پنجمین کنفرانس بین المللی مدیریت، گردشگری و تکنولوژی
پنانگ، مالزی | ۳۰ آبان ۱۴۰۱
OxfordCert Universal
5th International Conference on Management, Tourism and Technology (ICMTT)
21 November 2022 | Penang, Malaysia

A customized Technology & Innovation Framework for MNOs to Improve Customer Experience

Leila Bashir
MSC of Technology management of Tehran University, Iran
l.bashir@ut.ac.ir

Nasim Kazemifard
PHD of Computer Architecture, Beheshti University
Na.kazemifard@gmail.com

Mehdi Mohammadi
Assistant Professor of Faculty of Management, Tehran University, Iran
memohammadi@ut.ac.ir

Abstract
There are several researches about impact of Innovation and Technology management on business success or failure. Short products and services lifecycle, variety of customer demands, and business trends have lead the firms to be ready for changing and playing new roles according to industry paradigm changes and they cannot cope with innovative services offered by existing or new competitors unless adopting a TM framework. Mobile network operators face paradigm shift in their business, too.
In this article, in addition to reviewing the subject literature, semi-structured interviews, case studies and the use of the SEM method, we present our proposed framework for improving the MNO's customer experience. The results show that in the ICT industry, with a focus on the mobile sector, innovation has a direct impact on TM, but there is no significant relationship between them. In other words, innovation can act as a third factor in improving the customer experience through TM. The results also show that the identification and intelligence, acquisition and learning of technology has a significant direct impact on the customer experience.
Finally, the ITM model based on the eTOM framework and operational processes was implemented in the MCCI, which has led to an improvement of 26.64% of the customer experience.
Keywords: Technology management (TM), Innovation management (IM), Mobile network Operators (MNO), Customer experience (CEX), eTOM frameworks

Introduction

Technology and Innovation are two main subjects as the concept of policy making at the national and firm levels in the recent decade. Both national level policy makers and business managers are well

understood that while technological changes make new capabilities and tools in firms, it creates some new needs for stakeholders and makes new customers and markets emerging. Accordingly, an organization cannot be successful if it does not observe and get prepared for these changes.
In the sectors who are struggling with the short lifecycle of technologies and, consequently, minimum lifecycle of products and services, customers have a higher power of choice, and business trends show the emergence of new markets and new customer demands very frequently. In these cases, the firms will not be prosperous in the lack of readiness for changing and playing new roles (with high added value) according to industry paradigm changes and they cannot cope with innovative services offered by existing or new competitors; likeNokia's story.
Concentrating on ICT market, due to rapid technological changes and IT growth, new business models are emerging in the present era. More scholars emphasis on IT's advantages and different aspects, while less is paid to attention to IT's challenges (Chouki, M. et al., 2020) which makes T&IM to be highlighted in technology-oriented organizations (such as mobile network operators) to create values and risk management (Fernandes franca et al., 2020).
The TM system as a sub-system of organizational management systems helps mobile network operators (MNOs) and its managers to cope with technological changes and respond timely to the needs of the market and customers.
The purpose of this study is to present a suitable framework for implementing technology management in MNOs based on the concepts of innovation management (IM), technology management (TM) and knowledge management (KM). This model is developed based on a case study of the Iran MNOs (MCCI), due to their ongoing efforts to success implementation new technologies and maintain customer satisfaction.

I. Theoretical Background

Technological chaneges and innovation as a disruption source of organization, are affected the business, life and economy for several years since 1970s (Probert, D. et al., 2004). Usually the impact of technology on business is’nt one dimensional, but rather, new technology causes a cascading effect within firms. It has broader positive and negative societal and economical impacts (White&Bruton, 2007). So how can organizations be innovate and manage new technologies?

a. Technology & Innovation management

According to the publications, there are many various definitions of Technology and Innovation. Technology may be a new issue within the field of management (White&Bruton, 2007). Galbraith (Galbraith, 1968) defines technology as an application of science and technical knowledge. It’s been re-used by ADL (1981), Dussauge and Ramanantsoa (1992), Morin (1985) and Jolly and Thérin (1996). In Other definition, “Technology” relates to style, production and distribution of products and services, in response to plug needs (White&Bruton, 2007).

Each definition implies that technology may be a process-oriented concept affecting the strategic management elements, and “change” is usually the most outcome of technology (White&Bruton, 2007). Therefore, the definition of the TM should also reflect this systematic-strategic approach.

Jin and Zedtwitz (2008) defines TM as “the capability to form effective use of technical knowledge and skills, not only in an attempt to enhance and develop products and processes but also to upgrade existing technology and to get new knowledge and skills in response to the competitive business environment” (Jin&Zedtwitz, 2008). The team of researchers from the US NRC[1] concluded that TM combines the disciplines of engineering and management sciences with the aim of designing, development and implementation of technological capabilities, which can enable the implementation of strategic and operational objectives of the organization (Dembicka, 2017). Badawy (1998) suggested

[1] National Research Council

that the management of technology is "the practice of integrating technology strategy with business strategy" (Chanaron&Jolly, 1999).

TM are often conceived because the development and exploitation of technological capabilities that are changing continuously (Best, 2001) (NRC, 1987). The TM field includes aspects of both innovation management and knowledge management (Cetindamar et al., 2009), but they need differences.

Innovation is a key factor for economic process, too. Although the first actors for innovation are the firms, the policy makers also are important players (Kang, 2015). Organizations should retain their innovation paths by developing products, processes, marketing, and organizational methods to achieve and sustain competitive advantage (Calik et al., 2020). Innovation may be a part of technology management, and thanks to its "newness" characterizations, it's customized approach within a business. The innovation management (IM) requires technology; but the technology management doesn't necessarily require innovation (White&Bruton, 2007). TM and IM practices are getting intertwined.

Some have defined innovation as invention plus exploitation (White&Bruton, 2007). The innovation theme is pervasive across the board in most areas of management also as in TM (Cetindamar et al., 2009). Innovation is as providing an invention to market or commercialization it with aim of widespread use of the invention (Tidd&Besant, 2013). Rubenstein defined innovation as "the process whereby new and improved products, processes, materials, and services are developed and transferred to marketplace where they're appropriate" (Rubensrein, 1989). There are many various definitions of Innovation but there's a joint comment about it, that Innovation is really applying a replacement or new idea, design, and commercialization it at market (Tidd&Besant, 2013).

Now, what innovation management is? Today, new products or services are launched at an increasingly faster rate. Therefore, innovation management has become important for enhancing the effectiveness and efficiency of latest development. For a technology-based enterprise, the potential to soak up technical knowledge from universities and research institutes is crucial (Probert, D. et al., 2004). Successful innovation management depends on the highest management of the organization: willingness to commit the resources to permit individuals and groups to acknowledge "newness" and respond accordingly. Innovation management may be a comprehensive approach to managerial problem solving and action based on an integrative problem-solving framework, and an understanding of the linkages among innovation streams, organizational teams, and organization evolution (White&Bruton, 2007).

Also, Christopher M. Durugbo & et. (2020) in their article, pointed out the importance of innovation in international cooperation and examined the literature of IM in GCC countries. They have reviewed theories, trends and goals of innovation between 1980 and 2019 in 110 authoritative articles in the field of IM, and finally, have developed theoretical foundations in the field of creative complementarities, institutional-pump and ripple model of regional innovation in GCC countries (Durugbo et al., 2020).

MNOs as a technology-based enterprise face some challenges about technology changes, technology lifecycle, technology acquisition and technology learning. TM help them to unravel these challenges through its relationship with strategic management and knowledge management. Also, it's necessary for MNOs to vary the method of delivery of its products and services (P&S) to customers and offer new P&S to its customers.

As a result, T&IM addresses issues which are at the guts of strategic management. It thus relates to several other fields of management, including strategy with the technology selection, organization with the interaction between innovation and organizational change, law with the difficulty of protecting innovation (IPR), project management also as operations management with process innovations, e.g. right along the supply chain, in manufacturing or logistics (Probert, D. et al., 2004).

According to the literature, it is important to be defined T&IM in any organization, especially in technology-based organization like MNOs. They should be determine relationship between management of technology and innovation system with other managerial systems to promotion and improvement its performance.

b. Knowledge Management

The development of worldwide business competition with complex R&D challenges limits firm's activities and decrease their creativeness and innovativeness. This issue needs to check more on the interdependent factors between knowledge, innovation and technology management capability (Asim&Sorooshian, 2019).

Knowledge as a competitive advantage and organization capital is vital and basic for organization successful; so, the management of data and facilitate the knowledge create process are key subjects. Technical knowledge is vital in MNOs and that they got to learn new knowledge about new technologies. There are many defined technical projects in MNOs and every project attends with tons of information; the way to protect and manage them?

The complex technology innovation activities are emerging as a crucial issue, and include problems like how best to manage knowledge-based technology innovation activities, and the way a corporation should utilize knowledge-based technology innovation to enhance organization processes and core competence (Lu et al., 2007).

Knowledge combines various pieces of data with an interpretation and meaning. While information derives from data, knowledge derives from information. While information may be a static concept, knowledge is consistently changing. Moreover, while information is descriptive and explicit, knowledge includes a normative component and may be explicit or tacit (Chini, 2004). Nonaka and Takeuchi (1995) define knowledge as 'justified true belief' and proposed that innovation is that the primary sort of knowledge creation, and thru the operations of the knowledge spiral, when the latent and exhibited knowledge of a corporation interact, the result's innovation (Takeuchi&Nonaka, 2004).

The 21st century is that the era of technology and therefore the knowledge economy, and technological innovation and Knowledge Management (KM) became an increasingly important source of added value for businesses. Technological innovation and KM have also become increasingly problematic, and especially firms depend upon continual technological innovation supported the knowledge-based view and managerial response to changing environments to take care of competitiveness during competitive edge to facilitate imitation and reduce product life cycle (Lu et al., 2007). According to Table 1, KM is that the creation and acquisition of data by organizational staffs from inside and out of doors of organization, to make value and profit.

Table 1. Definitions of knowledge management

Source Definition	Source Definition
Birkinshaw (2001)	Knowledge management are often seen as a group of techniques and practices that facilitates the flow of knowledge into and within the firm (Birkinshaw, 2001).
Carrillo & Gaimon (2004)	KM is that the main method to lower the uncertainty of changes within the technological systems (Carrillo&Gaimon, 2004).
Jennex (2005)	defined KM as the practice of selectively applying knowledge from previous experiences of deciding making to current and future decision-making activities with the express purpose of improving the organization's effectiveness (Jennex, 2007).
Grant (2007)	KM refers to processes and practices through which organizations create value from knowledge (Grant, 2007).
Knoco (2014)	KM involves managing information (inform explicit knowledge),managing process and managing people, creation of innovation and managing of intellectual assets (Edosio, 2014).

There are several KM models that published by researchers like Nonaka and Takeuchi (2000), Bukowitz and Williams (1999), Wiig (1993), Choo Sense-Making (1998); All models basically includes of data and knowledge gathering and capture, organize and storage, Customization and Use.

As shown in Figure 1, the primary level of the structure is KM activities and KM cycle. Organizations may embody different knowledge and technologies in several organization processes or sectors, and furthermore organizations must integrate this knowledge and technology into innovation activities to specialize their innovation efforts (Pavitt, 1984)(Hamel&Prahalad, 1994). KM activities cause technological innovation in a corporation and ultimately it gives rise to a competitive advantage.

As a results of this section, knowledge-based technological innovation has numerous benefits. Firstly, knowledge-based technological innovation reduces the risks related to research and development. Secondly, knowledge-based technological innovation has the advantage of avoiding the duplication of research and development costs, and allows firms to realize by sharing technological know-how. Finally, when firm competitive advantage is predicated on technological competence during a wholly owned knowledge-based technology, the danger of losing control over that competence is usually reduced (Lu et al., 2007).

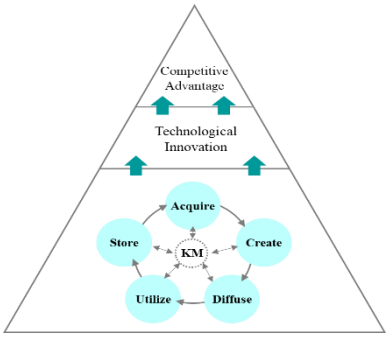


Figure 1. Hierarchy of KM and TI [36, 37]

c. Technology management models

Although studies on TM are abundant, they offer very few widely adopted methods for the practical application of TM principles, and few universally accepted conceptual models or frameworks to underpin them (Phaal et al., 2004). The term "framework" refers to understanding and communication of structure and relationship within a system for a defined purpose. In this case, the purpose is to understand the TM system (Centindamar et al., 2009); this paper presents a TM framework in MNOs developed by Phaal et al. In this section, some main models of TM are briefly reviewed.

TM framework is applicable to all firms regardless of their size and type (Production, Service-base, Telecom, etc.) and any firm can provide a TM framework according to its Properties; taking the advantages of TM, previously discussed.

Gregory proposed the first TM model based on process thinking. He proposed a general model, including five major activities in the field of TM of in an enterprise that include (Gergory, 1995): Identification, Selection, Acquisition, Operation and Protection of technology. The Gregory's model was completed, or refined multiple times by other researcher (Phaal et l., 2004, 2001) (Figure 2).

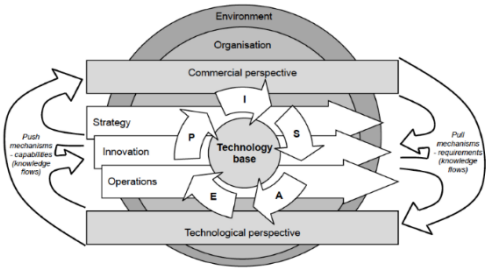


Figure 2. TM Framework [39]

TM activities are needed to realize technological capabilities-but where do firms exercise these activities? How can we depict the context within which TM activities as an entire take place? In Porter's value chain, TM is taken into account as a cross-cutting supporting activity to the core business processes (Porter, 1990). within the TM framework presented in Fig. 2, TM activities are typically linked to or embedded within core business processes (Phaal et al., 2004): strategy, innovation and operations. Therefore, the TM framework allows us to conceive that TM activities might operate in any business process, department, or business system level (i.e. project, strategic business unit, corporate) within the firm.

The framework emphasizes the dynamic nature of the knowledge flows that has got to occur between the commercial and technological functions within the firm, linking to the strategy, innovation and operational processes, if TM is to be effective (Phaal et al., 2004).

Strategy, innovation and operations are macro-level processes that subsume a large number of sub-processes, each being shaped within the organization to address its particular aims and context. After

identifying the particular business processes behind strategy, innovation, and operations, managers could integrate TM processes into these business processes (Centindamar et al, 2009).

There are numerous list of TM activities or process in literature; all of them emphasis on five activities: identification, selection, R&D/ Acquisition, Exploitation and learning. Thanks to these activities and literature analysis, published a final model by Cetindamar et. al. (2009). This framework includes six activities (Centindamar et al, 2009): Identification, Selection, Acquisition, Exploitation, Protection and Learning.

In most of the models, the differences are slight and limited to the change in classification and the recognition of the scope of individual activities. This indicates a lack of ability to accurately classify concepts in the field of innovation management, knowledge management and technology management. The common feature of all the described in the literature models is the determination of the general framework of technology management (Dembicka, 2017). Within the framework of the technology identification process it is important to conduct a market analysis of the available technologies, scanning and monitoring new technologies and their trends, technology foresight and forecast and find those that could have a significant impact on the development of the company. Gartner Reports is one of the entries identification in MNOs that help to recognition of technological opportunities. Other entries are benchmarking, market and competitors monitoring, patents identification and Participation in exhibitions. All of the these ways can help MNOs to new technologies identification accordingly to their needs.

The next step is the selection of the appropriate technology and acquiring it. There is an activity before selection and acquisition of technology and it is "Assessment". Technology assessment is a main activity to evaluate identified technologies with respect to strategy, market, technical etc. All the activities associated with the identification, selection and acquisition of technology may happen inside or outside the corporate.

The other two activities (exploitation and protection of technology) are dependent solely on the conditions within the company and have a huge impact on the generation of enterprise competitiveness (Dembicka, 2017). The last activity, learning, refers to technical knowledge management at company. Any firms can have any of the TM activities or all of them.

It is necessary to say that Technology and innovation aren't important in themselves, but must be used towards Competitiveness, create worth, meet the requirements and create a sustainable competitive advantage. Technology and innovation include of both the hardware and software and companies should attention to both of them. It means that companies should consider human, financial, knowledge and organization resources in addition to hardware equipment and tools. Due to technology nature, we can say technology is a dynamic element that changes and evolves in over time, so innovation and lifecycle management help to better technology analysis. On the other words, innovation capability is prior to technology capability and innovation should be considered in all over the value chain.

d. Customer Experience

Due to today's transformation in technology and market needs, customer behavior is changing. Technologies have impact on customer needs type and their behavior pattern. Today, a new concept has shaped in innovation field that called Customer innovation. Customer innovation effects on how to offer product or service to customers and it changes business environment. So thanks to technological changes and its rapid growth and due to customer needs, customer retention is the most important challenge faced by MNOs today.

Sundbo and Hagedorn- Rasmussens (2008) defined Customer Experience (CX) as "the customer's direct and indirect experience of the service process, the organization, and the facilities and how the customer interacts with the service firm's representatives and other customers" (Sundbo et al., 2008). In other definition, CX is a method of creating a differential advantage for establishing customer's loyalty (Davidson, 1992). TMForum defines CX as "the results of the sum of observations, perceptions, thoughts and feelings arising from interactions and relationships between customers and their service

provider(s") (WCIR, 2012). According to these definitions, CX is one of the main factors that influence business processes for CX management.

Sujata Joshi (2014) refers to some factors in his paper that affect customer satisfaction (Joshi, 2014). He classified factors to five major criteria of customer experience measures: Brand, Environment, Culture, Communications and Offerings.

Wipro council presented a multi-dimensional view of CX in telecom industry (WCIR, 2012) that include: Marketing and Sales, Customer Support, Brand, Product and Service Portfolio, Billing, Charging and Cost Management, and Service Quality.

Preethi Subramanian and Dr.Sellappan Palaniappan (2016), considered five Variables to Determine CX in the Telecom Industry. They include (Subamanian et al., 2016): Service Delivery / Billing, Network Performance, Customer Care Culture, Marketing, Promotions and Communication, Brand Value and Brand Image. Their result analysis showed that the following factors truly determine the customer experience in Telecom industry: Pricing of the operator, Billing issues, Indoor and Outdoor Network Coverage, Signal Quality, Call and Data Connectivity, Value as a Customer, Friendly Customer care, Knowledgeable and Responsive Customer care, Proud to use a brand, Brand Image and Positive publicity of the brand.

Noorain Imbug et al. (2016) examined the relationship between customer experiences and customer loyalty in the context of telecommunication industry. They introduced three dimensions of customer experience that consisted of core service, charging, and brands (Imbug et al., 2018). Their findings indicated customer experience positively influence customer loyalty in the telecommunication industry.

Due to literature and expert comments, is considered five main factors for customer experience in MNOs; Sales and Marketing, Brand, Customer support, Quality of network/service, Billing. Table 2 shows any five factors with their criteria:

Table 2. Customer Experience factors in MNOs

Factor	Criteria
Sales and Marketing	- Development and Provide new product/ service to market according to new technologies - Provide product/ service according to customer demands - Facilitate access to sales and supply channels - Product/ Service offer time to market - Product/ Service portfolio variety - Market environment - Market dynamics and attractiveness
Brand	- Brand Value and Brand Image - Proud to use a Brand - Satisfy All Customer Needs - Recognized Brand Image - Positive Publicity of the Brand - Convenient Brand Shops
Customer Care & Support	- Communication - Knowledgeable employee - Time to reply on customer needs - Value as a Customer - Customer Information Security - Attracting and care customers
Quality of network/service	- Indoor and Outdoor Network Coverage - Signal Quality - Call and Data Connectivity
Billing	- Pricing of the Operator - Billing Issues - Call and SMS Fee - Data Pack Charges

II. Proposed Innovation and Technology Management Framework for MNOs

As previously discussed technology management systems help MNOs to tackle technological challenges by modeling the structures, processes and tools regarding to their own capabilities and technology trends.

technology management system needs to be well integrate d with the overall business systems to be effective (Tidd&Bessant, 2018) . MNOs as technology-based firms have to associate their main processes with technology management processes. It is essential to link TM system with innovation system, knowledge management system, PM system, HR management system etc. in an organization; otherwise, the system will not work properly.

Our review from literatures show that ICT sector has brilliant footprints in innovation management, and although there are some defined TM models in other sectors like defense enterprise and SMEs, there is not an appropriate model for TM in MNOs. Therefore, MNOs needs an appropriate model that covers all technological aspects including business plans, innovation, technical knowledge, regulatory obligations, and security requirements. Based on Phaal et al. TM model (2004), European Innovation Management Standard (CEN/TS 16555), ADL's Innovation Excellence Model, and Iran national reward model for management of innovation and technology (IRAMIT)[2], we provide a TM framework for MNOs. After imposing our best practices, expertise, and experiences, we adopt it in accordance to eTOM[3] framework (Rel. 17.5) in order to make it practical with measurable KPIs (Key performance Indicators). Proposed model is based on innovation funnel and their components consist of eight activities that are related to legal and security requirements (Fig. 3).

The proposed model in Fig. 3 Includes eight main modules: Identification, Lifecycle Management, Assessment & Selection, , Development Management, Acquisition, Exploitation and Commercialization of Technology, Technology Protection, and Technological Learning. We will describe each module in this part.

1. **Identification:** It refers to technology intelligence that monitors and scans available /feasible /possible technologies in Telecom industry (that have impact on MNOs business) at present and future. This activity considers customer needs, market needs; operational, legal, technical and strategic needs. For example, Gartner reports studying is a once way of identifying technologies.

2. **Lifecycle Management:** Lifecycle analysis is one of the key tools of TM that enables the dynamic recognition of technology changes over time. Technology mature evaluation is an important activity for MNOs. Technology have limited Lifecycle and MNOs must invest on technology due to its lifecycle.

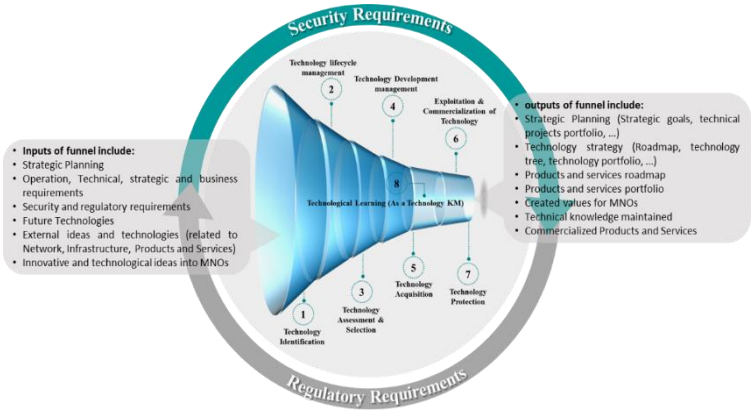


Figure 3. Proposed Framework of T&IM for MNOs

[2] This model is developed based on fundamental concepts and model values. Show more: www.iramitaward.ir

[3] eTOM (Business process Framework) is an operating model framework for telecom service providers in the telecommunications industry.

3. **Assessment & Selection**: "Assessment" refers to evaluation and analysis of identification technologies in terms of technical, market, strategic and environmental dimensions and "Selection" involves the choice of technologies that should be supported and promoted within the organization (Gregory, 1995).

Assessment and selection of technology is a complementary identification process. Two criteria are important in evaluation: Technology Attraction and technology capability.

Technology Attraction assessment analyzes and evaluates risks and opportunities of technology, whether new or existing technologies. Technology capability refers to four basic Components of technology: Technoware, Infoware, Humanware and Orgaware; this means that an organization needs some capabilities for technology absorption and acquisition.

4. **Technology Development:** technology development process is very important to improve technology, product and service development management. Technology development process design helps to facilitate product development process and in result reduce development time and financial resources.

5. **Acquisition of technology**: Acquisition decisions are concerned with choices among buy-collaborate-make alternatives, since technologies might be developed internally, in some form of collaboration, or acquired from external developers (Centidamar et al., 2009) (we separated development and acquisition steps as two important process in our framework). Technology can usually be achieved in two major ways:

- Internal R&D and innovation (Development activity);
- Technology transfer and technological collaboration;

6. **Exploitation & Commercialization of Technology:** After the acquisition and implementation of technology, companies start to exploit it for their own benefit. Exploitation refers to commercialization but it is a wider managerial function, since the expected benefits might be accrued through implementation, absorption and operation of the technology within the firm (Centidamar et al., 2009). For example, VOLTE as a technology is exploited by marketing to provide service to subscribers, after Preparation and implementation in network by CTO.

7. **Protection:** it is important to Maintenance technology after exploitation due to used high resources for it. This activity in our framework refers to protection of existing technologies in MNOs. Technologies must be protected because of environmental, regulatory, safety and political (sanctions) condition. Also, technology (network) optimization and promotion is key process in MNOs that we consider it in this activity. Protection of knowledge is important too. To protect organization knowledge, there are many tools that help to document information and lesson learned.

8. Technological Learning: Technological learning process goal is improving organizations competitive advantage by external technology acquisition and accumulation of technological capability and innovation development (Xie&Li-hua, 2008). Therefore, development and exploitation of technology accompany with lessons learned that should be documented

Considering the above modules in proposed model, all the inter correlations have to be properly defined through KPIs, and OLAs in case of intersectional communications. In all modules regulatory and security, obligations have to be confirmed and meet.

III. Methodology of modeling

This research is applied in terms of purpose and descriptive-correlational in terms of method. The research have three phases: First, T&IM Framework extraction, second most important customer experience's factors identification and third Investigating the impact of technology management on customer experience. In the following, the proposed methodology of each Phase is detailed along with the obtained results.

Phase 1: This phase is concentrated on answering to these questions "what is that the appropriate model supported innovation for TM implementation in MNOs?", "What is that the foremost vital TM processes/ activities in MNOs?" and "How is relationship between innovation, technology and knowledge management in MNOs?"

In order to answer these questions, the research process is based on a case study of Iran MNOs (MCCI). Figure 4 shows proposed methodology of T&IM framework extraction.

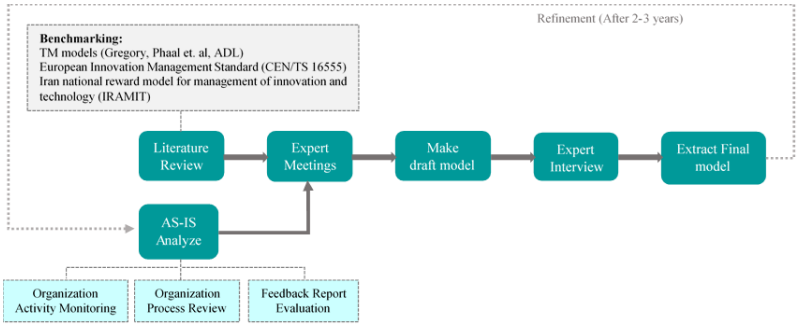


Figure 4. Proposed Methodology of T&IM Framework

To verify and validate of model, was held expert sessions. Based on the meetings, the most important activities of TM and the relationship between them were identified and was proposed final TM framework ultimately (Fig. 3). This framework can be refine after 2-3 years.

Phase 2: Based-on literature review and interview with experts, was identified five important factors of customer experience in MNOs. These factors include of Sales and Marketing, Brand, Customer Care and Support, Quality of networks/ services, Billing.

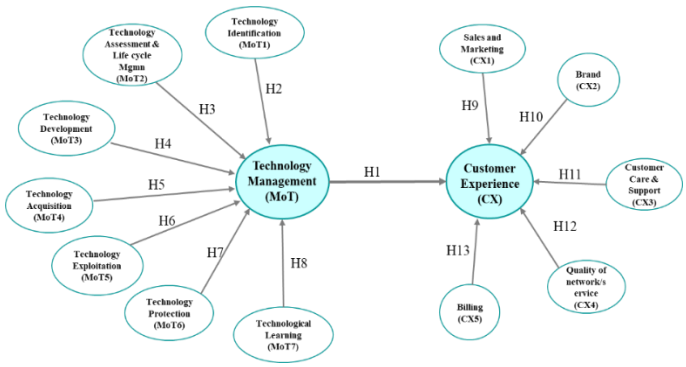


Figure 5. Conceptual research model

Phase 3: In order to investigate the relationship between T&IM and customer experience and based on research hypothesizes, conceptual research model is as figure 5.

Then, to measure customer satisfaction, based on the T&IM framework, a questionnaire was prepared and distributed among the MNOs customers. The target population for this study was limited to tow category: The employees working in MNOs located and mobile subscribers within Tehran, Iran. All items in questionnaire were scored based on five-point Likert scales ranking..

A total of 250 questionnaires were distributed and after deletion of incomplete responses, 222 questionnaires were usable. The respondents' information is given in the table below:

Table 2 . Respondents' information

MNO's Experts information	percent	Education	Work Experience
Male	46%	Bachelor: 25%	Less than 5 Years: 15%

Female	54%	Masters: 63% PHD: 12%	5 to 10 years: 51% 10 to 15 years: 22% More than 15 years: 12%
Customers Information	percent	Education	Use of MNOs services
Male	51%	Bachelor: 54% Masters: 37% PHD: 9%	Less than 5 Years : 12% 5 to 10 years: 32% 10 to 15 years: 37% More than 15 years: 19%
Female	49%		

I. Evaluation and Findings

For this study, hypotheses were tested supported structural equation modelling employing a Partial method of least squares (PLS) method. so on conduct the analysis, Smart PLS Version 3.0 software was used.

The analysis of the outer model specifies the connection between latent variables and their indicators. Tests performed on outer models include: Convergent Validity (the primary moment is above 0.7), Discriminant Validity, Composite Reliability (Data which has composite reliability over 0.7 considered as highly reliable), Average Variance Extracted (AVE), Cronbach Alpha.
The test results are shown within the Table 3 after deleting some obvious variables.

Table 3. Construct Validity and Reliability Test (model 1)

indicators	Cronbach's Alpha	rho_A	Composite Reliability	AVE	Result
CX	0.819	0.820	0.892	0.734	Valid
cx1	0.866	0.869	0.900	0.599	Valid
cx2	0.860	0.860	0.906	0.707	Valid
cx3	0.928	0.930	0.944	0.737	Valid
cx4	0.762	0.772	0.848	0.583	Valid
cx5	0.882	0.894	0.927	0.808	Valid
MoT	0.832	0.844	0.889	0.667	Valid
mot1	0.863	0.896	0.906	0.706	Valid
mot2	0.880	0.889	0.913	0.678	Valid
mot3	0.813	0.943	0.878	0.706	Valid
mot4	0.862	0.879	0.915	0.782	Valid
mot5	0.895	0.903	0.927	0.761	Valid
mot6	0.801	0.801	0.909	0.834	Valid
mot7	1.000	1.000	1.000	1.000	Valid

Table above shows that AVE value> 0.5, Cronbach Alpha> 0.7 and composite reliability> 0.7, which indicates that research variables have good reliability for all variables and dimensions. Also, Discriminant validity shows that all dimensions have good discriminant validity.
Outer Loadings and Path Coefficients shows as Figure 6. For measurement model, all the standardized factor loadings of each construct were high (above 0.70) that ensured the convergent validity.

According to Fig 6, the value of convergent validity is the value of the loading factor of outer path analysis where t-value> 1.96 (t-value>1.64) and p-value < 0.05. This means that each indicator is valid.

Based on the blindfolding score results, Q2 was obtained for Customer experience= 0.638 and Technology Management = 0.533. If Q2 >0, it indicates that the structural model has adequate predictive relevance. Hence, the model is robust and hypothesis testing can be done.

For the model used in this study, a GoF (goodness of fit) value of 0.785 is calculated which indicates a very good model fit.

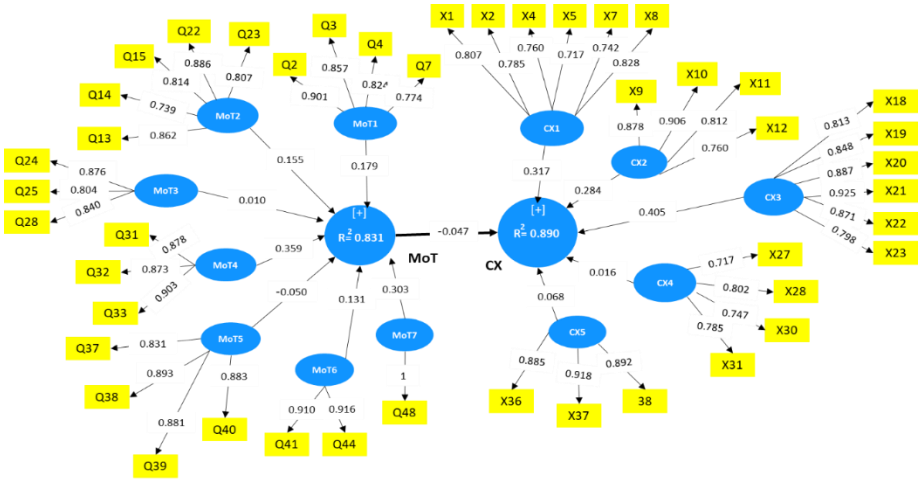


Figure 6. Outer Loadings and Path Coefficients (Model 1)

Hypothesis Testing

The hypothesis testing can be accomplished through partial Test and simultaneous test to know the impact of respective Variable and dimension. The result of hypothesis testing can be shown in Table 4.

The effect of Innovation on the research model is discussed below. According to the literature review, innovation management affects MoT and CX. In order to assessment this hypothesizes (H14, H15), the innovation variable was added to model 1 and the above tests were performed again.

Table 4. Testing of Hypothesis (model 1)

Hypothesis	Path	Standard Deviation	T Statistics	P-Values	Significant level	Direct Impact
H1: Technology Management -> Customer Experience	-0.047	0.022	2.112*	0.035	Supported	Rejected
H2: Technology Identification -> Technology Management	0.179	0.109	1.638	0.103	Not Supported	Rejected
H3: Technology assessment & Life cycle Mgmn -> Technology Management	0.155	0.120	1.297	0.195	Not Supported	Rejected
H4: Technology Development (R&D) -> Technology Management	0.010	0.040	0.264	0.792	Not Supported	Rejected
H5: Technology Acquisition -> Technology Management	0.359	0.064	5.588*	0.000	Supported	Accepted
H6: Technology Exploitation & Commercialization -> Technology Management	-0.050	0.025	2.036**	0.042	Supported	Rejected
H7: Technology Protection -> Technology Management	0.131	0.076	1.724**	0.085	Supported	Accepted
H8: Technological Learning -> Technology Management	0.303	0.035	8.639*	0.000	Supported	Accepted
H9: Sales & Marketing -> Customer Experience	0.317	0.042	7.532*	0.000	Supported	Accepted
H10: Brand -> Customer Experience	0.284	0.033	8.716*	0.000	Supported	Accepted
H11: Customer care & Support -> Customer Experience	0.405	0.040	9.995*	0.000	Supported	Accepted
H12: Quality of Network/Service -> Customer Experience	0.016	0.027	0.611	0.541	Not Supported	Rejected

H13: Billing -> Customer Experience	0.068	0.032	2.153*	0.032	Supported	Accepted

* Sig<0.05, t-value>1.96; **Sig<0.1, t-value>1.64

The results of PLS, Bootstrap and blindfolding test shows as follow:

Table 5. Construct Validity and Reliability Test (model 2)

indicators	Cronbach's Alpha	rho_A	Composite Reliability	AVE	Result
Innovation	1.000	1.000	1.000	1.000	Valid
MoT*Inno.	1.000	1.000	1.000	1.000	Valid
CX	0.819	0.820	0.892	0.734	Valid
MoT	0.832	0.844	0.889	0.667	Valid

Table above shows that AVE value> 0.5, Cronbach Alpha> 0.7 and composite reliability> 0.7, which indicates that research variables have good reliability for all variables and dimensions.

Outer Loadings and Path Coefficients shows as Figure 7. For measurement model, all the standardized factor loadings of each construct were high (above 0.70) that ensured the convergent validity. The value of convergent validity is the value of the loading factor of outer path analysis where t-value> 1.96 (t-value>1.64) and p-value < 0.05. This means that each indicator is valid.

Based on the blindfolding score results, Q2 was obtained for Customer experience= 0.565 and Technology Management= 0.524. If Q2 >0, it indicates that the structural model has adequate predictive relevance. Hence, the model is robust and hypothesis testing can be done. For the model (model 2) used in this study, a GoF value of 0.817 is calculated which indicates a very good model fit.

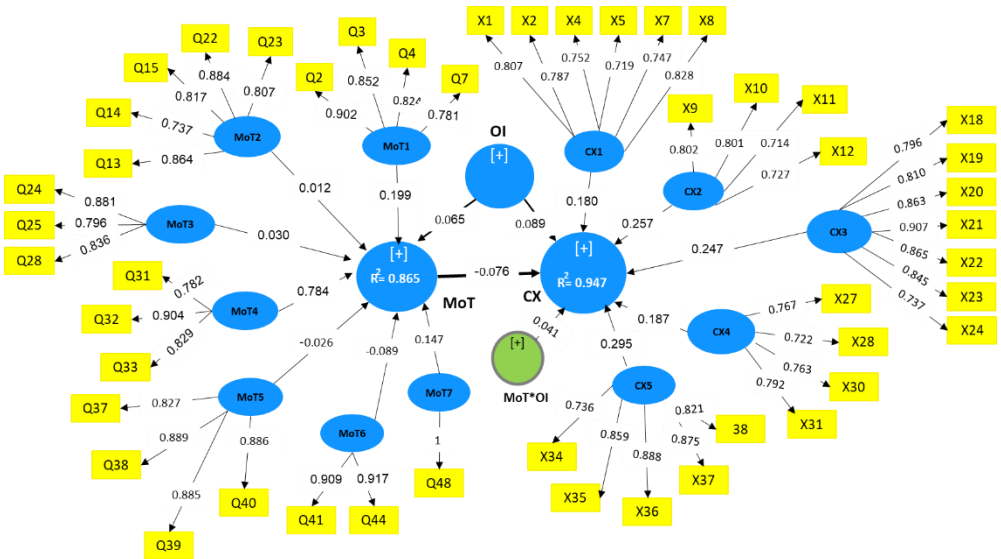
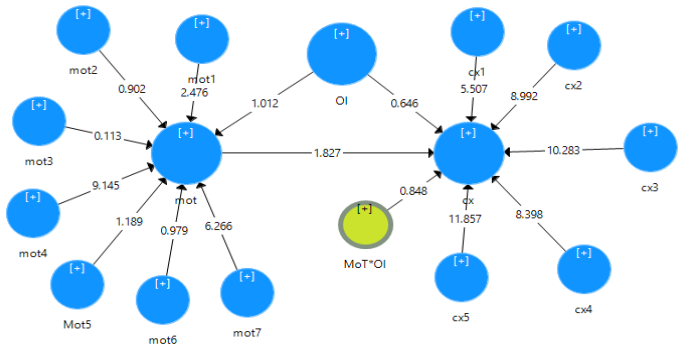


Figure 7. Outer Loadings and Path Coefficients (Model 2)



Sig<0.1; t-value>1.64

Figure 7. Significant of path coefficients (model 2)

Hypothesis Testing

The hypothesis testing can be accomplished through partial Test and simultaneous test to know the impact of respective Variable and dimension. The result of hypothesis testing can be shown in Table 6.

Table 6. Testing of Hypothesis (model 2)

Partial Test

Hypothesis	Path*	Standard Deviation**	T Statistics**	P-Values**	Significant level	Direct Impact
H14: Innovation -> Customer Experience	0.089	0.023	0.646	0.519	Not Supported	Accepted
H15: Innovation -> Technology Management	0.065	0.070	1.012	0.312	Not Supported	Accepted

* Sig<0.05, **Sig<0.1, t-value>1.64

Simultaneous Test

Hypothesis	Path*	Standard Deviation**	T Statistics**	P-Values**	Significant level	Direct Impact
Innovation -> Technology Management -> Customer Experience	0.041	0.017	0.848	0.397	Not Supported	Accepted

* Sig<0.05, **Sig<0.1, t-value>1.64

Table 6 shows that within the degree of confidence of 90% (α=0.1), where T>1.64 and p<0.05, there is not supportive influence of innovation on customer experience and technology management. On simultaneous test, it shown that innovation has indirect significant impact on customer experience mediated by technology management.

The direct effect test shows that the relationship between innovation and customer experience has a path coefficient score of 0.089 with t-statistics = 0.646 and p-value = 0.0519>0.05. This means that H0 is accepted while H1 is rejected. This proves that innovation has not a significant impact on customer experience. The second assessment is the relationship between innovation and technology management has a path coefficient score of 0.065 with t-statistics = 1.012 and p-value = 0.312>0.05. This means that H0 is accepted while H1 is rejected. There is also no significant impact of innovation on technology management.

The indirect effect test shows that the mediating role of innovation has a path coefficient score=0,041 with t-statistics = 0.848 and p-value = 0.397>0.05. This means that H0 is accepted while H2 is rejected. There is also no significant impact of innovation in mediating role on relationship between technology management and customer experience.

In this part, in order to declare and validate our findings, we are trying to compare the result with previous literacies. Due to the lack of research background on the impact of technology management on customer experience in MNOs Case study, we have targeted to find out this relationship.

Technology management has a direct impact to customer experience. In addition, Technology Identification, Assessment and life cycle management, Development, Acquisition, protection and technological learning have direct impact on Technology Management, although there is no direct impact between Technology Exploitation and commercialization with Technology Management. There is no significant relationship between technology identification, assessment and life cycle management and development with technology management. These findings does not fully support Gregory (1995), NCR (1987), phaal et. al. (2001) and Centindamart et. al. (2009), who found that identification, assessment and selection, R&D and acquisition, exploitation, protection and learning supporting technology management in any size and activity of companies.

Innovation management has become important for enhancing the effectiveness and efficiency of new product development. With the increasing role of innovation mediation, the impact of innovation on management of technology is direct but there is no significant relationship between them. In addition, relationship between technology management and customer experience remains significant and there are significant relationship between technology identification, acquisition and technological learning with technology management. This finding is aligned with the study before done by White, Margaret A.; Bruton, Garry D. (2007), who found that "the management of innovation requires technology; but the management of technology does not necessarily require innovation".

The result brings the implication for MNOs to use technology management to establish customer experience through direct and indirect mediated by innovation. While, the mediating role of innovation is not impact on relationship between technology management and customer experience.

MNO's should make open innovation network to identification of new/emerging technologies in communication industry and It is important that all technologies are acquired through appropriate and innovative methods after selection. In addition, in order to retain their customers, MNOs must seek to provide innovative products and services and create new markets, and while providing appropriate support to their customers, must strive to acquire the necessary technical knowledge and maintaining them (knowledge and technology). In addition, there is no significant relationship between quality of network/service and customer experience. This finding does not support Sujata Joshi (2014) and Preethi Subramanian and Dr.Sellappan Palaniappan (2016), who found that service quality and network performance supporting customer experience.

According to research literature, innovation is a key factor for customer satisfaction (Chia-Han Yang, 2018). Based-on research findings, innovation as a mediator role has direct and indirect impact on customer experience, but there is no significant relationship between them. However, by increasing the role of innovation mediation, there is significant relationship between sales and marketing, brand, customer care & support, quality of network/ service and billing with customer experience. This finding support Sujata Joshi (2014) and Preethi Subramanian and Dr.Sellappan Palaniappan (2016), who found that these factors supporting customer experience. This finding brings the implication for MNOs to be innovative and consider innovation as an important factor throughout of the sale and marketing to billing chain.

Also, in order to compare the results of the research with previous results of improving the customer experience, we reviewed the results of our company's survey of the past two years with the present results. The results show that the implementation of ITM system in the company has led to a 26.64% increase in our customers' experience.

II. Discussion and Conclusions

The reason of focusing on MNOs rather that other players in ICT market in this article, is the importance of their role in accelerating digitalization, and also their technological quick shifts from legacy to cloud based and software defined approaches in their networks and infrastructures.

MNOs are losing their market shares in case of not mitigating technological changes, and this highlights the importance role of TM system implementation in these companies.

In MNOs, there are many technological activities but they are not systematic and integrated. On the other word, innovation are not considered in different steps of technology identification to commercialization and TM steps are typically separate of each other.

Based on the results of hypotheses testing, it can be concluded that technology management has direct and indirect impact to customer experience, where the innovation has a mediating role and the relationship between technology management with customer experience is positive (significant) in MNOs.

We adopt the proposed TM system model based on eTOM framework and operational processes in our company, which shows 26.64 percent improvement on customer experience surveys.

Further study can be explored using a more extended sampling, industry and with consideration of markets outside Iran. In addition, more researches on assessment of direct and indirect impact of technology management into customer experience/satisfaction can be done to provide value for MNOs.

References

A.D. Little (1981). "**The Strategic Management of Technology**", European Management Forum.

Asim, Z. and Sorooshian, S. (2019). "**Exploring the Role of Knowledge, Innovation and Technology Management (KNIT) Capabilities that Influence Research and Development**" Journal of Open Innovation: Technology, Market, and Complexity,Vol. 05 (21).

Best, M. H. (2001). "**The New Competitive Advantage: The Renewal of American Industry**", Oxford University Press, Oxford.

Birkinshaw, J. (2001). "**Why is knowledge management so difficult?**", Business strategy review, Vol. 12 (1), PP. 11-18.

Carrillo, J. and Gaimon, C. (2004). "**Managing knowledge-based resource capabilities under uncertainty**" Management Science, Vol. 50 (11), PP. 1504-1518

Chanaron, J. and Jolly, D. (1999). "**Technological management: expanding the perspective of management of technology**", Management Decision, Vol. 37 (8), PP. 613-620

Calik, E., Cetinguc, B. and Calisi, F. (2020). "**A Comprehensive Validated Model of Innovation and Performance: An Empirical Study of Turkish Companies**", International Journal of Innovation and Technology Managemen, Vol. 17 (03).

Chouki, M., Talea, M., Okar, C. and Chroqui, R. (2020). "**Barriers to Information Technology Adoption Within Small and Medium Enterprises: A Systematic Literature Review**", *International Journal of Innovation and Technology Management,* Vol. 17, (01).

Chini, T. C. (2004). "**Effective Knowledge Transfer in Multinational Corporations**", New York: Palgrave Macmillan.

Cetindamar, D., Phaal, R. and Probert, D. (2009). "**Understanding technology management as a dynamic capability: A framework for technology management activities**", Technovation, Vol. 29, PP. 237-246

Dembicka, E. K. (2017). "**Analysis of Technology Management Using the Example of the Production Enterprise from the SME Sector**", *7th International Conference on Engineering, Project, and Production Management*, *Procedia Engineering*, Vol. 182, PP. 359-365

Dussauge, P. Hart, S. and Ramanantsoa, B. (1992). "**Strategic Technology Management**", 1st edition, Wiley, ISBN 0-471-93418-6

Durugbo, C. M., Almahamid, S. M. and Al-Jayyousi, O. R. (2020). "**Wisdom from arabian creatives: Systematic review of innovation**", International Journal of Innovation and Technology Management, Vol. 17 (03).

Davidson, R. (1992), "**Tourism in Europe**", Pitman Publishing, London.

Edosio, U. (2014). "**Knowledge Management Concept**.", Knowledge Management, Vol. 01.

Fernandes França, T. J., São Mamede, H. and dos Santos, V. D. (2020). "**Managing millennials as outsourced information technology professionals: A systematical review**", in International Conferences ICT, Society, and Human Beings 2020.

Imbug, N., Azwa Ambad, S. N. and Bujang, I. (2018). "**The Influence of Customer Experience on Customer Loyalty in Telecommunication Industry**", International Journal of Academic Research in Business and Social Sciences, Vol. 08 (03), PP. 103-116

Galbraith, j. k. (1968). "**The New Industrial State**", Penguin, Harmondsworth, England, ISBN 13: 9780140210828
Grant, R. (2007). "**Contemporary Strategy Analysis: Concepts, Techniques, Applications**", Oxford, 6th Edition, Blackwell Publishing.
G. Hamel and C. Prahalad, "**Competing for the future**", Harvard Business Review, vol. 72 (4), p. 122–128, 1994.
Gregory, M. J. (1995). "**Technology Management: A Process Approach**", Proceedings of the Institution of Mechanical Engineers, Vol. 209, PP. 347-356
Jally, D. and Therin, F. (1996). "**Technology Strategy: Towards a Resource-Based Approach**", Montreal: ASAC.
Jin, J. and Zedtwitz, M. v. (2008). "**Technological capability development in China's mobile phone industry**", Technovation, Vol. 28, PP. 327–334
Jennex, M. (2007). "**What is Knowledge Management?**", San Diego State University.
Joshi, S. (2014), "**Customer experience management: An exploratory study on the parameters affecting customer experience for cellular mobile services of a telecom company**" ScienceDirect, Vol. 133, PP. 392–399
Kang, B. (2015). "**The innovation process of Huawei and ZTE: Patent data analysis**", China Economic Review, Vol. 36, PP. 378-393
Lu, I.-Y., Wang, C.-H. and Mao, C.-J. (2007). "**Technology innovation and knowledge management in the high-tech industry**", International Journal of Technology Management, Vol. 39, P. Nos. 1/2.
Morin, J. (1985), "**L'Excellence Technologique**", J.Picollec Edition, Publi-Union.
NRC/ National Research Council (1987). "**Management of Technology: The Hidden Competitive Advantage**", Washington, DC: National Academy Press.
Probert, D., Granstrand, O., Nagel, A., Tomlin, B., Herstatt, C., Tschirky, H. and Durand, T. (2004). "**Bringing Technology and Innovation into the boardroom**", European Institute for Technology and Innovation management, Palgrave Macmillan, ISBN 0–333–99459–0
Pavitt, K. (1984). "**Sectoral patterns of technological change: towards a taxanomy and a theory**", Research Policy, Vol. 13, PP. 343–373
Phaal, R. Farrukh, C. Probert and R. D. (2004). "**a framework for supporting the management of technological knowledge**", International journal of technology management, Vol. 27 (1), PP. 1-15
phaal, C. Probert, R. D. and Farrukh, R. (2001). "**Technology management process assessment: a case study**", International journal of operations and production management, Vol. 21 (8), PP. 1116-1132
Porter, M. (1990). "**The competitive advantage of nations**", Harvard Business Review, Vol. 68 (2), PP. 73-93
Rubensrein, A. (1989). "**Managing technology in the decentralized firm**", New York, Wiley.
Sundbo, J. and Hagedorn-Rasmussen, P. (2008). "**The back staging of experience production in Creating Experiences**", Elgar, Cheltenham.
Subramanian, P. and Palaniappan, D. (2016). "**Determinants of Customer Experience in the Telecom Industry using Confirmatory Factor Analysis : an Empirical Study**", International Journal of Conceptions on Computing and Information Technology, Vol. 04 (04), ISSN: 2345 – 9808.
Tidd, J. and Bessant, J. (2018). "**Managing Innovation: Integrating technological, Market & Organizational change**", sixth edition, wiley, Uk.
Tidd, J., Bessant, J. and Pavitt, K. (2005). "**MANAGING INNOVATION: Integrating Technological, Market and organizational change**", 3th edition, wiley.
Tidd, J. and Bessant, J. (2013). "**Managing Innovation: Integrating Technological, Market and Organizational Change**", 5th Edition, wiley.
Takeuchi, H. and Nonaka, I. (2004). "**Hitotsubashi on knowledge management**", John Wiley & Sons (Asia) Pte I.td.
White, Margaret and Bruton, Garry (2007). "**The Management of Technology and Innovation: A strategy approach**", International Journal of R&D Management, Vol. 37 (4), PP. 379-380.
WCIR (2012). "**A Value based approach to improve customer experience: A Customer Experience Improvement Framework for Communication Service Providers**", Wipro Council for Industry Research.
Xie, W. and li-hua, R. (2008). "**Evolving learning strategies for latecomers**", Technology Management in China, Vol. 03 (02), PP. 154-167