organizations for the purpose of commercialization, then the knowledge covered by the temporary monopoly are not ever brought to market. Importantly, considerable effort has to be put into commercializing the unexploited technology/knowledge through spin-offs or through licensing to other companies in other markets (Wang et al., 2012).

The population was drawn from South African R&D intensive manufacturing companies, this population includes medium-sized enterprises as well as large organisations listed on the Johannesburg stock exchange. Data was collected using an online instrument and telephone interviews during the previous study phase (Phase 1) while the questionnaire was further developed for this phase (Phase 2) of the study and to then be further developed and refined of item wording and structure for use in Phase three (Final Phase).

The analysis of the findings of the Phase 1 of this study showed that manufacturing companies are affected by changes in business strategy. Private R&D outputs can be divided into those that lead to new company innovation (new products, processes and services), those that have value but are discontinued due to change in company strategy or lack of funds, and those that have no immediate value. Many companies are sitting on huge reservoirs of new knowledge which is never revealed. The conclusion is that the overall return on private R&D could be improved if these outcomes are freely available, especially if there is a change in strategy and the projects are discontinued for non-technical reasons. Uncertain business environment and consequent changes in company strategy have a negative influence on R&D portfolio value.

**Technology management and competitiveness in the globalized world / 231****VALIDATION AND QUERYING OF FUZZY ASSOCIATION RULES****Author(s):** Dr. JIMENEZ, Claudia<sup>1</sup>**Co-author(s):** RODRÍGUEZ, Ivonne Elizabeth <sup>2</sup>

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The amount of available data has been increasing at a very high speed in the arising digital world. As ever, people wants to get the most possible profit of data. In this sense, in recent years, technologies of Business Intelligence (BI) have been receiving special attention because we need to convert data into useful information and new knowledge. Data Mining (DM) constitutes the core of any BI process. However, current tools for DM are too specialized to be directly used by decision-makers. Thus, the intervention of DM specialists results imperative. This human intermediation implies not only high costs, but also more time to make more accurate decisions based on knowledge discovered. One of the most important tasks in DM is the search of relationships between variables or attributes. Existing algorithms for this purpose search for all the relationships that meet user desired minimum support and confidence degrees. However, this technique fails in generating too many association rules as "interesting rules" when they are not really of interest. Rules are said to be interesting only because they fulfill the specified minimum support and confidence. Therefore, a process of filtering the association rules which are really-useful must be carry out by humans. The challenge addressed here is the popularization of the so-called BI approach to improve decision making, avoiding over-cost of specialized human intermediation. In this work, we introduce a user-friendly mechanism for querying and validating association rules. This mechanism is based on fuzziness and combination of different metrics of strength.

Fuzzy sets theory provides a formal tool for handling vague terms of natural language. Fuzziness is often present in human communication, hence results very useful to provide intelligent interfaces that process it. The use of linguistic terms overcomes the difficulty to comprehend numerical responses given by an automated system. Nowadays, some database querying languages, as SQLf, are featured for fuzziness. We extend SQLf for allowing linguistic truth values as "very true". We design a general-purpose interface for interactive data exploration. The system will answer not only with numerical values indicating the validity of the considered association rule, but also gives linguistic truth value of the proposition defined by the rule. Validation is achieved using fuzzy quantifiers and different metrics as the Lift, Leverage or the Confidence for quantifying the strength of the association rules.

With the proposed mechanism, we have built a graphical user interface in a way that association rules might be easily validated by non-experts in DM, fuzzy sets based systems or database languages. The use of linguistic truth values will be a key for better comprehension of the results of an association rule validation. Really-useful rules will be more easily reached because measure of rule importance strength involves different metrics, not just support and confidence.

Novel Innovation process in the digital world may take advantage of existing large databases using BI. Development of transformation strategies, management of production and new business models require decision makings that would benefit with association rules mining. Mechanisms as we propose will allow decision-makers to deal in an easier way with complexity of DM systems without the demand of a BI processional work skills.

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## Knowledge indicators and dynamic capability

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The literature continues to voice many doubts regarding knowledge management (Gasparini, 2014) for the development of dynamic capabilities (King, 2009; Frost, 2014) and their relationship with the ability of business models to create value (Osterwalder, Pigneur, Tucci, 2005). It

remains to discover how to develop this management through practices involving knowledge indicators for strategic decision-making. Therefore, this study is innovative as it proposes the development of dynamic capabilities through systematic knowledge indicators, since the socio-economic environment of the business model requires constant improvement of organizational resources to meet the dynamic demands of the market and society in general. In this light, based on two case studies, a framework of analysis is suggested, composed of factors involving constant observation of the organizational context, the business model and its relationship with the ability to create value, measured by indicators that enable the constant acquisition of new knowledge. In the proposed strategic context, organizations require observations on their competitive condition (Leih, Teece, 2016; Jantunen, Ellonen, Johansson, 2012), and organic development is equally important (Locket, Wiklund, Davidsson, Sourafel, 2009), making the knowledge acquisition process a constant challenge (Teece, 2000; Eisenhardt, Santos, 2002, Wang, Ahmed, 2007; Chien, Tsai, 2012). Thus, the difficulties involved in the systematic identification, acquisition and application of new knowledge (Cohen; Levinthal, 1990) aligned with the adequate response to exogenous and endogenous demands is the problem discussed in this work. Therefore, two companies experience were studied to identify the indicators contribution to the development of routines with dynamic capabilities. The inductive case study approach was used (Eisenhardt, 2015). The first case is an air transport company with international operations. The other is a clothing chain operating in the south and east of Brazil. In these companies, the systematic collection of information and its nuances generate learning and new capabilities on the part of agents, enabling them to adapt constantly to the processes and routines in the business models. The competences in these companies are related to the dynamic capabilities creation. The development of knowledge indicators and their technological base in the business models in question permit the formation of knowledge through the continuous collection of information, which generates learning over time. The adequate management of these capabilities, oriented to contextual demands, leads to the formation of dynamic capabilities regarding the factors present in the respective business models. Thus, the companies develop knowledge that enabled the transformation of routines that construct new readings of the internal and external environment, creating capabilities for their dynamic sustainability in the market, in accordance with their strategic purposes. A recommendation for future studies is more in-depth research on the relationship between learning processes and dynamic capability. Knowledge indicators permit a better understanding of the permanent need to adapt the business model to its context and become a factor that generates new routines with dynamic capabilities.

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## Strategic action, new markets and business model

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By selecting four processes of new market entry for long-lived companies with orientation to continue to renew their business model, this work proposed to analyze these strategies, guided by the research question: How is the new market entry strategy related to the configuration of the business model? The qualitative case studies, enabled to visualize the heterogeneous processes used by the companies with recursive effects between these two constructs to be identified; one as a strategy and the other as an organizational base for its effectiveness. The work also highlights propositions and recommendations for future studies inherent to the proposed theoretical framework. Long-lived companies, unlike companies that cease their activities prematurely, may have succeeded in maintaining their capacity to meet the new demands of stakeholders, especially those in their markets, through constant strategic reactivation. The demand-side looks toward markets, coupling with customers (Danneels, 2003), rather than factor market and producers, to explain managerial decisions that increase value creation (Priem, Li & Carr, 2011). By selecting four processes of companies oriented to renew their business model continuously, this study proposed to analyze three new market entry strategies guided by the research question: How is the new market entry strategy related to the configuration of the business model? New market entry strategies have to do with the initiatives of the company regarding: a) examining flaws in the current or emerging market; b) the possibility of employing the capabilities of the companies in the new market; and c) adapting the company to the new market structure and costs. This

question refers to recognizing that consumers' heterogeneity of demand contributes to the business heterogeneity (Adner & Snow, 2010), and related to the business model. Thus, it is understood that new market entry means a new configuration of the business model, which provides the operational and administrative base required to enact the company strategies in the new market. Therefore, the adequate configuration of the business model was found to be capable of generating administrative support for effective changes that began with new strategic practices. The data also show that the companies' new market entry strategies lead to different processes and practices that are adapted to the operational conditions, resources and previously existing capabilities in the business model. In these cases, there are changes in the analysis and reconfiguration of products, in the definition of the markets involved, the routines of administrative processes, resources and operations and the creation of value. These have higher or lower levels of emphasis depending on the characteristics of each commercial activity. Therefore, validating the original proposition, it may be suggested that the capacity of the business model to create value is directly affected by support for the strategy. As the strategy defines the changes to be made to the business model to make it effective, the strategic actions in question helped to gauge the effective choice of new market entry strategy of the companies. In the four cases, a strong relationship was identified between the strategic actions chosen by the managers and the business model recursively. Their effectiveness can be proved because their actions are supported by new configurations of the business model.

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## **THE NATURE OF ENTREPRENEURIAL ACTIVITIES IN LESS INNOVATIVE ECONOMIES**

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Economic development involves change and therefore the entrepreneur figures, as gap and input filler, to be its prime mover. The recognition of the importance of the entrepreneurs and the markets in which they operate has led many countries to foster entrepreneurship. Within this context, entrepreneur may be perceived either as an adjective that solely reflects a behavior or as the economic agent related to innovative activities. Nevertheless, the entrepreneurial behavior does not ensure economic development solely by the establishment of new businesses or self-employment. Economic development hinges then on innovation, translated in the knowledge application within economic activities by the economic agent. In that sense, leading a business company does not necessarily mean to innovate and, consequently, to aggregate value and impact significantly on the economic development. What we argue here is that to be self-employed or to own a business is not sufficient to be considered an entrepreneur, if it does not master a specific knowledge that may be translated into innovation. However, worldwide rankings suggest that countries such as Uganda, Thailand and Brazil are the most entrepreneurial countries in the world, due to self-employed individuals, even though not being the most developed countries, nor promoting innovation. With that in mind, the purpose of this paper is to discuss the nature of entrepreneurial activities in economies that are not innovation driven. To illustrate the dynamic of entrepreneurship in such economy, the Brazilian case is analyzed through the Global Entrepreneurship Monitor (GEM) data. In Brazil, there are several policies to promote entrepreneurial activities and, in 2015, the Brazilian government announced that the country was the most entrepreneurial nation in the world. Thus, Brazil has been figuring as a country with a culture favorable to entrepreneurship. However, data show that Brazilian businesses are not established based on knowledge accumulation. Considering that the country presents few novelties on the technology applied on new businesses' creation, as well as low value adding, the common sense turned to deviate and adapt the entrepreneurial function to the simple act of opening a new business company. We conclude then that the so-called Brazilian entrepreneurs open businesses based on already existing products, which are based on already existing knowledge. In other words, the new Brazilian businesses are far from being actually new and are not led by entrepreneurs (innovators), according to the proposed definition, but by business owners (value circulator). Results highlight then the importance to consider the nature of entrepreneurship in different economies in order to support entrepreneurial activities that, in fact, promote economic development through innovation.

**Complexity of innovation systems in the future digital world / 236****FROM INDUSTRIAL TO SMART CITIES****Author(s):** Mr. ZAWISLAK, Paulo<sup>1</sup>**Co-author(s):** Ms. PUFAL, Nathalia<sup>1</sup> ; Mr. CAMBOIM, Guilherme<sup>1</sup><sup>1</sup> UFRGS**Corresponding Author(s):** nathaliapufal@gmail.com

In the paradigm emerging in the twenty-first century, focused on the knowledge economy, elements such as collaborative actions, conscious consuming, sustainability, health, mobility, accessibility and connectivity are main drivers. This new paradigm requires more than the industrial organization of the traditional economy, which has been pushed out to urban peripheries, in industrial districts. Cities have become service oriented and frequently chaotic living place for workers. Within this scenario, where brainwork has become the most valuable economic asset, bypassing machines and simply workforce, people are the main source for this new economy – and they are concentrated in cities. What may be seen is the migration of the economic activity guided by the creative industry instead of the manufacturing one. Rather than identifying what is needed to expand the traditional industry, the challenge now becomes to identify how to attract creative people to cities and promote its development towards the new paradigm of creative industry. Creative people seek for a place that offers high conditions for living, working and entertaining. It means more than solely presenting an attractive urban environment; it is important to stimulate the establishment of new ventures based on knowledge and creativity, and the interaction between these ventures with S&T institutions to raise up their technological base and promote innovation. The ongoing phenomenon has been carried out not only by public policies, but also by firms and individuals, which use their knowledge and creativity to find solutions to deal with the complex issues present in a city. However, it is needed more. It is required that public and private sectors get together in a governance arrangement to identify the main actions to be fulfilled, which may ensure basic conditions to attract creative people and new projects to attract creative businesses, so that these people can work on them and generate wealth through knowledge. Cities must be planned and structured to facilitate a whole innovation ecosystem in which knowledge flows smoothly. Thus, industrial cities must be transformed into smart cities, in which the state-of-the-art knowledge is applied to develop enough economic added value solutions to generate wealth and quality of life, based on existing and new resources. To become a smart city, it is required a set of new assumptions in several different dimensions to attract and retain creative and talented people. Thus, smart cities may provide the necessary infrastructure so businesses, individually or through public or private partnerships, use ICTs to create goods and services, that solve urban problems and, along with it, raise the intellectual potential of the city and its competitiveness. Instead of a city that segregates its individuals and businesses through traditional industrial structures, cities in the twenty-first century must aggregate them to promote development through smart solutions. However, are the cities ready to deal with this new paradigm? Do cities present basic conditions to develop innovation ecosystems? Therefore, this paper aims to identify the basics to promote a smart city in the XXI century. To do so, a theoretical discussion is promoted, through the review of different smart city definitions, to propose a general concept and compare the basics of industrial cities with existing smart cities initiatives. To further explore the basics of a smart city, qualitative interviews will be conducted with key actors of different dimensions, such as government, companies, S&T institutions and individuals.

**Economic and societal impact of technology / 239****THE POTENTIAL OF RADICAL INNOVATION VIA TTU-I IN THE FOOD INDUSTRY****Author(s):** Dr. ALTHOFF PHILIPPI, Daniela<sup>1</sup>**Co-author(s):** Dr. MACCARI, Emerson Antonio<sup>2</sup><sup>1</sup> Universidade Federal de Mato Grosso de Sul/Universidade Nove de Julho<sup>2</sup> Universidade Nove de Julho**Corresponding Author(s):** daniela\_philippi@yahoo.com.br

Radical innovations are relevant in economic development and for the agribusiness, mainly in social development, among other factors, due to increased food consumption in the world.

The number of enterprises that have adopted the concept of open innovation is on the rise, seeking research sources and development (R&D) in other organizations such as universities. Assuming that innovations generated from the University-Industry (U-I) relationship promote mutual benefits and benefits arising from a radical innovation in agribusiness cause major changes and benefits, this study investigated the potential of the effects of a radical innovation process via technology transfer (TT) U-I in the food industry. The study was based on the model of contingency effectiveness TT Bozeman (2000), expressive model in the TT study, which includes the description of the TT process by means of effectiveness of its effects. This is a case study in which the data collected from interviews with respondents of the process of the university and the receiving enterprise as well as documentary and bibliographical research were triangulated and analyzed qualitatively. The innovation studied originated from the discovery of a molecule that is able to retard the ripening process of certain pre-processed foods, extending their shelf life, preserving them and reducing their waste. Some peculiarities were observed, such as the distancing of the university from industry at the time of discovery. Various adjustments for the product to achieve the level of marketing were necessary, requiring the presence of researchers for an initial period at the company, something important for the marketing success. Some of the main findings of the case study that reflect on aspects to be observed in other TT studies involving radical innovations, mainly under the Bozeman model, are the direct link of the high degree of novelty of innovation with its success and the possible impacts on revenue and profitability to other elements of the productive chains. This is because a radical innovation has potential to create new business opportunities, downstream and upstream, with the emergence of new technological cooperation and even in TT, which may incur in the social-economic development with the improvement of quality of life and other beneficial indicators to society. Moreover, the prestige of the university to contribute effectively to the development of a radical innovation can be significant and the connection between the innovation to the agent (university) is inevitable. In addition to the increase of technical and scientific capacity, the communication capacity between members of the university and enterprises should also be further investigated.

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## **BRAZILIAN AND NORTH AMERICAN NATIONAL INNOVATION SYSTEMS: REVEALING DIFFERENCES**

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The global scenario and technological advances make the markets increasingly competitive, increasing the need for companies to have a differential to remain in the market, which can be reached through innovation facilitated by interaction with other institutions such as universities and research institutes. Innovation has been increasingly appreciated as a relevant vector of the economy of a country. For the development of innovations, many enterprises, especially in more developed countries, have sought to establish partnerships with universities and research institutes and governments have created policies to encourage this interaction. The importance of the subject as an object of study at universities is illustrated, for example, by the creation of the Triangle of Sabato, in the 1960's, the concept of the National Innovation Systems (NIS) in the 1980's and the Triple Helix Model in the late 1990's. The NIS constitute a network of institutions in the public and private sectors whose activities and interactions promote the creation and dissemination of new technologies. Their agents are organizations and institutions such as universities and research institutes, the government and enterprises. This study aimed to mark the differences of NIS between two countries. One in a developed country, the United States, and another in an emerging country, Brazil. The secondary purpose was to facilitate the understanding of the innovation environment in the macro context in each country. Based on exploratory and literature research, legal aspects are highlighted such as in the Bayh-Dole Act of 1980 in the United States. In Brazil, the Intellectual Property Laws of 1996 and the Innovation Law, in 2004, were studied as indicators related to innovation in countries, such as the Global Competitiveness Index (GCI), which includes evaluation of several variables such as the University-Industry Cooperation (U-I) and the backlog world ranking that shows from patent application until its concession. Research and Development (R&D) in the United States is more oriented to obtaining concrete results than in Brazil, focusing on development and engineering. In the United States, although



government participation in R&D investment is decreasing, investments of enterprises, universities and non-governmental organizations have increased to the point of offsetting the reduction of public incentive and improving the importance of scientific discoveries as support in technological innovation. It is expected that the research results allow better understanding of the NIS of both countries and inspire new actions and joint studies such as those that involve cases of U-I technological cooperation of both countries.

## Product and service development / 243

### The crowdfunding idea contest of BMW

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Idea contests integrate customers into innovation processes and enhance product development of companies. Utilizing the “wisdom of the crowd” as means to improve idea generation and idea assessment has received rising popularity in research and practice alike. One new mechanism to enhance such crowd-based approaches is a crowdfunding idea contest. Crowdfunding as important platform-based financial concept is based on the collective intelligence or rather wisdom of crowd-mechanism as the crowd decides what projects to fund and thus realize. In a corporate context, crowdfunding enables customers to propose own product ideas on digital platforms and to promote other product ideas by allocating a given monetary budget, leading to knowledge sharing and improving innovation management processes. Enterprises employing a crowdfunding idea contest have to cope with strategic decisions and design issues. In this paper we analyze the strategic decision process that lead to the design of a crowdfunding idea contest and investigate the design elements of such a customer-oriented product development approach. The research method for our study is a case study approach. We analyze the case of an idea contest called “Mobility Experience Challenge” carried out by the German automotive company BMW in collaboration with the crowdfunding platform Startnext. The idea contest addressed external individuals that were asked to submit their ideas for innovative mobility products and apps used in conjunction with cars and evaluate them. The data analysis was conducted using a design science approach, which intends to solve field problems by applying academical solutions and interventions. We were able to accompany the decision-making process of BMW during the design of the crowdfunding initiative, including challenges and ways of how to overcome these. The results show that BMW’s idea contest is based on the triad marketing, evaluation and financing. Moreover, several strategic discussion rounds and adjustments were needed until the initiative was designed. The contest design includes several different factors that can be clustered in organization, funding object and contest. Organization refers to the strategic level of the initiative, focusing on BMW. Funding object and contest contain concrete design elements that focus on the crowd. The findings of this study are highly relevant for the implementation of a new idea generation and selection approach in innovation management, which is critical for being competitive in technology driven markets. We introduce crowdfunding as new form of an idea contest on digital platform. Our employed design perspective of a company-driven crowdfunding has concrete practical implications that can help companies to implement crowdfunding in order to increase the success of idea contests and thus facilitate product development.

**Keywords:** crowdfunding; idea contest; product development; innovation management; design elements; design science;

## Technology management and competitiveness in the globalized world / 245

### Determination of information demand for efficient technology monitoring

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The application of effective, on the company's needs adapted technologies is a key factor for competitiveness and economic success. To ensure an early identification of emerging technologies, of changes in existing technologies or of related changes in the market's structures and participants many companies conduct technology intelligence (TI) activities.

Technology monitoring is one base activity of TI, which is defined as the systematic tracking of developments within a specified topic of interest (search field) as well as related trends over a long period of time. Due to the very large amount of available data within the technological and the market environment of a company as well as their possible interdependencies, it is necessary to focus technology monitoring. For this purpose, we suggest the use of leading indicators, which are able to timely point out technological developments and market changes.

In this paper, we introduce an approach for the systematic derivation of leading indicators for a certain search field. This approach is mainly based on the combination of methods which are already widely used in TI, such as scenario analysis, in combination with methods of other disciplines for deriving indicators, such as risk analysis. It therefore extends existing approaches in technology monitoring.

Our research shows that the reasonable definition of the information demand in the beginning of the technology monitoring process is a major factor for efficiency. This coincides with our experiences in consulting projects: many companies struggle with finding a balance when defining their search fields between resource efficiency and complete coverage of the topic. As part of our research agenda we start with analyzing and discussing existing approaches for the determination of information needs. We proceed with showing the influences of the search field characteristics, e.g. the position in the technology life cycle, on the implementation of technology monitoring activities.

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## CONSTITUTIVE ELEMENTS OF INTELLIGENT CITIES IN MINAS GERAIS

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Digital spaces and collaborative tools to stimulate the use of collective intelligence, focusing on benefits with human innovation, to find new solutions to the problems or even to predict them, characterize a Smart City. Therefore, what are the basic constituent elements of a place considered intelligent? Which of these elements are found in the cities of Minas Gerais? This research is not intended to test hypotheses, but simply achieve the proposed objectives, as follows: to identify the basic constituent elements of an intelligent city and list the inherent elements of the cities of Minas Gerais. The methodology is qualified as bibliographical and documentary research. An approach on this theme is emerging and indicating solutions to intricate organizational, social and material problems arising from rapid urbanization. The urban logic, strategic intelligence, and risk analysis of investments made the Urban Systems Company able to create the first ranking of smart cities in Brazil, indicating the cities interested in intelligence in their administrative, economic, and development processes. Among the most important cities in Minas Gerais: Belo Horizonte, the second place in governance classification, for intelligence services and partnerships with investment institutions in energy efficiency studies and management tools, and third place in the ranking of the most intelligent cities, according to economic sustainability criteria, promotion of a better quality of life and preservation of the environment; Sete Lagoas, due to the Cities of the Future Project, technologies focused on generation, transmission and distribution of energy, in addition to the implementation of the first experimental photovoltaic solar generation plant

in Latin America; and Uberlândia, for implementing Granja Marileusa, the city's first planned neighborhood based on Smart City concepts. It can be considered as an emerging opportunities for the Brazilian cities, the urban infrastructure monitoring systems; Data on people's behavior and lifestyle; Monitoring the health and well-being of the elderly population; New ways of including people with disabilities; Distance education or digital schools; Public management systems. For future studies, it is proposed to check, in Brazil, in all the cities of a state, or in all the states of a region, the constituent elements of intelligent cities. This proposal will make possible greater conclusions and affirmations referring to elements that configure a place like Smart City.

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## **INNOVATION CAPABILITIES IN BRAZILIAN LOW-TECH FIRMS**

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Innovation has always been part of all economy's realities, although distinctly characterized. In the case of low-tech industries, innovation appears differently from the high-tech ones, as they have traditional characteristics that deal with highly diffused and mature technologies (Reichert, 2015). Moreover, they usually adapt external technologies into their manufacturing processes, avoiding applying them integrally (Hirsh-Kreinsen, 2015). However, innovation can indeed occur in these industries, and the firms may have an innovative performance, even if in a less apparent way. This is the case of the Brazilian food industry, which represents almost a quarter of the Brazilian gross domestic product (Brasil, 2015). Low-tech industries mostly innovate in the design of products, methods of production and purchase of new equipments (Bell & Pavitt, 1995), emerging from the areas of product innovation, process innovation, marketing innovation and organizational innovation (Reichert, Camboim & Zawislak, 2015). Thus, the capabilities model proposed by Zawislak et al. (2012; 2013), which integrates these four areas to measure innovation activity, seems to be appropriate. This study aims to identify the innovation capabilities in the food industry and analyze their configuration, in order to understand how innovation processes occur within this important part of the Brazilian market. The model proposed by Zawislak et al. (2012; 2013) is used to analyze innovation process in the Brazilian food industry. In order to describe the organization of the capabilities presented and to have a better understanding about innovation process within these firms, a database from a project conducted in the Brazilian industry was used. A mixed method was applied, once it was used data from interviews with five food firms and data from a survey with 120 firms from this industry. Data from these two methods were jointly analyzed, complementing the exposition. From the results it could be perceived typical characteristics from low-tech industries, with predominance of the operational capability and low investment in R&D, once 57,8% of the companies invest less than 2,5% of their revenue in R&D activities. There is a difficulty in creating new products, so innovation usually is focused on small changes in operational processes, with improvements of an already existing product (49,2%) instead of creating a new one. The main investments occur in machinery and equipment (44,2%), with a focus on quality control (34,2%). These companies are market dependent, once 73,1% of them use a cost price definition. After the analysis of the activities developed within the Brazilian food industry, a low-tech sector in its origin, it was possible to determine how innovation processes should be structured in order to obtain market advantage. Though, firms in the food industry may be consider innovative, even if they don't present usual innovation activities, such as R\&D departments, use of patents, technological process, and so on. Firms in this industry perform in an innovative way, focusing on business activities. The present study stresses some material to better understand the dynamic environment of the Brazilian food industry context. Thus, once the innovative pattern of the firms comprised within this industry is identified, it becomes possible to have enough knowledge to help with the decision-making processes that firms within similar contexts can adopt when considering their innovation strategies, enabling them to see innovation with different lenses and proving that they can, indeed, innovate.

**Future thinking, strategy development, and theory of technology / 253**

## Disruptive technology scanning: Passive screening versus hands-on experimenting

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Technology scanning is the activity to gain insight on technologies outside a company's technological and market competences. This has traditionally been done in a rather passive way since such technologies rarely had a strong influence on companies. With the emergence of more and more disruptive technologies, correct and fast evaluation of trends and technologies outside the company's competences has gained importance and has emerged as a key success factor for surviving trends such as digitalization. Thus, companies are starting to get more actively involved in technologies even in the stage of establishing first contact with a technology. Traditionally, such immersive activities have been done only after defining a technology field to be of importance as a technology search field of the company. Such more immersive activities for unknown technology fields consume resources and risk losing focus on such defined and identified search fields. This paper gives recommendations on how to balance the resource level of initial analysis of upcoming trends while ensuring proper evaluation of potentially disruptive technologies based on the company's strategy regarding the use of external technologies.

The paper is based a literature analysis of existing case studies in technology scanning, corporate foresight and corporate technology incubators on the one hand, and on the other hand on observations from several industry projects on evaluating new technologies (particularly in the field of digitalization) ranging in immersiveness from the commissioning of trend analysis reports to active experimentation with the technology in topic-open incubators. The observations are condensed into model architectures of technology scanning which consider the various generic goals of companies regarding the introduction of new technology fields.

We find that the needed level of immersiveness is not a factor of company size or market factors, but rather of strategy and timing. The more a company wants to position itself as an innovation leader and the later it becomes aware of the potential importance of trends, the more immersive should its first contact with a technology be. We observe that for companies far removed from the considered technologies (for instance, traditional industry from internet of things technology) experimentation or other immersion may even be needed before the organization has the capability to clearly define and comprehend traditional search fields regarding the new technology as otherwise the scope cannot be focused on the relevant aspects for the company. These results are important for companies to decide on how to deal with potentially disruptive technology trends including digitalization and additive manufacturing, and emerging trends such as blockchain. The discussion is important to the IAMOT 2017 conference as the paper highlights theoretical results obtained from observing the first contact with digitalization (especially IoT) in companies who are just in the process of realizing the disruptive potential of these technologies for their markets.

**Small and medium sized enterprises and innovation / 260**

## Information technology entrepreneurship: challenges experienced by small, medium and micro enterprises

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The impact of the information technology (IT) sector in the creation of entrepreneurial ventures has been demonstrated for various countries. Entrepreneurship is a key ingredient to underpin economic growth for developing countries. There is limited research on technology entrepreneurship, particularly with regard to the challenges IT entrepreneurs encounter in South

Africa. This study examined the challenges IT-based firms in an incubator in the Durban region face. Business incubation is a dynamic process of business enterprise development that nurtures young firms, and helps them to survive and grow during the start-up period when they are most vulnerable. Incubators, furthermore, provide hands-on management assistance, access to financing and orchestrated exposure to critical business or technical support services.

A qualitative study was conducted on information technology (IT) small, medium and micro enterprises (SMMEs) in the Durban area, South Africa. Through case studies, an exploratory, theory-testing and theory-building approach was used. The sample was purposely selected from a stratified population of 47 and included eight participants who have been in an incubator for five years or less. Thematic and content analysis was applied to analyse the data with NVivo software.

A shortage of start-up finances to set up the business does not appear to be a major stumbling block for IT SMMEs. This study indicated that owners of IT SMMEs do not necessarily need more start-up capital. It appears that most of the finance can be raised through successful initial business deals. Therefore, the ability to initiate, chase and close deals was reported to be very pertinent. The need for finance appears at a later stage when it is needed for business expansion and growth. The IT SMMEs have a most urgent need for skilled workers and equipment. However, it seems that there is further emphasis on the need for advanced IT and marketing skills. Another serious challenge that IT entrepreneurs face is 'social engineering', a phenomenon that occurs when a person privy to confidential information shares it with, for example, a family member or a friend. Challenges that could be problematic in future appear to be the availability of IT technicians, the funding of employee training programmes and security difficulties in cloud computing.

#### Technology management and competitiveness in the globalized world / 262

### Management of Technologies in the 21rd DIGITAL Century

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In the paper the two aspects of Management of Technologies ("MoT") are lined out: a) Management of Technologies for Regions and Countries b) Management of the Technology Portfolio for Enterprises Strategic MoT for regions and countries is done to reinforce the competitiveness of the region in the ever harder global completion to ensure employment, the standard of living, social welfare and the quality of living. As far as technology strategies for regions is concerned, the EU bets on "S3" (Smart Specialization Strategy). "S3" - in simple words - is betting on the specific strengths fields of a specific region. As a matter fact, there are several strengths in a region: Strengths of enterprises, strengths in R&D, strengths in infrastructure etc. Regarding the technological competitiveness of the region in the global competition, two strengths are decisive: The strength in enterprises and the strengths in R\&D (IPR). If a specific region has a technological strength in both - enterprises and R\&D - this technology is called a "double strength technology" or "a double strength field" of the region. The author has derived a new concept to identify the "Double Strength Technologies" ("DST") of a region. The computation of these DSTs of a region - which can be done highly automatized - is shown on a few examples. This DST concept could - for example - be used in the frame of the elaboration of EC's S3 strategies of Europe's regions. As far as the "MoT" for enterprises is concerned, it is good to remember that there is but one reason for innovation: TO MAKE PROFIT! Profit is the difference between the prices that can be achieved and the production costs. Better (premium) prices can be achieved with Product Innovation, the production costs can be lowered with Process Innovation. In a chapters of the paper the "Ten most important Success Factors in Innovation of Technical Products in Enterprises" are described, in another chapter the "Ten widest spread Misconceptions" are line out. Within these two chapters many alleged doctrines of innovation management are disrupted! For example the "obsession for cooperation" is rebutted, but also some fairy tales about "Technology Transfer" and other myths of MoT. On the other hand the importance of some old, very basic rules for success in innovation are brought back into memory, like the "PIMS Concept" of the 1970 ies, or the findings of the three professors for innovation, Prof. Ansoff, Prof. Prahalad and Prof. Kondratjew. It is shown that MoT with Digital Technologies is no Rocket Science but a Task for Innovation Professionals! According to the author, much less MoT projects will fail in the 21rd DIGITAL Century NOT because of NOT knowing the

specific rules for innovation of digital technologies, but because the new young CTOs in the 21st century do not any longer remember the “Lessons Learned” for successful innovation of the 20th century! It is - however – lined out in the paper that for “INDUSTRY 4.0”, one major application of digital technologies, Europe is falling behind the global leaders in terms of IPR relevant for INDUSTRY 4.0. A list with the global TOP 40 enterprises regarding IPR relevant for INDUSTRY 4.0 is presented and discussed in the presentation. The author outlines the three most important Criteria for Success out of his personal experience within 28 years as CTO in industry. The Paper concludes with the well known Slogan of the famous Peter Drucker: “The CEO of an Enterprise only has two Functions - Innovation and Marketing!”

**Technology transfer, marketing and commercialization / 264**

## International technology transfer in national cultural context

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One of the way of technology commercialization on global market is transferring technology across border and making a profit via foreign direct investment, joint venture, license etc. The success of technology transfer is a key factor of technology commercialization on global market. However, technology transfer from one country to another countries where have different culture, are challenging. Most previous studies on technology transfer across border have focused on absorptive capacity such as human capital and the level of science and technology innovation. However, those absorptive capacities are not sufficient conditions. Technology is the accumulated asses of tangible and intangible knowledge and experience. Successful technology transfer means transfer those tangible and intangible knowledge. National culture reflects a country's central tendency in terms of values, beliefs, and preferences. They provide a basis for sampling the domain of a message, how much weight to give to what is sampled, and what the relationships are among various domains of message. Thus, in our study, the role of national culture on technology transfer across border is explored. For this, cross-sectional data covering 46 countries is analyzed.

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## How the fourth industrial revolution is represented in science literature

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Science, economy and industry, as well as society and government stand on the sill of a new technological revolution that will fundamentally alter the way of our live, our work, and relate to one another. In its scale, scope, and complexity the transformation will be unlike anything humankind has experienced before. The possibilities of billions of people connected by mobile devices, with unprecedented processing power, storage capacity, and access to knowledge, are unlimited. Artificial intelligence is ubiquitous around us, from self-driving cars and drones to virtual assistants and software that translate or invest. Digital fabrication technologies, meanwhile, are interacting with the biological world on a daily basis. Engineers, designers, and architects are combining computational design, additive manufacturing, materials engineering, and synthetic biology to pioneer a symbiosis between microorganisms, our bodies, the products we consume,

and even the buildings we inhabit. How do research and science work up the challenges and findings round this fourth industrial revolution? How is the landscape of the fourth industrial revolution represented in scientific literature? Which topics are frequently discussed? The fourth industrial revolution includes among others especially cyber physical system, digitalisation, industry 4.0 (especially in Germany), or internet of things. Which picture does science literature show if we combine these with topics covered in innovation management, in R&D management, in management of technology, or also combined with manufacturing, or production? Who is working in these topics? Technology monitoring and bibliometric methods aim at creating an overview on technological and non-technological information on the specific subject matter, in our case here is that the topics round the fourth industrial revolution, in order to identify emerging topics in research fronts, growing and declining topics, evaluate already existing networks and the potential in up to now unused collaboration. The data source can be scientific literature, patents, or other sources. The advantage of these methods is based on the possibility of content-based structuring of the information, the identification of subtopics, the visualization of the contents, of structure and connections of the information. The objectives of such a monitoring is to get insight into scientific literature (this is the data source in our case here – Web of Science) in order to identify

- research fronts and their emerging topics and technologies as well as their dynamics;
- perceptible highly cited articles as basis for later research;
- key players, i.e. the most visible organizations and authors, and the connections between them show collaboration patterns

This contribution analyses approximately 1,500 articles in Web of Science, structure and visualise them. The publication activities have doubled from 2014 to 2016. The most visible country is China followed by Germany, USA, and England. Also Asia is most represented; Europe follows on the heels of Asia. Even Austria is ranked under the first 20 most visible countries. The topics are covered over a broad range of research area, starting from engineering, computer science, business economics, automation control systems, etc. but also in social sciences, and food science, only to mention some of them.

**Keynote / 268**

## **voestalpine Special Steel Division – One step ahead in digitizing processes in the Metals industry**

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Digitization is amongst the most important topics for voestalpine. In this presentation, Mr. Rotter will highlight voestalpine Special Steel's Digital Journey approach, a focused long-term change effort that transforms the business for the future. Starting from the actual changes in the environment and the necessity to adapt to it, the presenter will provide an inside view on how voestalpine Special Steel deals with Digitization. He will not only demonstrate that a holistic approach - spanning from operational improvements to business model innovation thought from the customer – is necessary, but he will also briefly highlight concrete examples of Digitization at voestalpine Special Steel and reflect on the lessons learned.

**Future thinking, strategy development, and theory of technology / 273**

## **Commercial pressure, local responsiveness and synergies in globalized engineering services**

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This paper investigates how medium-size engineering service companies working traditionally in national markets have engaged with challenges of globalization and competition from multinationals. The Scandinavian region has many smaller domestic engineering companies in the industry,

which are under pressure in their established national and wider international markets. The paper uses strategic management of technology as a framework and is predicated on the proposition that strategies such as outsourcing, strategic partnerships, joint venturing and technology/knowledge transfer enable them to compete on a more equal footing. The research uses mixed-methods with empirical data from a desk study of sector development supplemented by qualitative studies of individual companies. The paper includes a case study of a medium size engineering service company based in Denmark with around 100 offices worldwide. The analysis shows the engineering service market has become a disruptive area dominated by a few large global players compared with the past where companies have operated in protected local markets. It reveals an array of strategies combining local, regional and global elements resulting in unique strategic “bundles”. Among the companies studied there is a plethora of strategies and diversification into other revenue generating activities. Mergers and acquisitions are the most important strategies among the largest companies. Also there are a number of network strategies involving local resources from sister companies etc. As with many other industries in the service and manufacturing sectors, there has been a tendency towards outsourcing of engineering services with currently the largest destination being India, with about 25 percent. China is also an important location with its role expected to increase in coming years. Several other countries also host offshored engineering, including for example the Philippines and Malaysia. An important question, given the industry’s high labour intensity and need to work closely with customers, is whether outsourcing provides the responsiveness necessary to counter the drive towards synergy and economies of scale. Consequently Scandinavia has tended to become a single “domestic” market. The case company illustrates many of the findings. It has a multidisciplinary profile in Scandinavia while establishing a more limited presence in North America and elsewhere in Northern Europe. And it is developing a global business focusing on separate areas such as large bridges, environmental consulting and developmental consulting. The paper adds to strategic technology management concepts and approaches by identifying the strong role of emergent strategy moves made by senior managers in the companies. It complements established theory and practice concerning the Resource Based View and Knowledge Based View as well as on network operations and extended enterprises.

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## **Identification of the relevant attributes of Industrial Development taking into account Human Development Indexes**

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The Human Development Index (HDI) is an indicator adopted by the World Health Organization to assess the quality of life of a given region. Its prediction can aid in non-planning and decision-making for advocacy and policy advocacy to improve its development. Thus, the data were collected in the respective survey are corresponding to historical behavior are index of the 149 countries analyzed. The temporal variables corresponding to the historical and intermediate periods from 1990 to 2012 were not published in the most recent report published by the United Nations Development Program (UNDP) on 07/24/2014. Their research aims to identify the risks of Industrial development leading to Conflict Human Development Indexes in the time period from 1990 to 2012 in 149 countries. To do so, the use of Data Mining was done using an Attribute Selection Task to identify such variables. According to the results found that the attributes Index of Study, Index of Income, Health Index, Index of Years of Studies Expected, Years of Study Expected, Years of Study, Life Expectancy, Gross National Income, Beverage, manufacturing, food, chemical, metals, minerals and medical sectors were selected in the evolution of the HDI from 1990 to 2012.

**Technology management and competitiveness in the globalized world / 278**

## **IT4IT™ as a Management of Technology framework: Perspectives, implications and contributions**



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Information technology (IT) is at the heart of digitisation of existing business models and dominates in the innovation efforts of many industries. IT has until now in many ways been regarded as exempted from the structuration and automation represented by IT. The IT4IT framework released by The Open Group in October 2015 suggests to a major change. IT has to be governed and structured along defined processes of value chains, life-cycles, service propositions, customer interaction and cost control as any other area of the organization. The purpose of this paper is to review IT4IT as a practical implementation of a Management of Technology framework and to review its perspectives and implications to the MoT society as well as the contributions it has to IT professionals, innovators and MoT practitioners. Methodologically this paper is based on an extensive case study of a large IT service provider. The IT service provider used the framework, along with other frameworks, to introduce larger degree of homogeneity of its own service “catalogues”, improved processes for navigating in the heterogeneous of its customers, and to ensure uniform processes of performance management and reporting. Methodologically this paper has been challenged by the novelty of the topic of IT4IT as only very little peer reviewed materials is available. A broad range of analogue communication channels therefore has to be reviewed and included, a.o. standards, whitepapers, blog postings, student works, professional presentations and Youtube videos. Key findings of this study are: (1) IT4IT as strong idealization of a practical MOT framework implementation especially in conversion from relative mature innovations to operational environments and life-cycle management. (2) IT4IT is driving IT further in the direction of commoditization and consumerization reducing uncertainty in IT implementation and operations and giving business stakeholders better opportunities for innovation. (3) As a MOT framework, IT4IT Conclusively, IT4IT is taking IT a step further in being a more manageable technology with more specific definitions of services, customer expectations, relationships between innovation and operations, and transparency of processes. IT4IT suggests a highly specific and novel interpretation of innovation and operations value chains that can inspire other MOT processes. Scholarly, IT4IT is new and lacks lack scale implementations, thus this paper has an ex-ante perspective and longitudinal studies must wait. Furthermore, there are discrepancies and inadequacies that must be subject for further studies. The IT4IT framework is an interesting suggestion to the MOT society for a professional framework that has gone further in governance and provides a more holistically approach than probably any earlier framework.

**Complexity of innovation systems in the future digital world / 279**

## Patent Analysis for Graphene Technology in ICT Industry

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Emerging technologies like mobile broadband, SDN, cloud computing and big data lead to the rapid development of ICT (Information Communication Technology) industry. Graphene, as an emerging and promising technology, plays an unsubstitutable role in the ICT upstream material industry and serves as the most disruptive new materials in twenty-first century. At present, application products of graphene technology, such as super capacitors, cells, touch screens, sensors, microelectronic devices, semiconductor products and so on, have been applied to ICT industry. Having a good understanding of application and development of graphene technology is the key to the future competition in electronic markets for ICT enterprises. Patent contains abundant technological, commercial and legal information which regard as vital data resource to identify technology innovation. Patent analysis is an effective tool to discover, portray and utilize technological information from different knowledge base. From current literature review, patent statistics and patent bibliometrics approaches are the most widely-used patent analysis approaches. In this paper, we take graphene technology in ICT industry as object of research and introduce GREP model based on patent analysis.

In order to realize the goals of patent analysis, we select patent data from Derwent Innovations Index platform which facilitates rapid, precise patent searching. After retrieving 2788 patents from Derwent Innovations Index platform, we shall pioneer GREP model to utilize patent analysis for promoting the development of graphene technology in ICT industry. Actually, GREP model is generally acknowledged as a convictive tool to analyze enterprise's internal competition advantages. By introducing patent indicators to the previous GREP model, we build up a new GREP model based on patent analysis, then analyze graphene technology in ICT industry from Governance, Resource, Entrepreneur and Product dimension. GREP model based on patent analysis should at least cover following basic tasks which are describing the status quo of technology, identifying core patents, mapping technological evolution path and finding technological hotspots.

It can be seen from the patent analysis above, improved GREP model can analyze industry current situation from microcosmic side and overcome the influence of subjectivity. China, as a country has massive graphite reserves, plays an important role in graphene market. However, there is still a gap between China and other countries like the United States and Korea of graphene technology in ICT industry. To confront with this situation, we put forward suggestions on the patent layout of ICT enterprises in China and the future development and innovation countermeasures of graphene technology in Chinese ICT industry. The final purpose is to summarize IP policy implications and suggest that GREP model based on patent analysis can optimize management in ICT Industry and other future emerging technologies and industries.

Furthermore, it is necessary for enterprises in ICT industry to attach great importance to graphene-related patents, which contains technology value and economic interests. Great efforts shall be focus on finding better patent analysis methods to identify technological hotspots precisely and make technical breakthrough in the near future.

**Technology transfer, marketing and commercialization / 280**

## FRAMEWORK FOR A MULTIDIMENSIONAL THREE-PHASE NETWORK DATA ENVELOPMENT ANALYSIS OF TECHNOLOGY-TRANSFER OFFICES

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This article uses an original three-phase approach for empirical assessment and comparative evaluation of the efficiency of university technology transfer. It is based on analysis of inputs and outputs of a disclosure phase followed by a value-add phase and a final license phase, using a multidimensional framework. The objective is to find university Technology Transfer Office (TTO) efficiency and effectiveness patterns for each phase as well as overall TT processes. A network Data Envelopment Analysis (DEA) model was used to analyze and describe the complicated TT operational processes using Association of University Technology Managers (AUTM) data collected from 90 US university TTOs for the period 2007-2013. It was concluded that the sampled TTOs were most inefficient in their value-add (2nd) phase and that the average overall efficiency as well as the efficiency of disclosure (1st) and license (3rd) phases decreased during the last five years of data analyzed. In addition, in line with other studies, analysis supports the contention that the presence of medical school does not increase TT efficiency or effectiveness. The present research's contributions focus on three areas: (1) Analysing and modelling TTO valorisation and commercialization process with a UML activity diagram to provide a clear picture of TT procedures and processes; (2) Proposing a three-phase DEA framework showing input/output indicators closely related to each phase of processes rather than a black box or separated activities; (3) Offering a strategy to conduct empirical studies on TTO's operational efficiency thereby helping to better understand future research operational problems.

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## Assessing The Reliability Of Organisational Management Systems Using A Simulated Probabilistic Fault Tree Analysis

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Managers of organisations are often faced with non-structured problems which involve quite a lot of uncertainties in their process. The reason is that organisations have not been recognised as dynamic and open and the stochastic nature of their complex systems is not fully appreciated. Hence, there is ample need for developing a tool that applies reliability techniques that are normally used in assessing the performance of physical complex systems, to help managers to assess the reliability of their departmental performances. Although some applications were previously designed to reveal the probabilistic nature of system's components performances, unfortunately, the results are still obtained from deterministic modelling which is inadequate for real understanding and analysis of complex systems' performance.

The aim of this work is the development of a simulated probabilistic fault tree analysis that can facilitate the accurate study of the possible events that can cause the failure of the system's failure. By allowing probabilistic input of basic events a Probabilistic Fault Tree Diagram (Prob\_FTD) can be built giving managers more freedom to check among a range of failure probabilities that the system might fall in rather than one limited deterministic failure value. The addition in this work is the use of the Monte Carlo Simulation (MCS) method to simulate this Prob\_FTD to get more accurate results and values for the intermediate and top events. This makes the analysis more rigorous and gives more practicality to the assessment of the whole system resulting in better management actions and higher reliable system performance.

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## Averting Failure of Project Systems by Implementing a Reliability Management Perspective

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There are a lot of reasons that contribute to the failure of projects and their systems. Among those reasons, one that is very significant to project failure is the lack of project managers to view the project as one whole system that need to be studied for its reliability. In this recommended reliability study, not only physical resources are considered in the analysis but the human reliability, which reflects the human resource (project managers and their employees and their relationships) that is present in projects, should be also considered. In other words human versus human factor should be included in the analysis and assessment of project systems reliability. This human factor should be an important consideration in all stages of project design, implementation and management as in most times it is overlooked by project managers and ignored in the success/failure analysis of the project. This paper strongly recommends the incorporation of a new reliability management perspective that views the human (management and employees), physical (material, machine and money) and client (external) resources as components in one whole integrated system all to be connected in a parallel reliability connection. This reliability view, if adopted, will allow project managers to operate their project systems effectively for achieving a higher rate of success and to avert possible chances of their failure.

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## TYPES OF KNOWLEDGE AND PATTERNS OF KNOWLEDGE TRANSFER

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The advancement of digitalization in traditional industries confronts established companies with the need to adjust their current competence base and develop expertise in hitherto unfamiliar fields. Inter-organizational networks like strategic alliances, regional clusters or industrial associations provide member firms with an infrastructure for knowledge transfer and thus represent an important mean for meeting this task. Hence, knowledge transfer via networks plays a key role in innovation and technology management.

While previous research yielded insights on why, when and how organizations choose to transfer knowledge, some important aspects of this phenomenon remain unaddressed. First, the exclusive focus of most studies on single types of knowledge (esp. technological knowledge) fails to adequately capture the complexities associated with innovation processes, particularly in the context of digital innovation. Second, academic knowledge on structural patterns of knowledge transfer in inter-organizational networks is still scarce. Nonetheless, identifying specific regularities on the dyadic level (e.g. the preference to acquire knowledge from a certain type of partner) or the extra-dyadic level (e.g. the tendency to form cyclic or transitive exchange structures between three or more firms) as well as finding explanations why they emerge bears significant potential for a better theoretical understanding of knowledge transfer processes.

In this paper, we address both gaps by answering to the following research question: “In what way and why do knowledge transfer patterns in inter-organizational networks differ dependent on the type of knowledge being transferred?”. Following the assumption that the properties of transferred knowledge may implicate considerable barriers to exchange, we draw on previous theoretical perspectives highlighting codifiability and context-specificity as key impact factors on knowledge transfer processes. We argue that four types of knowledge relevant in the context of innovation (technological, market, managerial and regulatory) possess distinct characteristics which make them differ on these two dimensions. Enriching these considerations with insight from network theory, we deduce hypotheses on differences between the four knowledge types in the emergence of specific structural transfer patterns.

In order to test the hypotheses, we investigate the knowledge transfer among the 92 member firms of the largest network of German municipal energy providers drawing on sociometric survey data. Structural differences between the four types of transfer networks were uncovered and tested for significance via exponential random graph models (ERGM). Concerning rather codifiable types of knowledge, our results provide evidence for a tendency of firms to select potential knowledge sources primarily based on superior resources (dyadic level). In line with this, the existence of in-stars, single firms which serve as knowledge source for many other firms, is significantly more probable than for rather tacit types of knowledge (extra-dyadic level). On the other hand, the results indicate an increased likelihood for reciprocal transfer (dyadic level) and transitivity (extra-dyadic level) if the type of knowledge transferred is highly context-specific. In all, our study refines and tests theory by explaining the emergence of structural transfer patterns for different types of knowledge. It hence contributes to a more thorough understanding of knowledge transfer in inter-organizational networks and provides a basis for offering implications for network managers on how to stimulate knowledge transfer among network members.

**Future thinking, strategy development, and theory of technology / 286**

## **A scalable structural 5 step approach to handle digital-transformation in companies**

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The production industry of Upper Austria covers several industrial branches with clear strongholds in materials production, machinery, automation, automotive etc. However, Upper Austria is not only the home of global leading industrial producers, it is more the home of an eco-system with

a healthy mix of Small and Medium Enterprises (SME), large Enterprises, producers of goods, producers of services and R&D competencies.

Managers in all types, branches and sizes of companies are facing the upcoming digital transformation – an upcoming megatrend. The complexity confronts managers with challenges. In this paper a scalable structural approach for implementing a megatrend in companies (irrespective of size or branch) is introduced and a specific “maturity model” is presented.

In the first step it is essential to define a clear - company individual - vision on digitalization. The vision has to focus on the “future market opportunities for the company” and also has to take into account new perspectives from R&D. In strategic workshops (e.g. design thinking, etc.) the company defines clear company targets! It is important that these targets are a) not too many, b) can be measured with clear key performance indicators (KPIs). Targets (KPIs) can address internal processes (e.g. lead time) and/or external ones (e.g. sales volume).

In the second step application fields are identified to pursue the vision. Thus if the vision is that digitalization should cut the production lead time in half within 12 months, the production is an application field. The second step also includes the support with specific technological information – like qualification networks.

Digitalization is a companywide task and therefore not isolated in a single department or upper management levels. In step two the application field was identified and decision makers are supported to be forerunners but they have to include their surrounding departments and staff (IT, HR, etc.). Step three is also for involving business partners like sub-suppliers, customers etc. A standardized maturity model is customized for this very purpose. It can be seen as a match making between the aims (the vision) and the most promising digitalization measures to reach the aims. The maturity model which is a heart piece of the 5-step approach provides detailed actions recommended in the specific application field. The maturity model is based on three dimensions. Dimensions are subdivided in criteria and sub-criteria and each sub-criterion is equipped with a reference table to facilitate the self-assessment. Output is an action plan that develops the digitalization status quo to the digitalization objective of the company referencing the vision.

The maturity model is the enabler to develop the identified application field to a company role model and learn how to manage the new technologies and the new approaches (Management of Technology MoT). Lessons learned are necessary to reduce teething troubles when applying digitalization measures to other departments. Potential for improvement with digitalization is throughout the company, along the value chain and product lifecycle.

This described 5-step approach has been tested in 8 companies (different branches and sizes) and brought significant optimization potential. A support software has been developed to provide a guided user interface for self-assessments. The software is combined with a database including the data (anonymously) of all companies to provide a possibility for benchmarking all applicants. A model roll-out is planned in Austria in the near future and trainings for software users are already bookable at BUSINESS UPPER AUSTRIA GmbH.

**Project and program management / 287**

## **Objective Management in Ports & Maritime Organization of Iran Using Strategic Management Theory & MBO Methods**

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One of the most important challenges in each organization is to achieving the most valuable targets and goals by using employees' performance and innovation with a focus on long-term strategy planning. In this paper we had shown how by using Strategic Management perfectly in the first steps and Imposing Managing by objective system in the downer layer in Ports and Maritime Organization, all performance of all employee in scattered location places in all ports of Iran from north to south of country will be managing in details under the close supervision of mangers indirectly will help this governmental organization to achieve their supreme goals, Priorities and expectations. In the first steps of this system all supreme goals of organization according to the National and international requirements Strategies will be decided by the board of

organization and announced to all departments to set their jobs and activity then by submitting activities under the proper supervision, all Organizational goals and planning flow top-down through members, the monthly progress is the last step of the system. Note that from managing directors to all experts, more than thirty processes and auditing have been applied.

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## **Technology Management Activities to Avoid Technological Lock-ins**

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Firms increasingly depend on technological advancements and need to be able to adapt to technological shifts. However, path-dependent processes may cause lock-in situations which hinder the adoption of more efficient technological options. In a path-dependent process small events trigger positive feedback loops which gradually reduce alternative options until a pattern becomes dominant. A rigidified action pattern builds up as an unintended consequence of former decisions and positive feedback processes. The resulting lock-in describes a situation in which flexibility is lost and only a restricted amount of options is selectable. Consequently, path-dependent developments may lead to unintended developments of technologies and technological standards, limit innovation capabilities of firms and rigidify business models.

While technology management frameworks address different aspects to recognize and exploit technological opportunities, less attention has been paid on the avoidance of lock-in situations. Therefore, the objective of this research is to analyse how different technology management activities can help to avoid technological lock-in.

This contribution is based on a review of technology management frameworks and a qualitative, exploratory research conducted in 15 companies operating in high- and medium-technology branches. The semi-structured expert-interviews with representatives from the top-management, R&D and technology management are used to identify how firms perceive lock-ins in the context of technological shifts. The findings are compared to technology management activities as described in literature in order to identify actions to avoid path-dependent developments. In addition, recommendations from the fields of strategic management and organization studies are considered and related to the technology management framework.

The research shows at which levels firms experience path dependence and different characteristics of lock-ins. Appropriate measures to recognize path-dependent processes and to avoid lock-in situations are discussed in relation to the technology management activities. Technology management is therefore not limited to methods to analyse, develop and integrate technologies, but can also integrate measures to recognize self-reinforcing mechanisms on technological, organizational and individual levels. The intention of this paper is to show how technology oriented firms experience path dependence and how technology management activities can help to avoid lock-in situations. Practitioners are provided with a compact description of the theoretical concept of path dependence and they learn about the practical implications.

**New business and investment models in the digital world / 289**

## **Patronage of content via crowdfunding**

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Crowdfunding is a way to make new ventures and enterprises become financially viable, through small payments made by individuals, since the beginning of the 21st century. It emerged from the concepts of crowdsourcing and microfinance, and only due to the evolution of the internet to the so-called Web 2.0. Since its inception, crowdfunding platforms have already distributed billions of dollars throughout the world. Not only businesses have been getting funds from the

crowd, but scientific research as well and even from specific academic crowdfunding websites. The possibilities brought by this kind of financing are many, but they used to be limited to great disruptive ideas, which imposes two challenges: having such ideas in a regular basis and getting fund continually. This difficulty was solved with the advent of Patreon, a crowdfunding company, created in 2013, that allows people to be patrons of content creators. With monthly payments, Patreon allows these content creators to remain financially viable and free of editorial restraints, producing knowledge or entertainment. Thus, the purpose of this paper is to discuss how crowdfunding has been evolving and how the public is motivated to become patrons of online content. To do so, an investigation of secondary data on crowdfunding history, evolution and benefits to companies and content producers and creators was conducted. After that, 14 in-depth interviews were undertaken with crowdfunders of web-based content in pursuance of comprehending them and why they pay, monthly, to these creators. In addition, a netnography of four patrons-only online communities was conducted, as a way to understand these patrons as groups, as well as individuals. Results show that this kind of crowdfunding, as seen in Patreon, is a growing market filled with possibilities, with an audience interested in helping content producers and small business to thrive. Individuals that partake in this practice have interest in feeling like co-creators, as well as belonging to something larger, being part of a community. They feel involved with the producers and want to be closer to people they look up to. Some consider the payment a donation, some consider the price for a good service from a source they trust and whose content they enjoy. Either way, they believe they are helping someone who needs and deserves funding to keep producing. In an online environment, these patrons also accept receiving less than they pay for, being satisfied with the social benefits of funding the project, whatever it may be. This topic's relevance is twofold. First, crowdfunding, and specially the Patreon kind of crowdfunding, is a growing business that is yet to reach its full potential and became truly widespread, for creators, entrepreneurs, people seeking new and innovative products and services and even for investors, since it is possible to buy equity through crowdfunding after the J.O.B.S. (Jumpstart Our Business Startup) Act was signed in the United States. Second, Patreon and other crowdfunding platforms can now also be seen by the academics as a way to fund research, with less bureaucracy and more editorial freedom, which is a reason itself to bring this matter closer to the scientific community, helping them to understand how to use this new possibilities.

**Future demands for work skills in the digital world / 291**

## **Proposal of a postgraduate course in the Argentine North-west (NOA) on Management of Technology and Innovation**

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In this paper we analyze the proposal of a Master degree offered by a network of five National Universities belonging to the CODINOA Network (Council of Engineering Deans of the NOA), regarding the subject of Management of Technology And innovation (MOT). The Industrial tissue of the region is composed mainly by SMEs. According to the bibliography, under these conditions, important shortcomings in the Technological Management can be seen; a deficient use of the computer technologies, both for the management as for the design and the production are highlighted. Relating to the academic offer of National Universities, in the targeted region, there are no universities degrees or postgraduate courses related to the subject. Regarding the area of computer science, the academic offer is oriented towards software development, although with little transfer to the industrial environment. These shortcomings undermine the competitiveness of companies and the consequent development of the region. Through the financing of the Strategic Program of Training of Human Resources in Research and Development (PERHID) promoted by the National Interuniversity Council (CIN) of Argentina, the proposal for the postgraduate course is elaborated. Through expert panel methodologies and brainstorming, national and international experts hired by the program, together with the stakeholders of the 5 universities, define the career objectives, the profile of graduates and the curriculum. The guidelines of the "Template for graduate programs in Management of Technology" are considered in the proposal

in view of a future application in the accreditation of the program. The result seeks to guide the Management of Technology and Innovation to its application in the local industrial SMEs, prioritizing the formulation, evaluation and management of technological innovation projects. The curriculum seeks to transfer knowledge that promotes competitiveness, through the management of Complex Systems and the inclusion of Systems Engineering in the dynamics of management. Based on the generalities of this type of postgraduate program, the creation of the career in the CODINOA network has been aimed at particularizing the contents in order to orient them to the regional problems highlighted in the NOA. As a result, a proposal for a master's degree program is obtained, which is expected to cover the region's academic offer while failing to collaborate with regional development and business competitiveness through the insertion of its graduates to Managerial levels in the productive tissue. The present work reveals the associative dynamics of the Universities, which combine their efforts in order to overcome restrictions and their particular vacancies. For the postgraduate courses in Technology Management, networking with other institutions is essential, especially those that allow an efficient transfer of knowledge in the thematic to the productive tissue. This work contributes to enhance the knowledge value chain in the NOA region, by the insertion of graduates in local industries.

**Small and medium sized enterprises and innovation / 292**

## **Innovation, product design and use of ICTs in Argentine SMEs: An analysis from a managerial perspective**

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This study analyzes the dynamics of Product Design and Innovation in industrial SMEs in the province of Tucumán, Argentina. This group of companies, according to the literature is not particularly innovative, and is made up of companies mostly with low technological development. For the analysis, 10 best performing companies were selected from a group of 50 SMEs selected at randomly. These companies constantly renew their products and do so through different approaches that are conditioned by the type of companies, their degree of technological maturity and the profile of their managers. Surveys applied to companies during a semester of Business Organization subjects were analyzed. The surveys are open and oriented, where the interviewers, who are students of the course, have studied in the form of cases the dynamics to be relayed in companies. Using qualitative analysis methodologies, the answers are categorized in order to classify them into standard response types, which are then analyzed to obtain the results. Dynamics of Innovation, Product Design and Use of ICTs in companies are highlighted in relation to the mentioned aspects. Finally, these results are related to the maturity in the management of the companies and the results are analyzed. The results indicate that a greater degree of maturity of the management is usually accompanied by a significant intensity in the Management of Innovation and Development of new products. The use of ICT is more intense in the companies with the highest performance, especially the fact that companies that implement ICTs in the products design processes usually have a marked difference in the performance of the overall management. One important result is the link between the company's performance and the manager's profile, which is usually favored by the profiles of collaborative leaders versus leaders with greater tendencies towards personalism. This works allow to learn about the importance of the use of ICTs in the SMEs, and the relationship that exist between the intensity of ICTs implementation, the manager profile and the enterprise performance. In Tucuman, the use of ICTs is not extended and the evidence found in this paper may be useful to understand the subjacent processes that ICTs enhance and consequently, enable competitiveness in the overall business process

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## **Technology management from a socio-technical transitions perspective**

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The ever-increasing pressure to fulfil the promise of sustainable development, the ever-moving target of sustainability, and the ever-changing definition of 'sustainable futures' calls for continuous, radical and fundamental research into our ability to understand the complex interactions between societal and technological elements in socio-technical systems. This paper presents the contributions that a socio-technical transitions perspective can make to the concept of technology management in order to ultimately contribute towards sustainable futures. This paper thus explores the topic of technology management through the lens of socio-technical transitions. The increasing need to transition from unsustainable socio-technical systems to sustainable socio-technical systems is continuously creating new challenges and opportunities, and managing technology in a way as to effectively bring about such transitions to sustainability need to be captured in technology management approaches, and converted into value through effective and dynamic management of technology towards sustainability. This requires a new way of understanding technology management and socio-technical transitions that captures the adequate level of integration between these two fields of research.

Technology management theories and approaches are primarily concerned with engineering and technology management, and the level of analysis is on the firm level. Theories concerned with socio-technical transitions primarily stems from social sciences and evolutionary economics, with the level of analysis being on the socio-technical systems level. This is highly relevant when considering the level of integration that is required between technology management and socio-technical transitions with the aim of managing technology towards socio-technical change. This research inquiry thus evaluates and compares the approaches, theories and concepts of technology management and socio-technical transitions with the aim of highlighting the contributions that the approaches, theories and concepts concerned with socio-technical can make to technology management. An approach is then developed that explains how a combination of technology management approaches and approaches to study (and foster) socio-technical transitions can strengthen abilities to foster sustainable futures. The proposed integration of socio-technical transition theories and approaches with the concept of technology management positions technology management activities relative to the concept of socio-technical transitions, and aims to highlight the importance of integration of approaches focussing on technology management and socio-technical transitions respectively. A framework is presented that supports such integration and emphasises the importance of the development and integration of frameworks that support sustainable development from both a social and technical perspective on an on-going base.

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## OPEN INNOVATION AND PROTECTION OF INTELLECTUAL PROPERTY RIGHTS IN BRAZILIANS WIND FARMS

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The second major oil crisis made countries acutely aware of their dependence on energy derived from oil and coal, and motivated them to seek alternatives in order to mitigate the associated risks, which threatened their national development and sovereignty. Thus, several governments decided to adopt a diversified energy matrix, through the use of energy from renewable and clean sources, which contribute to the reduction of CO<sub>2</sub> emissions and subsequent global warming, and to invest in sustainable development. Since 2004, the Brazilian government has encouraged the

use of clean energy sources, though large scale investment in wind power only began in 2010. Of note is the fact that recent climate changes have discouraged the use of hydropower, which, though clean, has shown strong signs of exhaustion. This paper aims to contextualize the use of wind energy in Brazil; to identify the increasing value and application of Intellectual Property Rights (IPR) as a factor for distinction and competitiveness; and to analyze the importance of open innovation for the development of wind farms. The methodology adopted was based on the review of secondary sources, such as bibliographic and scientific texts, and reports and programs from major institutions' websites, which presented strategic data and national projections. One result identifies that the adoption of wind energy in Brazil was responsible for supplying power to 4 million homes, generating over 70 thousand jobs, with great potential for further expansion. There was an increase in open innovation in the nation's wind power industry, as well as the creation of a network to identify research projects that would serve to increase the sector's competitiveness. However, the lack of long-term planning, insufficient infrastructure, and low rates of investment in R&D are obstacles for the expansion and consolidation of this alternative energy source in the country. This is reflected by the still incipient efforts aimed at protecting domestic production of IPR, and the country's low rates of knowledge and technology development, still largely dependent on foreign technology. In fact, patent applications directly linked to the sector are predominantly from foreign companies. For future research, we recommend a survey of patents filed by Brazilian companies linked to the wind energy sector, as well as a study of the economic impacts arising from open innovation. Keywords: Wind power, Intellectual Property Rights, Open Innovation.

## Industrial and manufacturing technologies / 296

### Technology Management on 3D Measurement for Industry 4.0

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This paper provides a novel approach for comprehensive 3D measurement data management in complex process chains in the automotive industry to fulfil technological requirements of Industry 4.0.

A variety of measurement methods and equipment are used in the automotive industry today to ensure the specified level of product quality. The multitude of devices and processes found in the automotive industry has always provided fertile ground for the harmonization of processes and methods. The desire for a standardized interface for the flexible design of the measurement process, is therefore a logical consequence. It requires a complex object model that not only includes the product model but also the equipment and tools, as well as the relevant test and tolerance data (product and manufacturing information and its relation to the 3D geometry).

Cross-domain data management also gives rise to the need for powerful measurement data management. Here, factors such as data-related recording, digital master, and control of the measurement process, as well as IT systems and interfaces play a role. Companies are hoping that this will bring about an increase in the level of process automation, improvements to the change process, further stabilization in the process, consistent quality statements, enhanced performance in individual process steps, as well as the early identification of risks. This challenge was recognized a number of years ago and was taken up by the Inspection PlusPlus Data Management Services (I++ DMS) initiative, a consortium of European automobile manufacturers.

Initial implementations of I++ DMS are being used in the quality management systems operated by German automotive OEMs. The data is not typically exchanged directly between the data-producing and the data-consuming systems but rather via an intermediate layer for persistent data storage. I++ DMS has not yet been able to sufficiently establish itself as a standard in the extremely complex measurement process. Implementation of the measurement process involving many different manufacturers and components is therefore still being stretched to the limit – a limit that would vanish with the definition of a uniform interface.

A project group entitled “3D Measurement Data Management“ was set up under the joint auspices of the VDA (German Association of the Automotive Industry) and the ProSTEP iViP Association

in order to address this issue. It is evaluating the current status of I++ DMS with regard to its suitability as the standard format.

The reference process created within the framework of the working group comprises not only inspection planning but the entire process chain: quality assurance, inspection plan, inspection task, and measurements. The group is focusing on two use cases: the process chain involved in exchanging quality data within a company and the exchange of quality data between an OEM and a supplier.

The findings and results of this working group have a tremendous relevance to introduction of Industry 4.0 in complex manufacturing processes. It is contribution to optimization of existing equipment as well as development of new equipment in the areas measurement strategies, measurement principles and evaluation rules. With this paper we will contribute to the conference topic "Industrial and manufacturing technologies" and give our answer to the question "How can be organized the management of production, facility maintenance, and digitalization?"

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## Digitale Transformation in Context of Engineering Collaboration

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This paper provides a novel approach for agile Digital Transformation of Enterprise Architecture Models in engineering collaboration in the automotive industry.

Emergent behavior is behavior of a system that does not depend on its individual parts, but on their relationships to one another. Such behavior exists in biological systems, physical systems as well as in the human performance. It is an inherited nature of a System-of-Systems (SoS). A suitable framework is needed to guide the development of SoS architecture, which includes emergent behavior. Enterprise architecture (EA) is a discipline driving change within organizations. Aligning and integrating business and IT thereby belongs to strategic management. The management of EA change is a challenging task for enterprise architects, due to complex dependencies amongst EA models, when evolving towards different alternatives. In this paper, various architecture frameworks are explored for an application on SoS architecture: the Department of Defense Architecture Framework (DoDAF) and Ministry of Defense Architecture Framework (MODAF) are declared inappropriate. The Open Group Architecture Framework (TOGAF), the Federal Enterprise Architecture Framework (FEAF) and the Zachman Framework on the other hand are suitable. The use of Zachman Framework to guide the architecture development is described in step-by-step details in this paper. The agent-based simulation is recommended to develop the SoS architectural models following the Zachman Framework guidance.

Zachman framework has gained a high importance in large companies. Question arises how it can be applied to SME, in particular with the collaborative engineering. As two concurrently emerging topics, the enterprise architecture (EA) and the digital transformation (DT) affect each other. Within SME, the adoption of enterprise architecture heavily depends on the position of the business owners and business leaders respectively. In the most cases, they are satisfied with an optimized workflow management. Process definitions according to TOGAF are on a very abstract level and provide solely an informal guidance that can be used as a starting point for further refinement in organizations. As a matter of fact, a SME is acting agile and flexible, and don't accept formalism easily.

OpenDESC.com is an industry-focused portal for engineering collaboration with features serving especially automotive throughout an extended enterprise. It is a holistic service, which includes both translation of engineering data into a custom environment and secured provision of engineering data to partners in an automotive SoS. The conception consists of a high-level architecture of the platform on the perspective of 6 selected layers of the Zachman Framework. We have investigated the emergent behavior of this architecture which is expected to be easy to adapt and transform for development of new services.

The findings and results of this research have a significant relevance to implementation of Digital Transformation in the complex global operations. It is contribution to coherence of Enterprise Architecture and agile Digital Transformation in development of new solutions and services. With this paper we will contribute to the conference topic “Product and service development” and give our answer to the question “How can new business models enhance the success of SMEs and large enterprises in a digital world?”

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## THE SECRET SECURITY FRAMEWORK FOR THE INDUSTRY INNOVATION ENVIRONMENT

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Modern society is experiencing the fourth Industrial Revolution, which demands managers to develop industrial development plans and re-industrialization efforts, in search for competition in a digitalized manner throughout the whole value chain. Digitalization is characterized by the integration and control of production, with the use of sensor and network connected devices, whereas physical world is entangled with the digital one, the so-called cyber physic systems. The intense information exchange between men and machines, among each other and with all other systems, values information from beyond the tangible world limits, reaching the intangible realms. In the particular case of the intensive growing knowledge industry, where innovation is part of the business plan, information and knowledge security must be considered throughout the whole productive chain so that one can reach the desired novelty via innovation embedded in new goods, products of services, to which we refer here as Secret Security. As a result of our research, we present in the paper a framework for the use of instruments of secret protection in the innovation environment of an industrial baseline. We have conducted an applied research that adopts the philosophical conception of social constructivism, by interpreting the endogenous and exogenous interactions, policies, regulations and instruments that operate in an industrial innovative environment. This qualitative research approach allowed us to discover and understand the use of instruments of secret protection in this environment. In the data collection step, we analyzed vast bibliographic review in order to meet the real understanding of the complexity of the innovation environment of the industrial base, which resulted in a framework and the mapping of the dimensions of knowledge representation of organizational areas that require attention in regards to secret protection, such as people, process, knowledge artifacts, organizational management, culture and technology. From the identification of 28 existing instruments used for secret security, containing recommendations to be applied in the dimension of protection, the main goal was to safeguard the industrial secret via the understanding that protection represents actions adopted to safeguard the secret and also that the roll of security is to establish conditions to neutralized potential threats to the industrial secret. Our work resulted in a recommendation plan to adapt the secret instruments used in the context, considering risks, likelihood and impact to each dimension of knowledge, to become effective.

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## DIGITAL CERTIFICATION AND THE ELECTRONIC PROCESSING SYSTEM OF THE BRAZILIAN COURTS

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The intensive use of Information Technology and Communications in contemporary society has provided advances and facilities in citizen relations with the Government, such as speed and a new configuration of cyberspace. However, frauds in the electronic environment are seen as a threat to organizations seeking to ensure access security and electronic procedures. Furthermore the Brazilian Judiciary has been criticized for the long duration of proceedings that affects the credibility of the Judiciary before the society, and in some cases demonstrates the inefficiency of the solution applied due to the natural dynamics of human relations. The objective of this paper is to contribute to the discussion of the use of certificates issued in the Brazilian Public Key Infrastructure (PKI-Brazil), presenting its implementation in the governmental sphere and highlighting the use of digital certification and the use of electronic procedure in the Brazilian Judiciary. Since Law 11.419/06 came into force it allowed the opening of electronic means in court proceedings, aiming to replace paper with digital documents, safeguarding the principles that govern the process, and consequently, in the implementation of a process and electronic procedures in the judicial spheres (civil, criminal, labour, and electoral). The exploratory and descriptive research was adopted, with the purpose of explaining and describing the main characteristics of the topics addressed. The professional legal activity and experiences of the authors in the use of the legal proceedings are contributing factors in the writing of this article. As for the sources, this is a secondary bibliographic research based on material already published, which allowed the authors to understand the application of Digital Certification in public administration and mainly, in the adoption of electronic processing in the Judiciary. The sources demonstrate that the adoption of digital certificates issued by PKI-Brazil has guaranteed the authenticity, integrity, authorship, non-repudiation, and confidentiality of documents and electronic transactions within the public administration, thus presenting, as an instrument of protection and security feasible for use by government agencies. However, one of the problems mentioned is the presentation of fraudulent documents at the moment of the identification of the citizen for the digital certificate issuance, which would undermine the legality of the certification. The adoption of a judicial electronic processing has been optimizing the Brazilian Justice system and speeding up the procedural acts desired with the implementation of Law 11.419/2006, however the adoption of the system is complex and there are criticisms and resistance of some professionals, especially those who still live the transition to the digital information age. The presentation of fraudulent documents at the moment of the identification of the citizen for the issuance of the digital certificate at the registration authorities (RA) poses a risk that can be mitigated by raising the awareness and qualification of the RA employees, as well as adopting some specific technological resources. The resistance of legal professionals is salutary to the complexity in the implementation of the Judicial Process in Digital Media and helps in the improvement of executing methods and forms, and the impact of the implantation can be positive if there is information and gradual adoption of this transfer from the physical to the electronic status. Considering the limits of the article it is recommended to develop studies with indicators that allow monitoring the evolution of the use of digital certification in the governmental spheres in the country, as well as in the effective verification of the reduction of delays in judicial proceedings in the Brazilian scenario.

**Technology transfer, marketing and commercialization / 301**

## **Technology Transfer Octagon- a qualitative tool to analyze TTO's performance**

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The purpose of this paper is to present a qualitative approach to evaluate Technology Transfer Offices' performance based on a state-of-the-art overview and on the results collected during group meetings (Grounded Theory). The paper outlines studies that have been conducted on TTO's performance, discussing the variables pointed out by different authors. It also delivers

evidences of the importance of bringing practice into theory as experts advanced on such matter by providing a broader view of variables and by introducing a TTO activity diagram. Finally, the paper challenges existing evaluating methodologies as it introduces a methodology – Technology Transfer Octagon - which focuses on a wide range of variables and on the importance of each one of them. It can be used to improve one TTO as it outlines its strengths and weaknesses, but it can also be applied to a group of TTOs in order to indicate the negative and positive impact of the variables on performance.

## New business and investment models in the digital world / 305

### Digital business models and collaborative economics

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The adoption of digital tools to facilitate the business and the daily life of its users has long been adapted in people's lives. In the transition to the digital world, they gain the most innovative business models. The sale of products on electronic sites, meetings through interactive media are increasingly frequent. Most of the activities are done through a mobile device, where applications (apps) found fertile ground to develop and also be a way to present a new business, an innovative business. Thinking about Schumpeter's words, innovation must be disruptive, therefore breaking paradigms, changing concepts. New products, bold services, breakthroughs and more creative business models make the difference in the marketplace. And some entrepreneurs have turned their attention to an important niche market, the relationships, and connections. The business verbs are to share, cooperate, divide and not just accumulate. This article will address this new relationship in which mobile applications are strengthening the digital business that has been explained by the concept of collaborative economics. Which means that through applications that are supported by communication technology and mobile devices, such as smartphones and tablets, with easy access, make a direct connection between consumer and supplier who are associated with a platform where they can communicate in a uncomplicated language. This is what has happened with the hosting system through "Airbnb", or the new way of getting around, through "Uber" and a case created in Brazil, Dinner, which connects people who like to exchange gastronomic experiences with hosts that offer dinners exclusive in their own homes throughout Brazil. The subject discussed in this paper is recently and the research is focused on the experiences of the authors and organized in an exploratory and descriptive method to describe and explain the concept and characteristics of the object of this study. As for the sources, this is a secondary bibliographic research based on material already published, mainly in digital form. Collaborative economics by connecting strangers with common interests and needs through social networks and applications make it easy to share and exchange services and objects on an unprecedented scale. And this can mean big profits, in 2014, according to Forbes magazine; collaborative ventures have moved more than \$ 110 billion worldwide, numbers that challenge the traditional structure. Thus, these private businesses are bothering the formal economy that to be in the market they invest and pay taxes to manage their businesses and many traditional entrepreneurs accuse this new model of unfair competition, imposing a definition and clarification of the concepts of real collaborative relationships and a profit business. The new entrepreneurs, who are mostly young students, realized that the consumer was eager for more individualized experiences, to make their choices, to give their opinion and to be understood in their needs. Thus, the satisfaction of the interested consumer, also allows the supplier an extra gain this when he makes his home, car or services available. Collaborative economics is an excellent alternative in times of crisis. But, it is still necessary to verify how these relations can be maintained, since the pressures for regulation and rules of limitation of action from the formal sector is a challenge. In the same way, for it to subsist, it needs the reliability to be built by the parties involved, then further studies will need to cover the future of this business models.

**Keywords:** New business models. Digital Business. Collaborative Economy

## Safety and risk management / 310

## GMDH Deep Learning Approach Improving Safety and Risk Assessment in Pipelines

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The sustainability of traditional technologies employed in energy and chemical infrastructure brings a big challenge for our society. Making decisions related with safety of industrial infrastructure, the values of accidental risk are becoming relevant points for discussion. However the challenge is the reliability of the models employed to get the risk data. Such models usually involve large number of variables and with large amounts of uncertainty. The most efficient techniques to overcome those problems are built using Artificial Intelligence (AI), and more specifically using hybrid systems such as Neuro-Fuzzy algorithms. Therefore, this paper aims to introduce a hybrid algorithm for risk assessment trained using the Grouping Method of Data Handling.

As mentioned above the sustainability of traditional technologies related with energy and chemical infrastructure constitutes one of the major challenges that today's societies and firms are facing. Besides that, the adaptation of those technologies to the effects of the climate change in sensible environments represents a critical concern for safety and risk management. Regarding this issue argue that social consequences of catastrophic risks are increasing rapidly, due mainly to the concentration of people and energy infrastructure in hazard-prone areas, aggravated by the lack of knowledge about the risks.

Additional to the social consequences described above, and considering the industrial sector as critical infrastructure due to its large impact to the economy in case of a failure the relevance of industrial safety has become a critical issue for the current society. Then, regarding the safety concern, pipeline operators and regulators have been performing risk assessments in attempts to evaluate accurately probabilities of failure of the infrastructure, and consequences associated with those failures.

However, estimating accidental risks in critical infrastructure involves a substantial effort and costs due to number of variables involved, complexity and lack of information. Therefore, this paper aims to introduce a well-trained algorithm for risk assessment using deep learning, which could be capable to deal efficiently with the complexity and uncertainty. The advantage point of the deep learning using near-miss accidents data is that it could be employed in risk assessment as an efficient engineering tool to treat the uncertainty of the risk values in complex environments. The basic idea of using a Near-Miss Deep Learning Approach for Neuro-Fuzzy Risk Assessment in Pipelines is focused in the objective of improve the validity of the risk values learning from near-miss accidents and imitating the human expertise scoring risks and setting tolerance levels. In summary, the method of Deep Learning for Neuro-Fuzzy Risk Assessment involves a regression analysis called group method of data handling (GMDH), which consists in the determination of the optimal configuration of the risk assessment model and its parameters employing polynomial theory. The research methodology employed by this study follows a hybrid research technique, which combines a qualitative induction of the risk assessment model and a quantitative analysis using public databases of accidents and near-misses. Regarding the induction of the model, an exhaustive literature review was performed in order to build the Neuro-Fuzzy algorithm and establish its initial parameters. Regarding the quantitative analysis, it was performed using last decade data from the public reports of The European Gas Pipeline Incident Data Group EIGG and The US Department of Transportation DOT.

The Findings of this study shows that risk values could be improved using artificial intelligence methods and deep learning algorithms in contrast with the traditional methods. Additional to this contribution, this study highlights the sensible and critical parameters of the fuzzy inference and learning system. Therefore, the main contribution of this study to the field of safety and risk management is by introducing an interesting deep learning approach to estimate accidental risks that will improve the decision making about safety operation of traditional and new technologies.

**Technology management and competitiveness in the globalized world / 311****Global additive manufacturing developments**Prof. STEENHUIS, Harm-Jan<sup>1</sup><sup>1</sup> *Hawaii Pacific University***Corresponding Author(s):** hsteenhuis@hpu.edu

Despite the often stated move from manufacturing to a service orientation, manufacturing is still an important part of the economy for many countries often accounting for 30% or more of the total economy. However, manufacturing in countries such as the U.S. has been faced with challenges, for example in terms of employment. On the one hand, even though the manufacturing output in for example the U.S. has grown, the employment has declined largely due to productivity improvements. On the other hand, multinational companies frequently use a strategy of outsourcing. While many sources identify outsourcing as a strategic option for companies which often reduces the overall cost of operations, others are more critical and consider outsourcing often a mistake. Research in recent years has demonstrated that options such as outsourcing may offer short-term advantages but these are typically not strategic and erode the industrial commons. Upgrading manufacturing has been demonstrated as being a better strategic option. Additive manufacturing is one of the options available to upgrade manufacturing capabilities. The potential of additive manufacturing has been recognized globally and many nations have initiated programs to develop additive manufacturing capabilities.

The purpose of this study is to explore global trends in the development of additive manufacturing capabilities. Of the five main research strategies, i.e. survey, experiment, case study, grounded theory approach and desk research, the desk research strategy was selected for this study. The exploration of global development of additive manufacturing requires a broad perspective and access to data from a variety of fields which is an advantage of desk research. Data collection was oriented on several different industries and the countries that seem to be ahead in the development of additive manufacturing capabilities in those particular industries. The data was mainly collected from a variety of different industry sources that publish up-to-date developments in additive manufacturing.

It was found that additive manufacturing is globally developed although not every nation has the same capabilities or the same resources to develop additive manufacturing capabilities. However, a few things stand out. Under president Obama, the U.S. has heavily invested in additive manufacturing and for instance created America Makes, a national additive manufacturing innovation institute. This institute has a broad orientation and demonstrates the U.S. commitment to manufacturing. In terms of industries, countries such as Australia, Germany and the U.S. are front runners in the application of additive manufacturing in healthcare. There are many sophisticated challenges in this industry for example in terms of manufacturing tissue. The construction industry is another industry with many challenges, in particular in terms of the material and process properties. China is a leading country in this field. The United Arab Emirates (Dubai), once primarily known for tourism, has drastically changed its economy in the last decades and recently announced plans to become the epicenter of additive manufacturing for example also through construction projects.

By exploring global developments in additive manufacturing, this paper contributes to our knowledge on global technology diffusion and gain further insight into national technological competitiveness.

**Management of technology in developing countries / 313****An Interrogation of Public Private Partnership Contracting Risks: A South African Case Study of ICT Service Delivery**Dr. ALBERTUS, Rene<sup>1</sup><sup>1</sup> *University of the Western Cape***Corresponding Author(s):** ralbertus@uwc.ac.za



Public Private Partnership (PPP) project in the public sector of South Africa have come under major scrutiny in the last decade due to overspending and the failure of PPP projects being completed timely. The ruling party government have been under major scrutiny by the media, specifically the Treasury to be held accountable for the mismanagement of public funds. Opposition Parties on behalf of the citizens are demanding that public sector management are held accountable and that the right management be put in charge of managing PPP projects risks. To try and get a better understanding of PPP project risk we will investigate the PPP contract for an information and Communication Technology (ICT) service delivery project between the Department of Labour and Siemens. In this regard the study looked at the contract to unearth its strengths and weaknesses as a mechanism for identifying and managing risks. Using an agency theory risk framework and qualitative content analysis, the researcher interrogated the PPP contract from a risk perspective. Content analysis, was used to interrogate the PPP contract documents, to build on a comprehensive risk framework. The agency theory framework suggested that risk factors for ICT service delivery are widely acknowledged in literature however; these were not specified in the PPP contract for ICT service delivery. The analysis identified risks inherent in PPP contracting that should be addressed to manage ICT service delivery. The risk framework provided risk strategies, which could provide important insights for managing risk in PPP contracting relationships for ICT services.

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## **TECHNOLOGY ASSESSMENT OF ARTIFICIAL INTELLIGENCE**

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Artificial Intelligence(AI) has drawn significant attention in our society and many have high hopes of what AI will bring, such as improvement in productivity and quality. However, there are also growing concerns and warnings of what the technology will bring, such as mass unemployment from job substitution or social inequality. Thus, we have conducted Technology Assessment(TA) of artificial intelligence to analyze the current state and to predict its subsequent impact on our society. The main purpose of TA was to reduce the risk caused by AI technology and to promote its positive impacts. In order to gather opinions and insights from various perspectives, we not only organized expert committee but also held citizen forum. 24-hour online survey also opened to anyone during the whole assessment process. Possible impacts of AI on our society were actively discussed, along with policy suggestions. The results were largely classified into 3 categories; changes in industry, changes in life & culture, and new ethical problems. In this paper, each TA process, as well as the result and future perspectives will be described in more detail.

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## **Digitalization of the Industry – State of the Art and Best Practice Examples**

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## **The future of innovation: hyper innovation, slow innovation and no innovation**

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**Opening Ceremony / 320**

## **AIT and its Role in the Global Innovation Landscape**

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## **Innovation at voestalpine**

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## **The Threats We are Facing**

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## **General Framework for Technology Management in the Digital Age**

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**Keynote / 325**

## **Innovation Strategy for Digitalization**

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## **Innovation Policies and Promotion of Technology Priorities Through Financing Technology Development Projects – An Overview of the Iranian Knowledge Enterprises in Different Areas of Technology**

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In recent years due to Iran's specific situation and obligations imposed by sanctions from one side and requirements emphasized by national policies and strategies from the other side, knowledge economy has become an important factor in the country's economic development. Therefore, a focused attention has been devoted to knowledge enterprises in Iran's economic playground.

This paper focuses on financing requests proposed by Iranian knowledge enterprises active in developing hi-tech and mid-tech in different areas of technology and tries to provide a clear picture of future developments of these technologies in the country to a set of different actors ranging from policy makers, administrators, investors and owners of knowledge enterprises.

The study examines and compares a variety of services that knowledge enterprises request from Innovation and Prosperity Fund (a national financial institution established to provide financial support to Iranian knowledge enterprises) in selected technology fields and provides an analysis of the reasons behind different requests for financing knowledge enterprises in the selected technology fields. Four areas of technology have been specifically examined including electronics and control, information technology and computer softwares, bio-technology and advanced products in different technologies. Study outputs show that information technology and computer software companies request fewer funds because their production requires less time and cost. Therefore ICT projects are not as much dependant on public funds as projects in other areas of technology. However since ICT acts as an infrastructure for other areas, it requires continuous attention and support from public sector. In conclusion, the results of this study indicate that the demand for financing and the amount of money knowledge enterprises request depends on the specific field they work in.

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**Boosting innovation in developing countries and economies in transition through the promotion of the Innovation Management System Standard**

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**TECHNOLOGY COLLABORATION TO PROMOTE REGIONAL SUSTAINABLE DEVELOPMENT**

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**Welcome address IAMOT**

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**Innovation policies & Promotion of Technology Priorities  
through Financing Technology Development Projects**

**Panel-WS / 334**

**Development of Science, Technology and Innovation in Iran**

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**An Overview of the Iranian Technology Achievements in  
Different Areas of Technology**