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INSTITUTE OF INFORMATION TECHNOLOGY

Vietnam Academy of Science and Technology

STI – THE KEY LEVERAGE FOR VIETNAM IN GLOBAL VALUE CHAIN

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Agenda

- Technology-Leveraged Development Trend in IR4
- STI-Driven Economic Development Model
- Key Factors in STI Model
- The Semiconductor Choice for Vietnam
- Typical Policy Recommendation
- Conclusion

Technology-Leveraged Development Trend

- The 4th Industrial Revolution (IR4):
  - Breakthrough technology and huge impact to human, society and governments around the world
    - Emerging digital techs (AI, Big Data, IoT, robotics, semiconductor…): disruptive change to traditional market (e.g. Grab, Uber; Amazon, Alibaba…)
  - Key points: R&D activity + STI management capacity
  - Digital economy – new room and the key for future growth
    - Bigger share in world economy in general and each country
    - Digital techs and adequate human resources, digital skills and less regulated environment: catalyst for innovation

Technology-Leveraged Development Trend

- Big techs: taking the headline for the development trends
  - New market creation and huge expectation
    - Generative AI: ChatGPT – OpenAI, Bard – Google, Bing - Microsoft
    - Advanced semiconductor: ASML, Nvidia, TSMC and the likes (big players in the world's financial market)
    - E-Commerce: Amazon, Alibaba
    - Social network and its generated marketing: Facebook, WeChat, Tiktok
    - Mobile computing: Apple
    - Digital service: Google, Microsoft
- Key advanced technology in the next decade:
  - Artificial Intelligence – AI; Internet of Things – IoT; Digital Reality: Virtual Reality (VR) and Augmented Reality (AR); Blockchain
  - Quantum Computing
  - National competitiveness level: a key factor measured by large/multi-national tech firms
    - Different nation: different priority for a specific tech group

Technology-Leveraged Development Trend

- Breakthrough technology impact to world market:
  - Before the year 2000, world's largest market capitalization are industrial conglomerate (Ford, General Electric), oil & gas (ExxonMobil), banking and finance (Citigroup)
    - Average 50-100 years of age
  - 2010 – 2015: substantial change
    - Big techs take over the top (Apple, Microsoft, Google, Amazon, Facebook) and widen the gap with other sectors
    - Quite young: 30-40 years of age at most
  - In the next 5-10 year time
    - The era of STI firms: EVs (Tesla), semiconductor + AI (Nvidia, TSMC, ASML, Samsung…)
    - Current big techs continue to innovate for competition and **survival**

Technology-Leveraged Development Trend

- Typical issues for the development of Vietnam:
  - Low-middle development level on world stage
    - Rather low value in global value chain
  - Recent complicated geopolitics – STI competition and sanctions between big powers
    - Challenges
    - Opportunities: High-level human workforce
  - **Immediate issue:**
    - Nurture human resource to solve challenges and utilise opportunities from global competitition
    - Relocation of manufacturing and service bases in global scale

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STI-Driven Economic Development Model

- STI: key factor in the future growth (economic performance + social well-being)
  - STI in the New Economy - OECD Policy Brief, 2000
  - Vietnam STI Report – Vietnam, Australia and World Bank 2021
    - STI – a new engine of growth for Vietnam in its economic transformation
- Scientific advances + technological change: important drivers of economic performance
  - Digital technologies: huge impact on economy and society
  - OECD: high rate of innovation, shift to knowledge-intensive
  - Governments: sharpening policy tools in the context of global competition
    - Enable business and citizens to adapt to the demands and opportunities of the new “digital economy”

STI-Driven Economic Development Model

- OECD's New Economy
  - Multi-factor productivity (MFP) increases in several countries (Australia, Denmark, US, Norway…)
  - Greater efficiency in the use of labour and capital
    - Smarter and more innovative ways in industry and service sectors
    - Correlation between ICT capital investment and workforce skills, higher productivity and better management performance
  - Innovation: driven by market demand
    - 12 European countries: 30% manufacturing turnover from new or novel products
    - **Scientific output and patent** issuance/registration surge
  - Service sector: main stage for hi-tech and innovation – **major component of new economy**
    - Higher productivity growth w.r.t other sectors
    - New service jobs – new skilled personnel

STI-Driven Economic Development Model

- OECD's New Economy
  - Hi-tech and innovation: moving from large firms to small/start-up
    - Traditionally, large firms – key drivers of economy growth and innovation
    - Nowadays, small but "exponential intelligence" firms take the lead
    - Digital tech firms are on the top trend of innovation
  - In digital economy, small and intelligence are keys
    - Essential for "creative destruction", e.g. Uber, Grab; Google, Facebook vs. Kodak, GE
    - Big techs = several M&A of notable tech start-ups
    - For example: Microsoft , Google – 100 M&A; Nvidia = Mellanox (networking gear – Israel & US) + Bright Software (Cluster + HPC software – Netherland & US), and ARM Holdings (power-saving chip design – UK & Japan)…

STI-Driven Economic Development Model

- Vietnam – Australia – World Bank report on STI
  - Current STI development in Vietnam:
    - Analytical support for STI strategy in Vietnam 2020-2030
    - Socio-economic development strategy in Vietnam 2020-2030
    - Strengthen National Innovation System towards innovation-driven enterprises and subsequently sustainable high growth in Vietnam

- Report findings:
  - Gain from structural transformation (less agriculture, more industry and service): to the point of saturation
    - Comparative advantage of low labor cost and **low value** segment in GVC is diminishing quickly
    - Economy openness: vulnerable to trade war and local protection in key markets for Vietnam

STI-Driven Economic Development Model

- Report findings:
  - Both challenges and opportunities in the new context, especially IR4 and digital economy
    - Challenges: export-led manufacturing sector will be heavily impacted due to job losses/labor-saving technologies
    - Opportunities: technological catch-up as there is only this way ahead for Vietnam, leading to new room for economic growth, moving from “replacing” technologies to “enabling” technologies in GVC, i.e. higher added value via innovation
  - Productivity and innovation are intertwined
    - Productivity growth: 1. better allocation of resources from less efficient firms to better firms; 2. upgrading STI capacity for existing firms; 3. Moving up GVC by taking higher value work
  - Current NIS in Vietnam: underdeveloped
    - Innovation ecosystem and its **linkages between components**: weak or absent

STI-Driven Economic Development Model

- Report findings:
  - How to strengthen NIS and its ecosystem?
    - Deal with multiple fronts at the same time, dependent on many variables and uncertainties
    - Large capital investment (state budget and private sector) but risky and uncertain
  - Limited resource and many works to do
    - Careful selection of priority areas
    - SWOT + potential global and local market foresight (e.g. AI/ML + intelligent tools for market prediction, technology map)

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- Key Factors in STI Model
  - Key Factors
  - Technological Foresight with AI/ML Support
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Key Factors in STI Model

- National STI ecosystem: highly correlative with future growth of each country, including Vietnam
  - Cierra, X., and W. Maloney, 2017. “The Innovation Paradox: Developing-country capabilities and the unrealized promise of technological catch-up”. Washington D.C., World Bank.

- Ecosystem structure: key assets – scientific output, tech development and innovation
  - Supply side (R&D institutions, universities): human capital, firm innovation upgrading support, domestic S&T system, international collaboration
  - Demand side (firms): incentives to accumulate knowledge asset (external pressure), core capabilities (internal)
  - Oversight, coordination and resolution of ecosystem (govt): accumulation of assets and allocation of resources (human + knowledge + finance)

Key Factors in STI Model

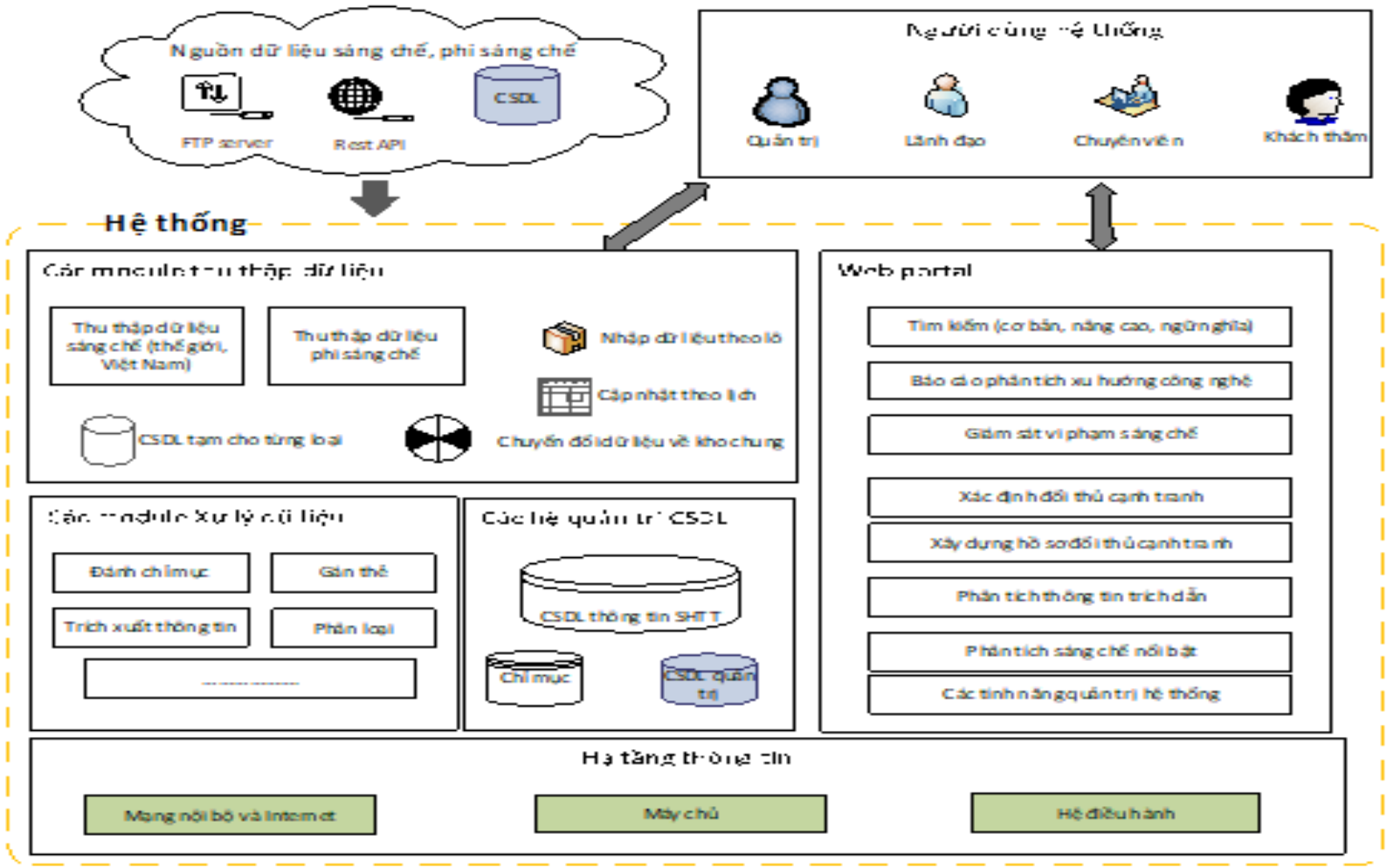
- AI/ML-based intelligent tool support the coordination of the whole ecosystem
  - Strategy from govt: choice of **potential tech with high impact/breakthrough** and new economy in the global stage
    - Tech: medium term (3-5 years);
    - What about long term (10 years or more)?
    - Question: How to identify potential techs? STI-related information, Big Data, AI/ML

    ➔ **Technological Foresight – a key for any organization (state/enterprise) development strategy – The AI/ML tool made in Vietnam**
  - Supply side: concentrating resource (capital, hi-skilled human workforce)
  - Demand side: guiding firms for their own tech development or tech licensing from the IP holders
    - Market trend and competitor's tech capability

An Advanced Technology Analytics System

- System overview
  - Developed, operated and integrated as services at IoIT
  - A product from National IP Asset Program
  - Similar systems in developed countries
    - US, EU, Japan, Korea,…
    - COMPAS – Korea (from 2005)
- Infrastructure – Large Data Center: integration of key techs
  - Cloud Computing – OpenStack
  - Big Data storage and execution
  - Large bandwidth network
- Big data: IP records from key database
  - USPTO + EPO
    - 12 million patents records (1978 – present) – techs (realized in 3-5 years)
    - 250 million scientific publications (Google Scholar) – mainly scientific publication (for 10 years or more)

An Advanced Technology Analytics System

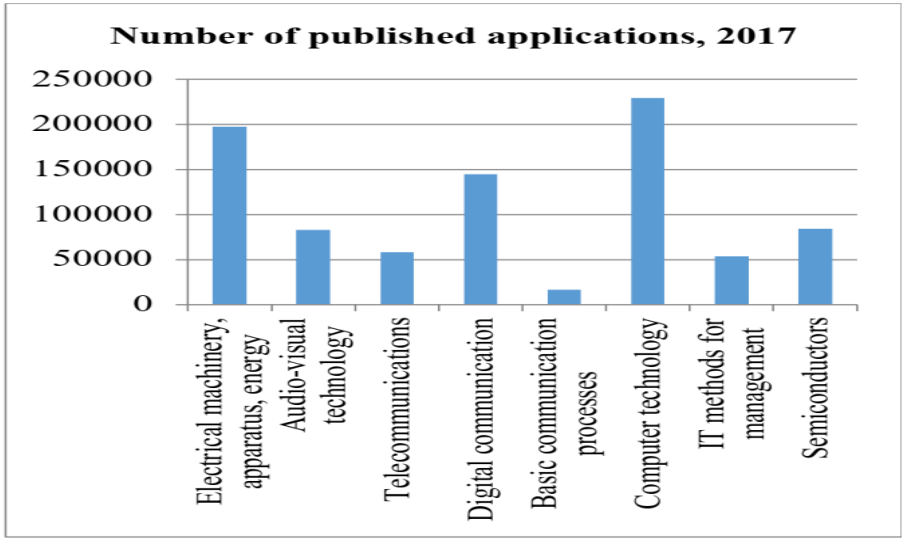


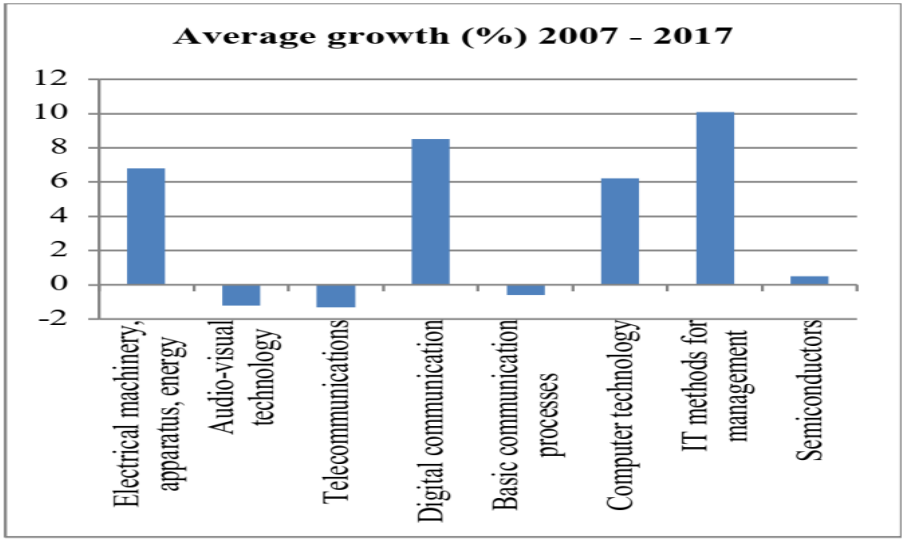
An Advanced Technology Analytics System

- Cloud-based PaaS – Platform as a Service
  - Intelligent data crawlers for online data sources
  - Open-source big data and non-structured database management MongoDB, ElasticSearch
  - Flexible and quick indexing
    - Search and analytics optimization

- Cloud-based SaaS – Software as a Service
  - Technological foresight – tech map
  - Patent violation checking
  - Competitor profiling
    - Profile: technological strength and weakness
    - Strategy evaluation
  - Top and focused IP identification
  - …

An Advanced Technology Analytics System





- IP database in 2007 – 2017
  - Average growth rate (application forms): 5.6%/năm
  - Number of patents: 3 mil (total 12 mil from 1978 – present)
  - Key growth areas: > 10%/yoy
    - Special machine devices
    - Software
    - Food-related chemistry

An Advanced Technology Analytics System

- Advanced tech identification: micro-electronics and semiconductor
  - Largest number of patents
    - Computer: 230.000 for the year 2017 only
  - Some other tech areas:
    - Telecommunication: 8.5%/year
    - Software (digital transformation): 10.1%
    - Hardware (computer engineering): 6.2%
  - Least number of patents:
    - Audio/Visual tech: -1.2%

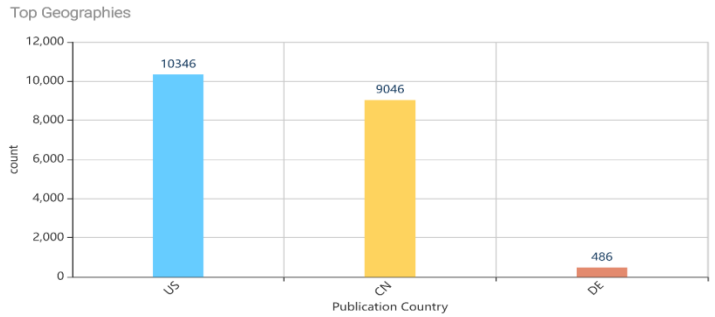
An Advanced Technology Analytics System

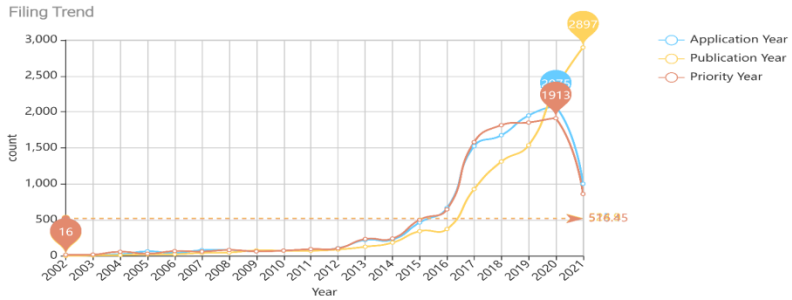
- Priority among developed countries
  - Electronics and energy:
    - Japan (Mitsubishi Electric, Toyota), Korea (Samsung Electronics), Germany (Bosch): IoT, manufacturing sector
  - Digital tech:
    - US (IBM), China (Huawei): computer and services
  - Pharmaceutical:
    - Switzerland (Novartis, La Roche): biotech
  - Food-related chemistry
    - Russia

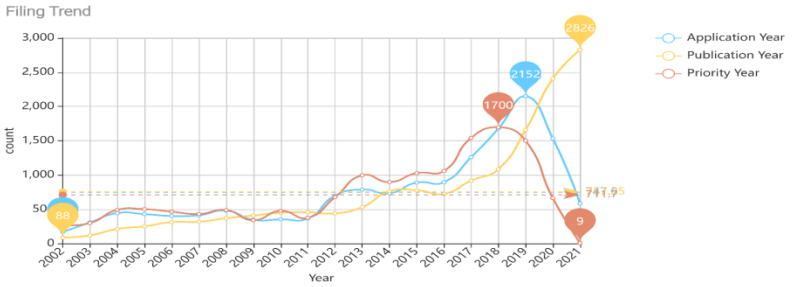
An Advanced Technology Analytics System

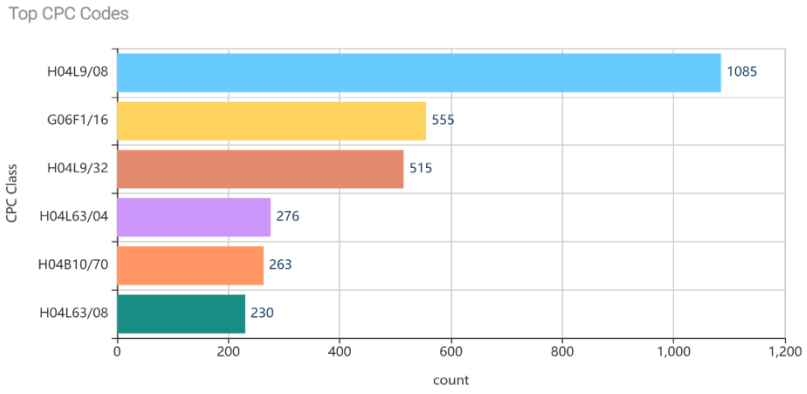
- IP data sampling
  - IP from 3 countries: US, China and Germany
  - Top R&D areas:
    - Quantum Computing
    - 5G telecommunications
    - Cloud computing
    - Electric Vehicles (EV)
  - CPC – Cooperative Patent Classification (an extension of IPC)
    - A: Human neccessities
    - B: Performing operations, transporting
    - C: Chemistry; metallurgy
    - D: Textiles; paper
    - E: Fixed constructions
    - F: Mechanical engineering; lighting; heating; weapons; blasting engines
    - G: Physics
    - H: Electricity
    - Y: Emerging, general technological development

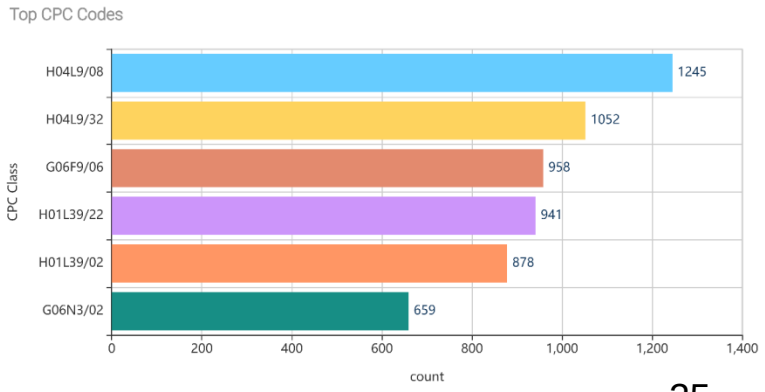
Quantum Computing



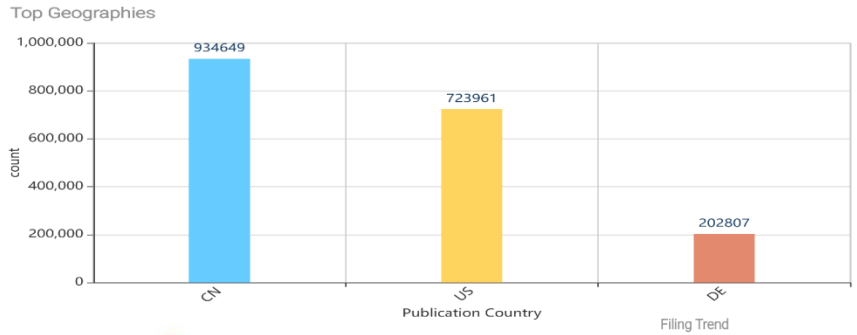


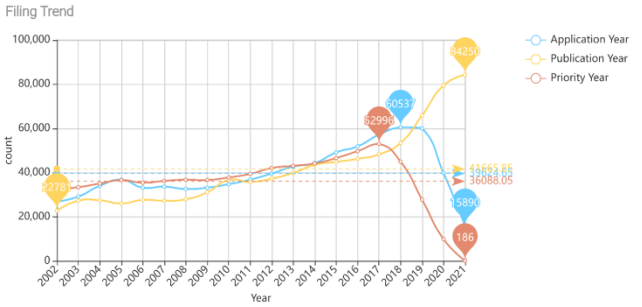


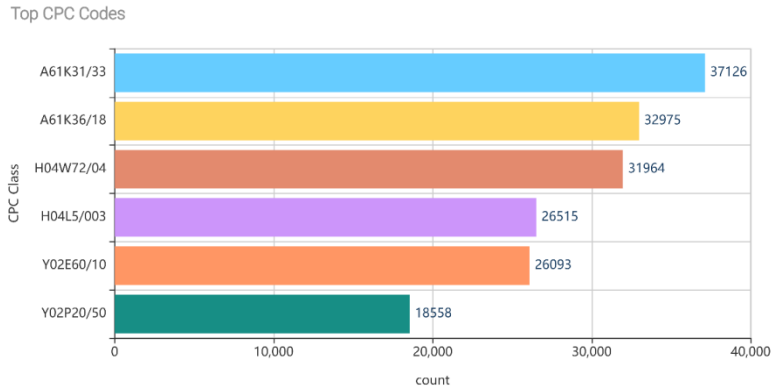


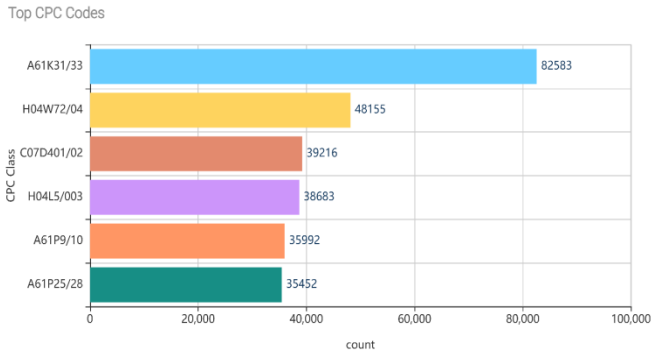


5G Telecommunication

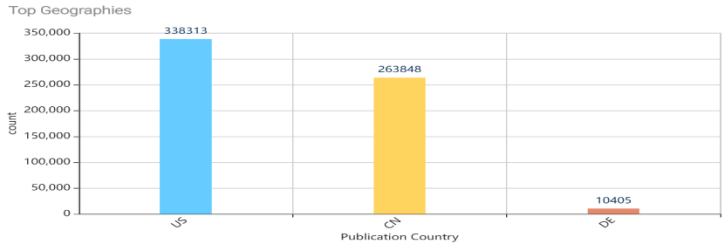


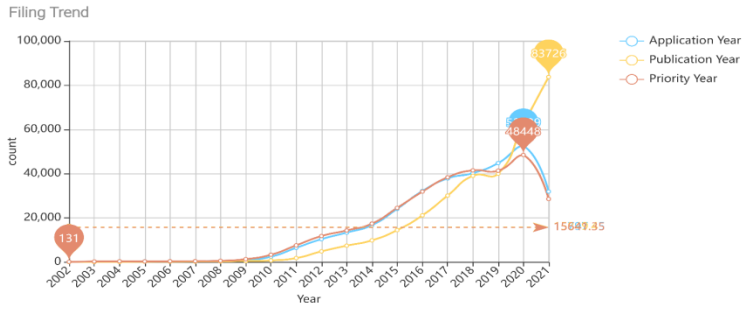


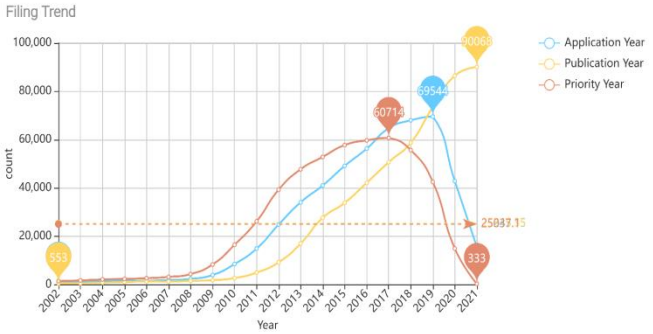


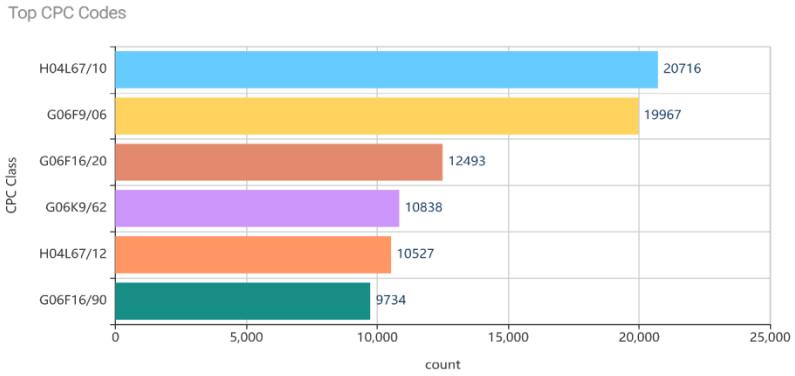


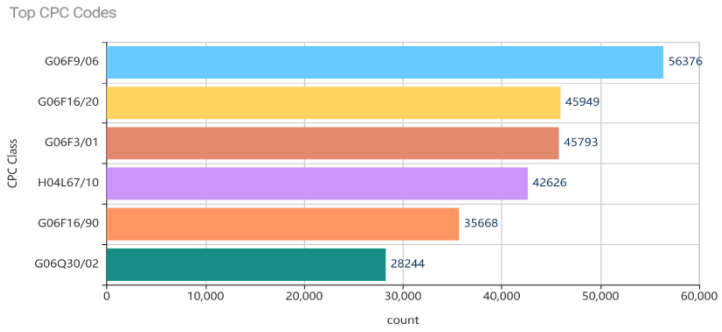
Cloud Computing



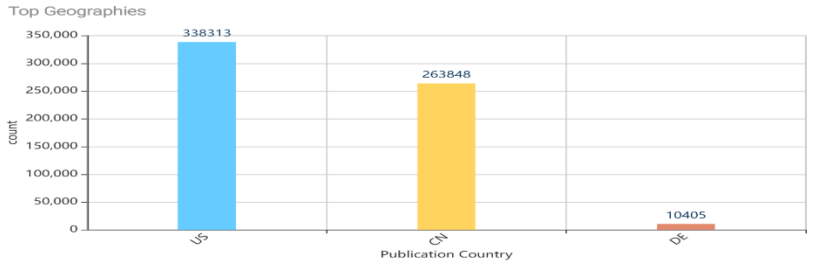


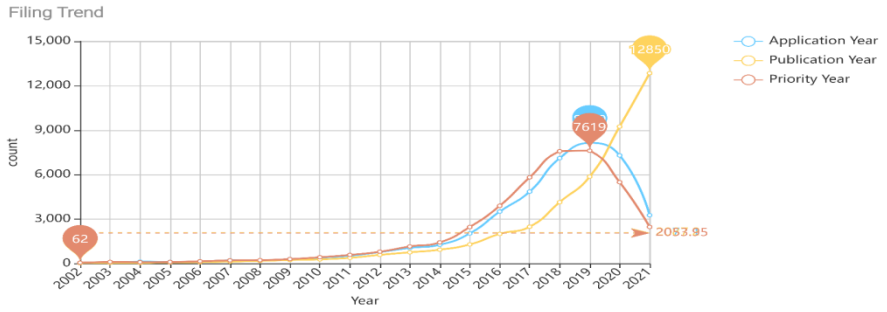


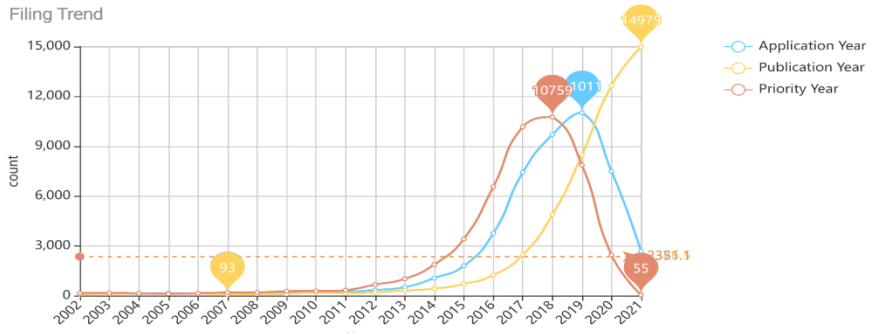


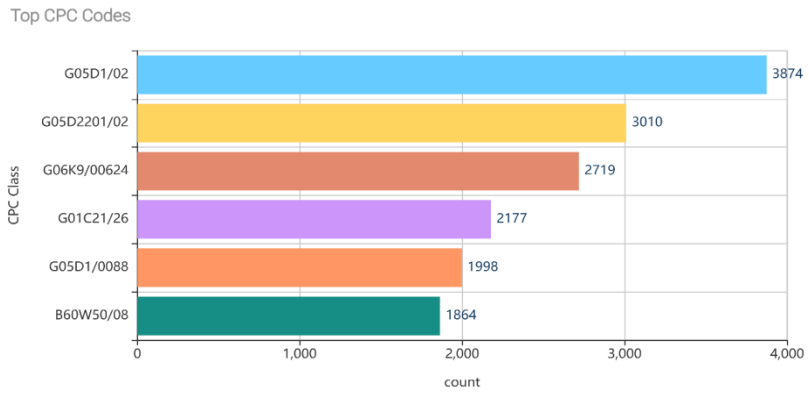


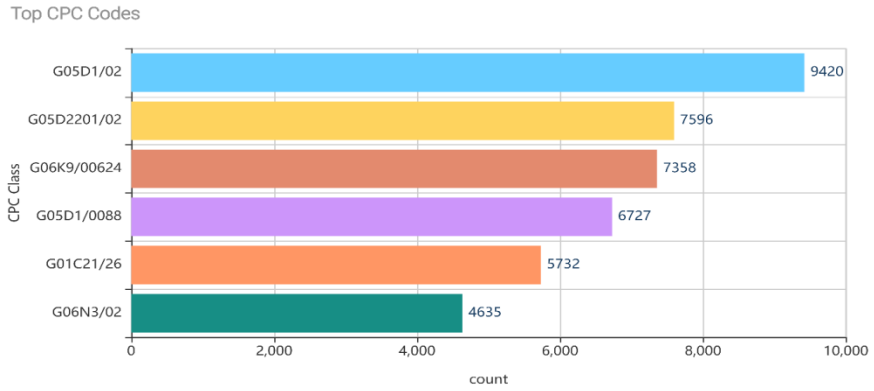
Electric Vehicles











Key Factors in STI Model

- Typical analytical data from key technology
  - Taking from world's biggest IP databases (USPTO, EPO)
    - Lacking Chinese and Japanese IP database – emerging tech powers from Asia (much more than Chinese and Japanese filing in the USPTO)
    - Machine translation is essential
    - IP – **ready techs** and usually for medium term (3-5 years to get commercial values)
    - What about long term (10 or more years)? **Google Scholar** and **scientific publication**
  - Some key tech examples
    - Mature: 5G telecommunication
    - Current: Cloud and EV
    - Potential in future: Quantum computing

Key Factors in STI Model

- Recent world geopolitics and STI competition, emerging core tech are essential to revise and to update Vietnam approach
  - Trade war between US, EU + alliance with China, new emerging regional power (BRICS)
  - Tech sanction: semiconductor, advanced chip, AI
  - Relocation of investment, offshoring to friend-shoring
    - Stable supply chain + global value chain for countries (the West)
  - From Q4, 2022, ChatGPT and Generative AI – breakthrough tech
    - Potential high impact
- Vietnam should prepare itself (capital, human resource, incentive) for the change of investment flow
  - Technological foresight and trend: Big Data, AI/ML, Robotics, IoT, Cloud and Edge Computing; biotechonology, energy and environment tech,
  - Digital transformation, Smart city

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The Semiconductor Choice for Vietnam

- Recent annual reports on Vietnam economy
  - PwC Market Research and Economic Study: H1, 2023
  - Market Intelligence - S&P Global: Q3, 2023
- Key findings of current Vietnam economy:
  - Impacted by global and domestic economic uncertainties
    - Moderate growth rate: 4.2% in 3Q of 2023
    - Weak exports due to less demands in US and EU
  - Rather low value in global value chain
    - What activities does Vietnam participate in the GVC?
    - GVC = research and development, design, production, logistics, marketing, and **services**.
    - Vietnam: mainly in the service lower end of process, hence low value accumulation

The Semiconductor Choice for Vietnam

- By technological foresight, digital techs are candidates in Vietnam STI selection
  - Which tech is the top priority and relevant to Vietnam? E.g: Semiconductor (hardware) and AI/ML (software)
- Initial analysis and data about semiconductor
  - Market potential: direct and indirect markets by semiconductor at global scale
  - Readiness of STI ecosystem:
    - Govt
    - Supply
    - Demand

The Semiconductor Choice for Vietnam

- Potential market:
  - Latest data from Statista Co: clear and well-structured, up-to-date (2023)
  - Direct market: semiconductors
  - Indirect markets:
    - Hardware and devices: consumer electronics, cloud, robotics, IoT
    - Software: AI, IT service, e-commerce
- Semiconductors: ~600 bil USD (2023), expected to be 1.000 bil USD (2030)
  - Foundation of all types of digital economy (direct or indirect)
  - 4 segments: discrete semiconductors, **integrated circuits**, optoelectronics, **sensors & actuators**
  - Highly innovative, knowledge dense + extremely high cost
  - Design (fabless), testing and packaging, fabrication

The Semiconductor Choice for Vietnam

- Closely related hardware and device markets: ~3.000 bil
  - Data Center: 330 bil (servers, storage, networking gear)
  - Devices: 720 bil (PCs, smartphones)
  - **IoT**: 1.800 bil (healthcare, automotive, consumer and industrial IoT, smart cities)
  - **Robotics**: 40 bil (industrial and service robots)
- Closely related software and service markets: ~4.000 bil
  - Cloud services: 720 bil (IaaS, PaaS, SaaS)
  - AI/ML: 250 bil (AI Robotics, NLP, computer vision, Generative AI, autonomous and sensor tech)
  - **ITService**: 1.300 bil (consulting, implementation, outsourcing)
  - Telecommunication: 1.400 bil (voice, data; fixed, mobile phones)

The Semiconductor Choice for Vietnam

- Other related markets: ~20.000 bil
  - **Consumer electronics**: ~1.000 bil
  - E-commerce: ~15.000 bil (2023) and expected to achieve 60.000 bil by 2030
- Markets in red are regarded as suitable to Vietnam
  - No need and impossible to participate in GVC of high-end chips (Data Center, Digital Devices, Cloud, AI)
  - Ecosystem should provide and prioritize STI on these markets, oriented for global market
- STI ecosystem: How to involve the parties
  - Govt
  - Supply
  - Demand

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Typical Policy Recommendation

- Nurture and improve STI ecosystem in Vietnam
  - Govt: open regulation framework, sandbox
    - Efficient allocation of resource
    - Rationale tech selection, relevant to the current development level + AI/ML analysis
  - Supply side: high-skilled workforce and elite R&D
    - Focus on some key tech, with priority
    - International collaboration
  - Demand side: more competitive and innovative firms
    - Small and medium tech startups: more incentive and less regulated
    - Big tech firms: more responsible + investment for strategic techs, M&A if necessary

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Conclusion

- IR4 context and challenges
  - Role of R&D activity and STI management capacity
  - STI ecosystem – a key leverage for new economy development in Vietnam
    - Higher added value in the Global Value Chain
  - Technological foresight: key factor for management
- Current economic growth of Vietnam
  - After 3 decades, saturated – need other way for new room to grow
  - STI – identified as the leverage
- STI-based development model
  - Technological foresight
  - Key factors in the STI ecosystem
- Some policy recommendation to strengthen STI
  - Govt, supply and demand in a whole framework

THANK YOU FOR ATTENTION !