FOURTH INDUSTRIAL REVOLUTION (FIRE): IMPACT ON EDUCATION AND SKILLS DEVELOPMENT

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Presented by:
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OUTLINE

1. Introduction: Technology and Progress
   - What is the Fourth Industrial Revolution (FIRe)?
   - What are the FIRe Frontier Technologies?
   - Specific Examples of Emerging FIRe Technologies

2. Potential and Perceived Impacts of FIRe
   - Sustainable Development Goals (SDGs)
   - Likely Unintended Consequences for the Philippines
   - Employment
   - Changing Nature of Work
   - Desirable Characteristics of Human Capital
   - Innovation Ecosystem

3. Ways Forward: Gardening Innovation
   - Preparing the Ground (Education)
   - Ensuring Quality Learning for All
1. INTRODUCTION

- Emerging FIRe poses a huge challenge to human resource development
  FIRe → rapid technology change → new business activities and/or changes in nature work

- In theory, technology affects job in three forms:
  - Human labor being replaced by technology
  - New jobs being created because of technology
  - Jobs being complemented by technology

- Over-all net effect of FIRe in the labor market and the economy will clearly depend on which effect is strongest.

- Some outlooks suggest that more jobs will be created than lost from FIRe, especially in Asia-Pacific (WB 2019; ADB 2018)

- Others (e.g. Butler-Adam 2018) suggest that more jobs will be displaced by technology compared to the number of jobs that artificial intelligence can create.
1. INTRODUCTION (2)

- It is deemed critical to have a better understanding of the FIRe and its frontier technologies which is a useful first step in formulating any strategies and interventions that will enable workers to cope with the challenges and also, take advantage of the opportunities that FIRe brings.

- Objectives
  - Explain about FIRe and its frontier technologies
  - Discuss FIRe potential and perceived impacts on the nature of work, and the entire labor market, as well as the future skills required for the Philippines’ labor force
  - Identify ways forward to improve the country’s preparation for the full impact of FIRe, particularly in human capacity development, aside from strengthening social protection for those who may have difficulty to cope with the emerging disruptions.
1.1. What is the Fourth Industrial Revolution (FIRe)?

• First came steam and water power; then electricity and assembly lines; then computerization. Throughout history, we have improved industry by migrating from established production methods to utilizing cutting-edge technologies.

1st Revolution
(1784)
Steam, water, mechanical production equipment

2nd Revolution
(1870)
Division of labor, electricity, mass production, assembly line

3rd Revolution
(1969)
Electronics, computers, internet, automated production

4th Revolution
(???)
Cyber-physical systems
1.1. What is the **FIRe** (2)?

“Characterized by a fusion of technologies that is blurring the lines between the physical, digital and biological spheres.” – Schwab (2016)

https://www.youtube.com/watch?v=LX8ucERD6RI
1.2. FIRe Frontier Technologies

Frontier technologies identified by select organizations

- No universally agreed definition of frontier technology
- It shows that the following technologies have been most commonly identified as frontier: 3D printing, the Internet of Things, AI, and robotics

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<thead>
<tr>
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<tbody>
<tr>
<td>Internet of Things</td>
<td>Fifth-generation (5G) mobile phones</td>
<td>Artificial intelligence</td>
<td>Mobile internet</td>
<td>3D printing</td>
<td>3D Metal Printing</td>
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<td>Big data analytics</td>
<td>Artificial intelligence</td>
<td>Robotics</td>
<td>Automation of knowledge work</td>
<td>Collaborative economy tools</td>
<td>Artificial Embryos</td>
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<tr>
<td>Artificial intelligence</td>
<td>Robotics</td>
<td>Internet of Things</td>
<td>Internet of Things</td>
<td>Alternative internet delivery</td>
<td>Sensing City</td>
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<td>Neuro technologies</td>
<td>Autonomous vehicles</td>
<td>Autonomous vehicles</td>
<td>Cloud technology</td>
<td>Internet of Things</td>
<td>Artificial intelligence for Everybody</td>
<td></td>
</tr>
<tr>
<td>Nano/micro satellites</td>
<td>Internet of Things</td>
<td>3D printing</td>
<td>Advanced robotics</td>
<td>Unmanned aerial vehicles/drones</td>
<td>Dueling Neural Networks</td>
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<tr>
<td>Nanomaterials</td>
<td>3D printing</td>
<td>Nanotechnology</td>
<td>Autonomous and near-autonomous vehicles</td>
<td>Airships</td>
<td>Babel-Fish Earbuds</td>
<td></td>
</tr>
<tr>
<td>3D printing (additive manufacturing)</td>
<td>Biotechnology</td>
<td>Next-generation genomics</td>
<td>Solar desalination</td>
<td>Zero-Carbon Natural Gas</td>
<td></td>
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<tr>
<td>Advanced energy storage technologies</td>
<td>Materials science</td>
<td>Energy storage</td>
<td>Atmospheric water condensers</td>
<td>Perfect Online Privacy</td>
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<tr>
<td>Synthetic biology</td>
<td>Energy storage</td>
<td>3D printing</td>
<td>Household-scale batteries</td>
<td>Genetic fortune-telling</td>
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<td>Blockchain</td>
<td>Quantum computing</td>
<td>Advanced materials</td>
<td>Smog-reducing technologies</td>
<td>Materials’ Quantum Leap</td>
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<td>Advanced oil and gas exploration</td>
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</table>

ESCAP (2018)
### 1.3. Specific Examples of Emerging FIRe Tech

<table>
<thead>
<tr>
<th>FIRe Tech</th>
<th>Specific Examples</th>
</tr>
</thead>
</table>
| **Robotics and AI** | • robots for building cars, assisting in surgery, and even vacuuming your floor while simultaneously entertaining your cat.  
• autonomous vehicles and drones, voice assistants and shopping bots.  
• autocomplete feature on smart phone, recommendations in websites when buying clothing, music, or household goods  
• ability of fb to recognize your face in a photo posted by friend and get tagged, and facial recognition in your Iphone X. |
| **IOT** | • devices connected to the Internet, about trillions of sensors communicating with these devices, and with one another. The connected devices, working with the sensors, monitor things like building elevators, checking them for current status and predicting failures before they happen |
| **3D-printing** | • make a tiny statue of yourself with the Pope.  
• print a transplantable organ, in a process called bioprinting.  
• print engine parts for cars, materials for houses, and more |
1.3. Specific Examples of Emerging FIRe Tech (2)

**BIG DATA**

- While big data has no definition, these digital footprints have **3Vs** *(Gartner 2001):*
  - **Volume**
    - Health records
    - Insurance
    - Transactions
    - Mobile sensors
  - **Velocity**
    - Batch
    - Near Time
    - Real Time
    - Streaming
  - **Variety**
    - Structured
    - Unstructured
    - Semi-structured
    - All the above

- Awash in a flood of data !!!: “drowning in numbers”
- Twenty-five years ago, the first SMS was sent. The world now sends 26 billion text messages every day—or 18.1 million every minute. We type 188 million emails, send 41.6 million messages on FB messenger and WhatsApp, and enter 3.8 million queries into Google every 60 seconds.
- From the beginning of recorded time until 2003, we created **5 billion gigabytes** (exabytes) of data. In 2012, data was reported to double every 40 months since the 1980s, with about 2.5 exabytes/(2.5 x 10^{18} bytes) of data being created per day. That is, 5 exabytes were then being created every 2 days.
- In 2016, around **16.1 zettabytes** of data has been produced — 1 zettabyte = 10^{21} bytes, enough to fill 80 billion 16GB iPhones (which would circle the earth more than 100 times). 20 exabytes were then being created every 10 minutes. By 2025, 163 zettabytes would be produced.

**DATA:** “the new oil”

**Information is power!”
1.3. Specific Examples of Emerging FIRe Tech (3)

Utilizing Big Data for Business

- **Predictive Modeling Association Rules and Collaborative Filtering**: Amazon using customer database to inform clients that “customers who bought Product A also bought Product B, and Product C …”

- **Sentiment Analysis**: Social media data, such as tweets on Twitter, are scrutinized in terms of “polarity” (i.e., positive, negative, or neutral) of sentiments on a product.

- **Text Analysis**: In Japan call center, agents input “what customers say” and instructions are then given to call center agents on workstations on “what to say”

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Top Brands Then and Now

<table>
<thead>
<tr>
<th>2007</th>
<th>2018</th>
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</thead>
<tbody>
<tr>
<td>Exxon Mobil</td>
<td>Apple</td>
</tr>
<tr>
<td>Petrochina</td>
<td>Google</td>
</tr>
<tr>
<td>General Electric</td>
<td>Microsoft</td>
</tr>
<tr>
<td>China Mobile</td>
<td>Facebook</td>
</tr>
<tr>
<td>ICBC</td>
<td>Coca Cola</td>
</tr>
<tr>
<td>Microsoft</td>
<td>Amazon</td>
</tr>
<tr>
<td>Royal Dutch</td>
<td>Disney</td>
</tr>
<tr>
<td>GazProm</td>
<td>Toyota</td>
</tr>
<tr>
<td>AT&amp;T</td>
<td>McDonalds</td>
</tr>
<tr>
<td>Samsung</td>
<td>Samsung</td>
</tr>
</tbody>
</table>

Improving Small Area Estimates of Poverty in PH

1.3. Specific Examples of Emerging FIRe Tech (4)

Utilizing Big Data for Development Purposes
Improving Small Area Estimates of Poverty in PH

- Reliable and timely data is crucial for targeting
- Quality data is needed in evaluating of “shocks” and of policies to poor
- Big data complements conventional data to ensure better devt outcomes

<table>
<thead>
<tr>
<th>LANAO DEL SUR</th>
<th>2006</th>
<th>2009</th>
<th>2012</th>
<th>2015</th>
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</thead>
<tbody>
<tr>
<td>Poverty Incidence</td>
<td>38.6</td>
<td>48.7</td>
<td>67.3</td>
<td>66.3</td>
</tr>
<tr>
<td>Coeff. of Variation</td>
<td>18.4</td>
<td>15.5</td>
<td>8.0</td>
<td>4.82</td>
</tr>
</tbody>
</table>

Albert (2018)
2. Potential and Perceived Impacts of FIRe

Sustainable Development Goals (SDGs)

<table>
<thead>
<tr>
<th>SDG</th>
<th>APPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture (SDGs 1, 2, 5, 8, 10 and 12)</td>
<td>Recent advances in image recognition allowed researchers to scan more than 50,000 photos of plants to help identify crop diseases at sites using smartphones with a success rate of over 99 per cent</td>
</tr>
<tr>
<td>Healthcare (Goal 3)</td>
<td>AI applications have been developed that substitute and complement highly educated and expensive expertise by analyzing medical images. 3D printing produce patient specific prosthetics, orthotic braces and customized medical implants.</td>
</tr>
<tr>
<td>Environment and climate (Goal 13)</td>
<td>AI and deep learning can help climate researchers and innovators test out their theories and solutions as to how to reduce air pollution</td>
</tr>
</tbody>
</table>
2. Potential and Perceived Impacts of FRIRe (2)

Likely Unintended Consequences in Philippines

<table>
<thead>
<tr>
<th></th>
<th>Economic Implications</th>
<th>Socio-Cultural Implications</th>
<th>Political &amp; Security Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Robotics and AI</strong></td>
<td>• Technological unemployment</td>
<td>• Rise of monopolies and oligopolies</td>
<td>• Political polarization</td>
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<td></td>
<td>• Income Inequality</td>
<td></td>
<td>• Instability</td>
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<tr>
<td></td>
<td>• Disruption of traditional business models and</td>
<td></td>
<td>• Data and access security risks to automation</td>
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<tr>
<td></td>
<td>global value chains</td>
<td></td>
<td>• Espionage, Terrorism, Autonomous warfare</td>
</tr>
<tr>
<td><strong>IOT</strong></td>
<td>• Disruption of traditional business models</td>
<td>• Erosion of personal privacy</td>
<td>• Lack of trust in institutions</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• Cybersecurity problems</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• Data fraud</td>
</tr>
<tr>
<td><strong>3D-printing</strong></td>
<td>• Disruption of existing business processes</td>
<td></td>
<td>• Weapons proliferation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Cyber-sabotage</td>
</tr>
</tbody>
</table>

Albert et al. (2018)
2. Potential and Perceived Impacts of FIRe (3)

Employment

Share of wage and salaried employment in key manufacturing subsectors at high risk of automation (per cent).

According to Chang and Huynh (2016), in the Philippines:

- nearly half (49%) of wage workers (males: 44%, females: 52%) face a high probability of getting affected by automation

- those working as fishery laborers (580,000), waiters (574,000), carpenters (525,000) and office cleaners (463,000) face a high potential of automation

- around 89 per cent of salaried workers in BPO sector fall into the high risk category of automation
2. Potential and Perceived Impacts of FIRe (4)

Changing Nature of Work

- Autor (2015) argues that **extent of machine substitution** for jobs tend to be **overstated** by ignoring strong complementarities which increase productivity, raise earnings and augment demand for labor
  - Case in Point: Bank Tellers were not replaced by ATMs when the latter started to get used in the 1990s

- Autor however adds that **even if automation does not reduce quantity of jobs, it may affect the qualities of jobs that are available**

- Policy implication: **human capital investments** must be at the **heart of any long-term strategy** on preparation for impact of technology on jobs
2. Potential and Perceived Impacts of FIRe (5)

Changing Nature of Work (2)

WB 2019 World Development Report

- Through digital transformation firms can grow rapidly (challenges traditional production patterns)
  - Digital platform enabling firms to reach more people faster

- Technology is changing the skills employers seek (complex problem-solving, teamwork, and adaptability)

- How people work and the terms on which they work is changing (short-term work, online platforms)

We know that tech can:
1. Substitute for labor
2. Create new jobs
3. Complement labor

Note: (a) overall net effect in labor market and economy depends on which effect is strongest. (b) rapidly changing classification: with AI and machine learning, what is not “codifiable” today maybe codifiable tomorrow; (c) people may not need “job security”
2. Potential and Perceived Impacts of FRIRe (6)

Changing Nature of Work (3)

10 Jobs Artificial Intelligence Will Replace
1) Telemarketers (99%)
2) Bookkeeping clerks (98%)
3) Compensation and Benefits Managers (96%)
4) Receptionists (96%)
5) Couriers (94%)
6) Retail Salespeople (92%)
7) Proofreaders (84%)
8) Computer Support Specialists (65%)
9) Market Research Analysts (61%)
10) Advertising Salespeople (54%)

(and 10 That Are Safe … for Now)
1) HR Managers (0.55%)
2) Sales Managers (1.3%)
3) Marketing Managers (1.4%)
4) Public Relations Managers (1.5%)
5) Chief Executives (1.5%)
6) Event Planners (3.7%)
7) Writers (3.8%)
8) Software Developers (4.2%)
9) Editors (5.5%)
10) Graphic Designers (8.2%)

https://blog.hubspot.com/marketing/jobs-artificial-intelligence-will-replace
2. Potential and Perceived Impacts of FIrE (7)

Changing Nature of Work (4)

10 Jobs Created by Technology That Didn’t Exist 10 Years Ago
1. Uber Driver
2. Social Media Managers
3. Airbnb Host
4. Cloud Service Specialist
5. YouTube Content Creators
6. App Developers
7. Driverless Car Engineer
8. Drone Operator
9. Millennial Generational Expert
10. Use Experience Designer

https://blog.nasstar.com/10-jobs-created-by-tech-that-didnt-exist-10-years-ago/

Opportunities have also been created. Philippines is 5th largest supplier of “online labor” acc to Online Labor Index (Kässi and Lehdonvirta 2018)
## 2. Potential and Perceived Impacts of FLRe (8)
### Changing Nature of Work (5)
*LinkedIn Future of Skills 2019 Report*

<table>
<thead>
<tr>
<th>Top Skills in PH</th>
<th>What do professionals with this skill do?</th>
<th>Demand vs average **</th>
<th>Top 5 industries</th>
</tr>
</thead>
</table>
| 1. Social Media Marketing        | Promoting products and/or services through social media platforms to achieve business goals                                                                                                                                                | 4X                   | • Marketing & Advertising  
  • Internet  
  • IT & Services  
  • Outsourcing/Offshoring  
  • E-learning |
| 2. Frontend Web Developing       | Converting data to a graphical interface to build websites or web apps                                                                                                                                                                 | 13X                  | • IT & Services  
  • Computer Software  
  • Outsourcing/Offshoring  
  • Internet  
  • Financial Services |
| 3. Human Centered Design         | Developing solutions to problems with a deep focus of understanding the human perspective in all steps of the process                                                                                                                                 | 5X                   | • IT & Services  
  • Marketing & Advertising  
  • Computer Software  
  • Design  
  • Internet |

2. Potential and Perceived Impacts of FIRe (9)

Desirable Characteristics of Human Capital

- Flexible, adaptive and agile human resources with skills on 4Cs:
  - Communication
  - Critical thinking and problem solving (including Self-management, Planning and Organizing)
  - Collaboration (i.e. Team-work)
  - Creativity and Innovation (including Initiative)

http://www.battelleforkids.org/networks/p21
2. Potential and Perceived Impacts of FIRe (10)

Desirable Characteristics of Human Capital (2)

- Workers who are trainable, creative and adaptable to rapid changes
  - Part-time and self-employment are integral components of emerging labor market
  - Employees who are stuck in manual and clerical works will likely be laid off if they fail to equip themselves with future skills
  - Workers likely to move from one work engagement to the next (with minimum costs); many may even have a number of careers
    - EdSurge, a LinkedIn executive, claims that people will likely change careers 15 times over their lifetimes.
2. Potential and Perceived Impacts of FIRe (11)

Innovation Ecosystem

Country Archetypes

- **According to World Economic Forum (2017) assessment of 100 countries future preparation, 7 ASEAN countries spread across three archetypes:**  
  - **Leading** — Malaysia and Singapore;  
  - **Legacy** — Philippines and Thailand; and  
  - **Nascent** — Cambodia, Indonesia and Viet Nam.

  - **Legacy country** - has a strong production base today, but at risk for future due to weaker performance across drivers of production, including tech and innovation, human capital, global trade & investment, institutional framework, sustainable resources, and the demand environment.
2. Potential and Perceived Impacts of FIRe (12)

**Innovation Ecosystem (2)**

- Investments in R&D, hard and soft infrastructure, as well as capacity development of human resources and institutions are complementary factors for improving innovation ecosystem, ensuring **Inclusive Development** and for enhancing our **Readiness for Future of Production**
- Learning from experiences of other countries
  - China’s HR investments in 1978
  - Singapore: Skills Future

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**Drivers of Production**

- **Structure of Production**
  - **North America**
  - **Sub-saharan Africa**
  - **Middle East and North Africa**
  - **Latin America and Caribbean**
  - **Europe**
  - **Asia and the Pacific**

**High Potential**

**Nascent**

**Legacy**

WEF (2017)
2. Potential and Perceived Impacts of FIRe (13)

Innovation Ecosystem (3)

Innovation is widely regarded as a major driver of economic output, productivity and competitiveness … but not all firms innovate in Philippines.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>PHILIPPINES 2009 SIA</th>
<th>PHILIPPINES 2015 PIDS</th>
<th>ALL COUNTRIES 2015 WORLD BANK ENTERPRISE SURVEY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of firms that introduced a new product/service</td>
<td>37.6</td>
<td>30.7</td>
<td>32.9</td>
</tr>
<tr>
<td>Percent of firms that introduced a process innovation</td>
<td>43.9</td>
<td>30.6</td>
<td>40.9</td>
</tr>
<tr>
<td>Percent of firms that spend on R&amp;D</td>
<td>40.3</td>
<td>26.7</td>
<td>21.9</td>
</tr>
</tbody>
</table>
3. Ways Forward

Preparing the Ground: Education

- watering (finance, support to innovators)
- removing weeds (competition, deregulation)
- nurturing soil (research, information)
- preparing the ground (education)

World Bank (2010)
3. Ways Forward (2) - Preparing the Ground: Education (2)

- Skills and competencies developed in school should be like LEGO blocks which can be used to create different figures using the same building blocks.

- Need for lifelong learning, continuous training and retraining; the only way to keep up is to continuously learn, unlearn, and re-learn.
  - A key skill is “learning how to learn.”

- Pedagogy should go beyond transmitting knowledge into encouraging reconstruction of knowledge.

WEF (2015)
3. Ways Forward (3)
Ensuring Quality Learning for All

Issues in PH Educational System

- Curricular changes in basic education (through K-12), tech-voc and higher ed, but are these “future-ready”?
- Currently basic education struggles to achieve mastery in core competencies (MPS < 50% in NAT)
- Low passing rates in professional board examinations (around 40%)
- Enterprise-based training, a critical component, very insignificant (3% of total graduates)
- Training Certificates that are not valued by employers

How Much Has Really Changed?

Laurentius De Voltolina depiction of 14th century lecture, The Yorck Project
3. Ways Forward (4)

Recommendations

- Back to basics (3Rs: reading, writing, ’rithmetic; science and 4Cs) in basic education; plus work-integrated learning in tech-voc and higher education for “systems thinking”

- Make education and training respond to needs of industry (e.g., creating new fields such as “data science”) and experiment with assessments (simulations, games).

- Provide incentives for enterprise-based training, and for industry to value “training certificates” (especially from well-known MOOC providers such as Coursera)
3. Ways Forward (5)
Recommendations (2)

- Study
  - What works and what doesn’t to foster “flexibility” in workplace
  - Diagnostics for measure “soft skills”
  - Digital platform workers, the Platform Economy and Creative Economy

- “Whole-of-government” mechanisms across DepED, CHEd and TESDA for improved planning and for upscaling models that work (e.g. Dynamic Learning Program of Christopher and Ma. Victoria Bernido)

- Build systems for life-long learning
Preparing the Philippines for the Fourth Industrial Revolution: A Scoping Study
(PIDS Discussion Paper 2018-11)

Harnessing government’s role for the Fourth Industrial Revolution
(PIDS Policy Note 2018-14)

Papers During PIDS Annual Public Policy Conference on FIRe

Video: https://www.youtube.com/watch?v=LX8ucERD6RI

[ Thank you ]

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