IBIMA Publishing
IBIMA Business Review
http://www.ibimapublishing.com/journals/IBIMABR/ibimabr.html
Vol. 2015 (2015), Article ID 375305, 16 pages
DOI: 10.5171/2015.375305

Research Article

Egypt National Railways: ICT Can Save Egyptian Lives

Amr H. Badr-El-Din[1] and Ramy A. Fathy[2]

[1]Management Information System
The American University in Cairo, Cairo, Egypt

[2]Digital Services Policies, NTRA, Cairo, Egypt

Correspondence should be addressed to: Amr H. Badr-El-Din; abadreldin@aucegypt.edu

Received date: 12 September 2014; Accepted date: 23 December 2014; Published date: 10 July 2015

Abstract

Since 1992, the Egyptian National Railways (ENR) has been encountering tremendous losses in lives and revenues. The losses were due to the lack of a proper IT infrastructure, making the network unqualified to handle the millions who use its railways every day. The safety measures along ENR's 6,700 kilometers of railways network have been managed by human operations, which makes railway transportation too risky. When he came into office as Minister of Transport in 2010, Alaa Fahmy put safety as the highest priority. The intention of this research case is to investigate and showcase how ICT centric short term strategic actions combined with ICT centric long term strategies and reforms can be adopted to solve the eminent problems of safety and efficiency in the Egyptian railway sector. A one year longitudinal participant observation methodology has been adopted in this research case data collection process where the study was conducted in an uncontrolled observational manner to minimize any interference or manipulation to the real-life setting. Investigation has revealed that by focusing on ICT centric strategic actions that enhance the sources of the competitive advantage of the transport sector in Egypt, in addition to implementing long term strategies that are expected to boost the competitive advantage of the transportation sector in Egypt; a tenth of a minute operation risk factor of 0.01%-0.001% has been realized. This factor is in compliance with the IEC international standard for electrical, electronic and programmable electronic safety-related systems. Furthermore, safety measures, reflected by the very low reported number of causalities during the study period, was ultimately improved

Keywords: Automatic Train Protection, Competitive Advantage, Egypt National Railway, Public Strategy.

Introduction

Having successfully led Egypt Post for four years (Mar. 2006 to Jan. 2010) to becoming ranked third worldwide in the UPU congress elections after three years of his rein, Eng. Alaa Fahmy was appointed to lead the Ministry of Transport in January 2010.

In January 2010, when Alaa Fahmy came to office he felt quite uneasy about the loss of

Cite this Article as: Amr H. Badr-El-Din and Ramy A. Fathy (2015)," Egypt National Railways: ICT Can Save Egyptian Lives ", IBIMA Business Review, Vol. 2015 (2015), Article ID 375305, DOI: 10.5171/2015. 375305

lives on the ENR. It took him three months of contemplation, but by the end of the period, he decided to change the strategy of the Ministry to safety first. Under Alaa Fahmy, one died and one got injured in September 2010 in Sandub. Indeed, Fahmy's strategy prioritized safety and used technology for safer trains, which was reflected in the low number of human losses compared to losses in other years.

On the morning of March 10, 2010, three months after Alaa Fahmy had been sworn in as the Minister of Transport, he sat in his office and gazed through the window; the last three months had been very stressful for Fahmy and the ministry's senior management. Living up to his reputation for turning around Egypt Post, "sometimes with blood on the walls," Fahmy had already taken aggressive moves in restructuring the Ministry.

Feeling a great responsibility on his shoulders, Fahmy told his senior consultant for technology that they were now responsible for around 2.3 million people traveling in trains per day. "Their lives are our responsibility," he said. Based on this very statement, the whole strategy behind the ENR changed. Fahmy changed the Ministry's focus to a "safety first" policy, even if it came at the detriment of other things like punctuality. According to Goldfinch (Goldfinch, 2013), between 2006 and 2010, three major train accidents occurred, killing 165 people. The following year, and due to the results of Fahmy's adopted strategies which will be presented in this paper, in 2010-2011 there was a single death and single injury and not because of any train accidents.

Losses in Revenue and Losses in Lives: The Problems of ENR

For over two decades, the ENR, the entity that governs the railway sector in Egypt, has been encountering tremendous losses, both in lives and in revenues. The revenues generated by the railway sector are used to fund ENR, which is an Economical Public Authority and a subordinate to the Ministry of Transport (MoT). Surpluses generated, if any, are directed to the government.

Losses in Revenue

According to (UK Trade & Investment, 2010), "Egypt is considered the largest railway market in the Middle East and Africa with around 6700 km of railways network". Despite this high market potential for the railway industry in Egypt, the ENR has been operating with major losses. According to a policy note (Baeumler, 2005), ENR has not been covering its operating costs, "between 2000 and 2004, operating losses ran about 30 percent and 60 percent of revenues before interest payments to about 100 percent after interest payments." In addition, in 2004, the annual operating loss was estimated at EGP[1] 1,404 million. As for the duration between 2000 and 2004, the cumulated operating losses were EGP 4,560 million. Baeumler stated that, "ENR simply does not generate enough cash flow from operations to be profitable," (Baeumler, 2005), adding that cash flow has been negative between 2000 and 2005, except for the year 2002.

According to a report on Egypt's economic status by the Organization for Economic Co-operation and Development (OECD), Egypt's transportation problems are due to the equipment's quality, maintenance and security. Indeed, there is serious lack of investment in railways (Organisation for Economic Co-operation and Development OECD, 2006).

Losses in Lives

In addition to its financial losses, ENR has witnessed losses in lives as well, making it a grave burden on Egypt's public sector. Between train collisions and derailments, railway accidents have killed over 1,500 people since 1993 (El-Masry, 2013). Referring to the loss in life and revenue (Carr and Adam, 2014) mentioned that "The Egyptian National Railways (ENR) is a staggering behemoth that employs almost 70,000 people and transports some 1

[1] (1 USD) is approximately equal to (6.03 EGP) at December 2004 according to the Egyptian Central Bank Records.

million passengers on 1,300 daily services, making spectacular losses in the process."

According to Goldfinch, Egypt has one of the worst railway records worldwide. "Accident followed accident, one disaster followed another, and trains transport their passengers to death. The railways granted time to some, and souls were lost without guilt, but Egyptian officials were still not alarmed and no price was put on the blood of Egyptians that spilled on the tracks," (Goldfinch, 2013).

Yahia Shamalah, chairman of the Central Administration of Railway Engineering, argues that the main reason why accidents happen is due to people's behavior. He explained that there are the formal track crossings and then there are other illegal crossings built by the people. The Egyptian Railway Authority only supervises the first type, the formal crossings. The second type, which is essentially built to facilitate transportation of carts, is left unsupervised except by the people living in these rural areas. Shamalah also mentioned the problem of robbery. He said that switchers, metal nails and steel are stolen from railway lines, generating losses of EGP 38 million in 2012, also causing train accidents as a result (El-Masry, 2013).

The president of an independent railway workers syndicate, Mohamed Abdel Sattar, said that financial and administrative corruption is another problem facing ENR and in his opinion is the main reason why train accidents happen. He also attributed the losses to the lack of training for the workers, as well as the misallocation of resources that prevents proper maintenance (El-Masry, 2013).

The human errors continued to be responsible for losses of lives long after the period under study (2006-2010). On November 17, 2012, a train hit a school bus near Manfalut in central Egypt killing 50 children. The BBC stated that Egyptian roads and railways "have a poor safety record" (BBC News, 2012). Also, on January 15, 2013, a train derailment in Cairo killed 19 (BBC News, 2013). This incident pushed Egyptian critic Hamdi Qandil to state that the railway situation in Egypt cannot be fixed, but needs to be completely changed (Ahram Online, 2013).

Problem Statement

The intention of this research case is to investigate and showcase how ICT centric short term strategic actions combined with ICT centric long term strategies and reforms can be adopted to solve the eminent problems of safety and efficiency in the Egyptian railway. Such strategies leverage theories of competitive advantage and corporate strategy to ensure the long term competitive sector's sustainability.

A one year longitudinal participant observation methodology has been adopted in this research case data collection process where the study was conducted in an uncontrolled observational manner to minimize any interference or manipulation to the real-life setting. The setup was applied on a total of around 15000 employee responsible for the operation, maintenance, and business process of 6700 KM railway network tracks.

A close non-invasive observation for the impacts of the conducted strategies on the performance and safety measures have been conducted in the research and data results has been gathered and analyzed using multiple reliable information sources.

2006-2010: A Focus on Revenues

All the aforementioned problems culminate into grave safety concerns and substantial losses in revenues. Since 2006, the MoT has been focused on both targets. However, which target was the priority, was subject to the Ministers' views during the period. Between 2006 and 2010, the Ministry opted for a revenues first approach. Once revenues were guaranteed, they would be used to increase safety. In 2010, the priority changed to a safety first approach, even with more losses in revenue.

Between 2006-2010, the focus of the MoT was on generating revenues, which in turn

was based on increasing the number of trains operating on the railway by decreasing the headway time between two successive trains. Although this meant that the safety was compromised to a degree, it also meant more operating trains, and thus more revenue for the railway sector. Indeed, in two years, the railway sector started generating profits after it had been losing for years.

During that period, specifically in 2006, policy recommendations by the World Bank dictated a restructuring plan by the government that led to the creation of eight subsidiary companies to carry out reforms that encompassed maintenance of the trains, cleaning, real estate management, and information technology. This happened after the law that formed ENR in 1980 was amended in 2006, in a way that allowed ENR to "grant public utilities contracts to investors" (Carr & Adam, 2014).

At that time, (between 2006 and 2010) MoT's strategy was geared towards generating revenues. Only when revenues had been generated would the Ministry then restructure the ENR in such a way so as to improve its safety standards.

Safety before 2010

Despite the revenues generated between 2006 and 2010, or rather because of the way revenues were generated, trains were less safe. The most famous incident was Al Ayyat train collision that killed 30 people in 2009 (see Figure 5). The accident occurred because railway operations were based on human operations and minimal ICT infrastructure, which the railway workers did not make use of. On 24 October 2009, a cow was crossing the railway when it was hit by a train. The safety alert system which had not changed since 1905 (Nasr-El-Din, 2006)—the year when the British inaugurated the railway—consists of red balloons that should be set off along 2 kilometers by a railway worker. The system was designed so that the following train should see the balloons and decelerate to prevent collision. In this case, the railway worker did not set off the balloons, the worker responsible for reporting the accident was not at his office, and the driver of the following train, coming at a speed of 120 km/hour had shut down his alarm device. The human error in this case example was the direct cause of loss of so many lives.

Andrea D'Ariano explores real-time control of train schedules in the Netherlands. She states that transport operators manage the train traffic, and may re-schedule delayed trains starting from the next station. She mentions real-time monitoring of "track occupation and clearance" (D'Ariano, 2008). In parallel, transport operators are responsible for this operation in Egypt. The human operations become problematic when an employee does not do his job, or in case of emergencies like when a train stops. In that case, fast response is required in a risky operation ultimately controlled by humans.

Between 1992 and 2013, tens of people died from train collisions and derailments yearly, with a few exceptions (1996, 2001, 2003-2005, 2007, 2010). The highest number of deaths occurred in 2002 when 373 died in Al Ayyat train collision. The highest number of injured (between 1992-2013) took place in Alexandria in 2006 (see Figures 5 and 6).

The World Bank Loan for ENR

In 2007, ENR launched a project that included modernization of management and operation, and also the renewal of signals, centralized control systems and tracks. This project was possible because of an agreement with the World Bank on a USD 270 million loan to the government for the restructuring project, that later increased by USD 330 million (see Figure 4) (Carr & Adam, 2014).

The World Bank process to approve the ENR's was a lengthy and complicated process (Refer to Figure 3). The process started by a feasibility study and an initial study. Once the Egyptian Ministry of Transport approved, a formal request was sent to the Ministry of International Cooperation, followed by the Prime

Minister's approval, The President's and finally El Shoura council and the Parliament's approvals.

Given its losses, the World Bank provided ENR with a loan of USD 600 million in 2007 to improve the network signaling in two stretches along its widespread network (see Figure 4). According to UK Trade & Investment's sector briefing, "the loan's duration is 30 years, with 5 years grace period, at an annual rate of 1.5%".

According to Boulos Salama, Professor of Railways at Cairo University's Faculty of Engineering, the restructuring plan that was launched since 2006 solved the revenues problem, and the government made EGP 9 billion over three years (Railway Gazette, 2007). He said that the priorities for the restructuring works were the double tracking of 55km of the main railway line between Alexandria and Borg El Arab in the west. In addition, the plan included replacing the mechanical signals that were still being used on 85% of the railway networks.

According to the World Bank agreement, the bank provided ENR with USD 330 million for replacing the mechanical interlocking on the Beni Sueif - Asyut line (250 km) and USD 270 million for replacing the electro-mechanical interlocking on the railway line between Arab El Raml and Alexandria (162 km) (see Figure 4).

Concerning the proposed changes on the Beni Sueif-Asyut line, the bank loan would finance the supply and installation of signaling equipment (The World Bank, 2010). According to the agreement, the modernization of the signaling system included the installation of a computerized Central Traffic Control (CTC) for the line. The computerized system consisted of an automatic block signaling system on the railway line, electronic interlocking systems at the train stations, as well as a level-crossing protection system. In addition, the railway staff would have access to computerized information about train circulation, a graphic presentation of the trains, event recording, as well as dispatcher communications (The World Bank, 2010).

The modernization of the signaling system; however, would not enhance the safety of the railway system since, at the core of the operation, the system still relied on manual human intervention when it comes to notifying the actual locations of the trains. Operators at the CTC while connected to the train drivers through wireless means, would update the trains' locations manually on the trains location panel and communicate with the field operators responsible of the interlocking systems with any necessary command and control procedures.

It was obvious that the allocated items for the project needed to be changed to reflect the true needs of ENR in enhancing the safety of the rail way transportation system. However, given the complicated nature of the World Bank process for allocating funds, it was imperative not to change the overall allocated budget for the project. In addition, since the process had already been started, it was necessary to negotiate with the potential applicants – who would execute the project– any potential project amendments.

Getting the House in Order

Besides laying-off redundant and highly paid personnel, Fahmy restructured the ministry's departments (see Figure 1).

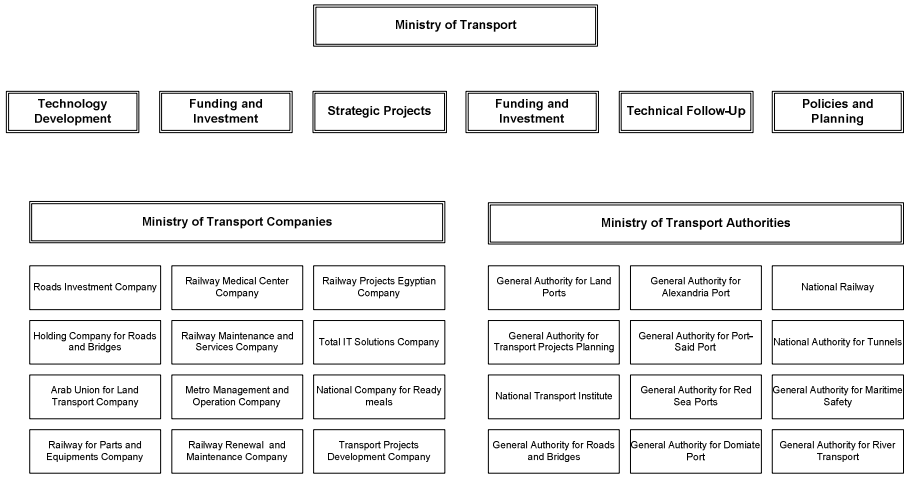

Figure 1: Ministry of Transport Restructure

He divided the tasks between public authorities and private companies and initiated a strategy of Public-Private Partnership (PPP), which refers to a cooperation between the private and the public sector.

In his restructuring strategic plan, Fahmy also defined multiple functional layers for the different transportation means (buses, trains and ships) as well as the relation between them (see Figure 2).

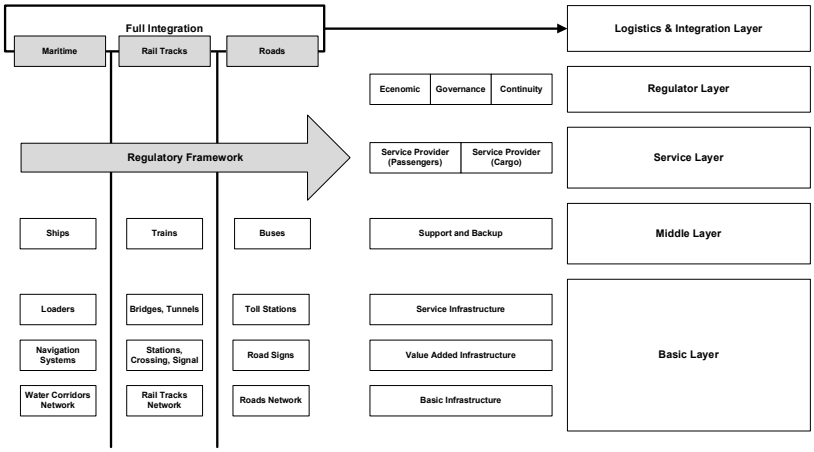

Figure 2: Ministry of Transport Reform Structure

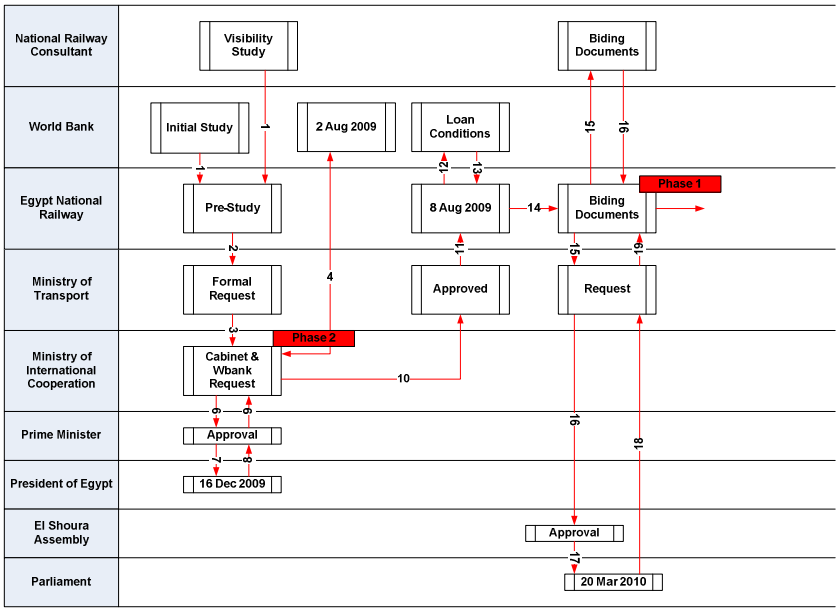

Figure 3: World Bank Process to Approve ENR Loan 2007-2010

As an example, for trains, the basic layer is the infrastructure layer that consists of three sub-layers: service infrastructure (bridges and tunnels), added value infrastructure (stations, crossings and signals) and basic infrastructure (rail tracks network). In his vision, the government would be the sole entity responsible for the infrastructure layer, however, private companies could be beneficial participants in the super-structure layer through the production of the trains. In sum, this was more or less the revenue-based strategy that he envisioned.

Stimulating Competitive Advantage

Numerous theories have been reported over the past two decades about the sources of competitive advantage. Much of these theories were developed to explain and help stimulating the competitive advantage of firms in the private sector. These strategies can be tweaked however to be applied in the public transportation sector.

The dominant model in the field during the 1980s was the competitive forces approach developed by (Porter, 1980). This approach emphasizes the actions a firm can take to create defensible positions against competitive forces. A second approach, referred to as a strategic conflict approach focuses on the competitive market product imperfections, and entry prevention strategies while employing other tools of game theory to keep the rivals at a disadvantage (Shapiro, 1989). Actions like strategic investments, pricing strategies, and the like are foreseen to be some effective tools that can realize the objectives of this approach. Both the competitive forces and the strategic conflict approaches appear to have the common perspective that advantageous firm position can be attained from gaining a privileged product market positions with respect to the competitor products.

On the other hand, some alternative approaches focus however on building competitive advantage through employing entrepreneurial activities, and exploiting fundamental firm-level efficiency advantages. One thread of this literature, often referred to as the 'resource-based perspective,' emphasizes as mentioned in (Teece, Pisano, and Shuen, 1997) on the firm-specific capabilities and assets and the existence of isolating mechanisms as the fundamental determinants of firm performance (Penrose, 1959), (Rumelt, 1984), (Teece, 1984), and (Wernerfelt, 1984).

Another component of this efficiency-based approach is developed by (Teece, Pisano, & Shuen, 1997). Elementary efforts are made to identify the dimensions of firm-specific capabilities that can be sources of advantage, and to explain how the combinations of firm-specific competences and resources can be developed, deployed, and sustained. This concept is denoted the 'dynamic capabilities' approach in order to stress that existing internal and external firm-specific competences are utilized to address surrounding changing environments. Elements of this approach have been reported to include the works of (Schumpeter, 1942), (Penrose, 1959), (Nelson & Winter, 1982), (Prahalad & Hamel, 1990), (Teece, 1976), (Teece, 1986 a), (Teece, 1986 b), (Teece, 1988), and (Hayes, Wheelwright, and Clark, 1988).

Adopted Methodologies

In an effort to analyze the actions conducted by the MoT during Fahmy's ministerial period, an adapted form of the 'dynamic capabilities' approach is observed to be apparently applied in his strategic actions and reform endeavors. With a more ICT centric strategy, the 'ICT based Dynamic Capabilities', approach is foreseen to be the key strategic reform action employed during this period where the internal and external firm-specific competences is exploited through adopting an ICT based operation and management. Employing ICT, as the core tool for effectively managing the firm competences and exploiting the capabilities of the firm resources; was one fundamental strategic enhancement tool observed to complement the 'dynamic capabilities' approach.

Employing the competitive forces and the strategic conflict approaches in the public domain could be a tricky strategy and especially in the transportation sector. Situations of monopoly and the lack of a clear identification of potential competitors operating in this sector can deem these models irrelevant to the case of the Egyptian railways. By employing game theoretic concepts and intra-governmental competition between employees (e.g. concepts of strategic conflict approach), a reward based scheme can trigger the widespread eagerness to adopt competitive forces and strategic conflict strategies amongst different sectors of the public institution which might ultimately lead to their overall inefficiency.

Resource based strategies, on the other hand, are the most straightforward strategies that can be applied in the reported case. However, they do lack the dynamicity of creating a competitive atmosphere which in some instants, create a defensive attitude between employees while in other instants create a sustainable, collaborative, and synergetic environment.

Accordingly instead of employing tools of strategic conflict techniques, or resource based strategies, a strategic 'Trophy of the House' model was observed to have been successfully adopted as a notable short term strategy. In such an approach policies and strategies had been adopted to stimulate competition between governmental agencies, however, with an overall target of realizing the highest overall effectiveness and efficiency of the transportation sector as a whole. Employees could compete with each other to win the 'Trophy of the House', by increasing their effectiveness and efficiency of their achievements and claim the honor of being a fundamental driver for realizing the overall sector objectives. Innovation management tools and ERP systems were used to manage the overall process.

On the other hand, long term ICT centric strategies were established to enhance the agency's specific competences related to safety insurance and reliable operation. It was thus perceived that 'ICT based dynamic capabilities' model does bring the required innovation, effectiveness, and efficiency to the strategic management ecosystem of the ministry along with its agencies.

Adopted Strategies and Reforms

Fahmy's more immediate concern, and his top priority was safety. By focusing on ICT centric strategic actions that enhance the sources of the competitive advantage of the

transport sector in Egypt, he undertook eminent short term actions that focused on solving the issues of safety and efficiency in the railway sector, while advising to implement long term strategies that are expected to boost the competitive advantage of the transportation sector in Egypt.

March, 2010, Safety First: Short Term Strategy

On a short-term basis, Fahmy took two decisions: "the clean kilometer" which concerns the functionality of the equipment on board the trains and "the empty block" which concerns the difference in departure time between two trains. On a long-term basis, Fahmy changed the agreement with the World Bank in order to reallocate the USD 600 million loan to fund the usage of ICT for railway transportation, which would consequently improve safety.

Within the short-term strategies, "the clean kilometer" implied doubling the salaries of train drivers provided they made sure that all their train equipment worked effectively. This included the regular checkups of the onboard safety equipment like alarm devices used by drivers for emergencies, as well as cleaning equipment. "The clean kilometer" concept is based on Robert Kaplan's idea of the balanced scorecard in addition to the 'strategic Trophy of the House' concept.

Kaplan aimed at measuring and managing the intangible assets for better management (Kaplan, 2010). The balanced scorecard is a comprehensive management system which enables organizations to develop their vision, mission, and strategy and translate them into action. It provides feedback around historical financial records, and potential strategic indicators which are foreseen to direct a business towards future success. Internal business processes and external outcomes are accounted for in order to continuously improve performance and results.

Fahmy focused on developing critical Key Performance Indicators (KPIs) that follows Kaplan's balanced scorecard formulation, with a stress on internal business process performance by means of innovative business measures. By tying bonus salaries for these drivers with these KPIs, a trophy concept was developed which triggered a healthy competitive wave between different train lines and the wave cascaded to other agencies related to the MoT. ICT tools were used to manage the KPIs, and link performance with compensation.

Fahmy's second decision, "the empty block" entailed that no train would move before the preceding train reached the next station. Prior to this policy, trains would be directed to move within stations by railway workers in the operating room. The operator would call train drivers to ask where they were, and according to their location he would direct other trains what to do, making sure there is enough distance between them. In the case of single tracks, the operator's role became even more essential: to inform the train driver that another train was heading towards him and guide him into a secondary track until the second train has passed. In the meantime, the operator would inform the worker responsible for diverting the rails for the first train to park. Such an operation was totally reliant on humans.

In the implementation of Fahmy's "the empty block" concept, operations were still kept in the hands of humans, but with the maximum possible operational safety. Given that a train has to arrive to the next station before the following train moves, it makes the headway time (time between two consecutive trains) enough to prevent any train collision. Again, ICT tools were developed to model the impact of such strategies on the overall safety indicators of the sector versus the foreseen negative impact on the revenues.

March, 2010, Safety First: Long-Term Strategy

In the long-run, the major change in ENR that Fahmy wanted to make was to introduce ICT in a form of the Automatic Train Protection System (ATPS) which he asked his senior consultant for technology to explore. According to the latter, the

system cost USD 100 million and would cover the total length of the railway from Alexandria to Luxor, making use of part of the World Bank loan. As mentioned above, the World Bank loan was slated to modernize the signaling for two specific stretches (see Figure 4). The new system would take three years to install and start operating. The first year, ENR would buy the ATP and the installation would take place during the following two years. It would operate from Alexandria to Luxor, which includes the railway between Alexandria and Cairo, the busiest section in Egypt's railway network (Thales Group, 2013).

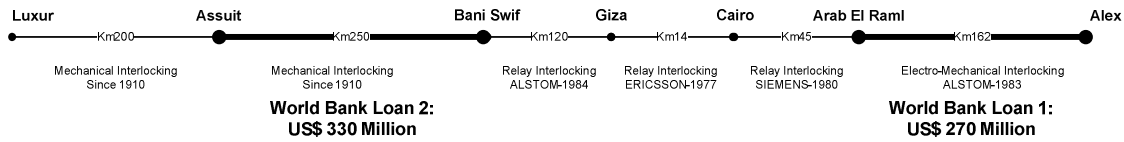

Figure 4: Allocation of the World Bank Loan

From a technical perspective (see Figure 8) ATP operates through an RFID tag on the railway track located every kilometer and an RFID reader inside the train. The tags are fixed on fiber cables and connected to a computer system. Each tag is marked by position, in other words at which kilometer it is located – a tag has an identity defined by its location. The readers are connected to a control room where all the tags are being read. Therefore the ATP is based on the transmission of signals and information between operating trains and a central electronic control room. It stops the train from exceeding a maximum speed and adjusts the speed to an appropriate level when it comes close to STOP signals. For example, if a train passes the STOP signal illegally, the brakes will be automatically applied (The Automatic Train Protection (ATP) Program, 2011). In addition, the ATPS would define the appropriate speed for a train as it approaches a train in front of it. It sends a signal to the driver to lower the speed. If the driver does not react, the train would automatically decelerate to reach the required speed.

In his ATP case study about emergency message handling, Johannes Faber explains that ETCS is an international train control system by the European Commission (Faber, 2005). It is used to maximize railway safety and to improve track use by ensuring cross-border interoperability. He states that the ETCS applied at a level 3 (the second safest implementation level) uses a Radio Block Center (RBC) that controls train traffic in defined areas and grants "movement authorities (MA)" (Faber, 2005) to trains. The communication between the RBC and the trains operates using a GSM-R radio connection (Faber, 2005). Faber explains that ETCS aims at increasing the possible traffic density, while keeping the traffic safe. He states, "Therefore the moving block principle is used, by which the MA's are always given up to a position known as the safe rear end of the preceding train. This allows trains to minimize the gap between them." (Faber, 2005).

Faber gives an example: if an accident of a first train occurs while the minimum distance is maintained, ETCS allows the following trains to stop before reaching the first train. The ETCS operates as follows: the first train sends an emergency message to the RBC. Once the RBC receives it, it sends it to all the trains that are coming close to the first train. If the train drivers do not apply the brakes for any reason, the breaks are automatically applied by the ETCS. The message is transmitted to the train drivers through visual and audible alerts (Faber, 2005).

On another note, there are international standards that determine the safety level of railway transportation. Indeed, automatic systems need to be properly monitored in

order to ensure that they operate correctly (Carbone, 2011). The International Electro-technical Commission (IEC) is a worldwide organization for standardization. IEC standards requirements for electrical, electronic and programmable electronic safety-related systems indicate four Safety Integrity Levels (SIL), ranging from 1 to 4, with 4 being the safest (see Figure 7), (Carbone, 2011).

Each SIL level defines two parameters: probability of failure on demand (PFD) and risk reduction factor (RRF). PFD refers to the likelihood that a system failure occurs when asked to perform an operation, and RRF refers to the extent to which risk can be decreased by using a system with the corresponding SIF (Carbone, 2011) (Carbone, 2010). The SIL level for a system is maintained by keeping the PFD the same. A "fail safe" concept is applied by stopping all trains at once for a few minutes, which allows the system to reset with the original probability. Such a strategy is used to ensure that no system failure occurs, even within the corresponding probability level for the operating system.

Egypt uses a system that operates with an SIL level 0 because it does not use ITC, given that the railway operation depends on humans. The use of ATPS in Egypt can make the system reach SIL level 4. The use of ATPS can prevent all such tragic accidents by transforming railway operations from manual to automatic, with international safety standards, hence saving lives.

'ICT based dynamic capabilities' model can be seen as an effective tool of incorporating ICT to exploit the internal and external firm-specific competences. Incorporating ICT in the core management and operation of the organization, had the potential impact of shifting the safety level of ENR from SIL level 0 to SIL level 4, using a single core step; which has a definite impact on saving lives.

Observed Results

According to the internal reports produced at the MoT on the number of deaths and injuries resulting from railway collisions during the period from 1992 to 2013 (Ministry of Transport, 2013), it is observed that a reported figure of a single death and a single injury has occurred during 2010 – 2011; i.e. during the study period (see Figures 5 and 6). Investigations on the source of causalities have furthermore revealed that these reported incidents were not due to any train collisions or operational hazards.

Minister	Place	Month	Year	Death	Injured	Year	Death	Injured
			1992	43	0	**1992**	**43**	**0**
			1993	40	0	**1993**	**52**	**60**
	90Km from Cairo	12	1993	12	60			
			1994	40	0	**1994**	**115**	**0**
	Two Delta Trains	3	1994	75	0			
	Northern Cairo	2	1995	11	0	**1995**	**135**	**0**
	Qwesna	4	1995	49	0			
	Beni Suef	12	1995	75	0			
			1996	0	0	**1996**	**0**	**0**
			1997	21	0	**1997**	**32**	**0**
	North Aswan	2	1997	11	0			
	Kafr El Dawar		1998	50	80	**1998**	**50**	**80**
	Northern Egypt	4	1999	10	50	**1999**	**20**	**57**
	Qalyubiya	11	1999	10	7			
	Southern Cairo	12	2000	9	2	**2000**	**9**	**2**
	Marsa Matrouh	10	2001	0	0	**2001**	**0**	**0**
H.E.Ibrahim El-Demiri	Al Ayatt	2	2002	373	0	**2002**	**373**	**31**
	Manashi	3	2002		31			
			2003	0	0	**2003**	**0**	**0**
			2004	0	0	**2004**	**0**	**0**
			2005	0	0	**2005**	**0**	**0**
	Alexandria	2	2006	0	20	**2006**	**71**	**239**
	Sharqiya	5	2006	0	45			
	Qalyoub	8	2006	66	144			
	North Cairo	9	2006	5	30			
	Aswan	9	2007	0	0	**2007**	**0**	**0**
	Tahta	4	2008	1	2	**2008**	**61**	**74**
	El-Balah	5	2008	0	0			
	Benha	7	2008	2	2			
	Marsa Matrouh	7	2008	58	60			
	Etay-El-Barud	10	2008	0	10			
	Maintenance Workshop	5	2009	2	10	**2009**	**33**	**79**
	Misr Terminal	7	2009	0	3			
	Farshut	10	2009	0	5			
H.E.Mohamed Lotfy Mansour	Al Ayatt	10	2009	30	55			
	Abnud	11	2009	1	6			
H.E.Alaa Fahmy	Sandub	9	2010	1	1	**2010**	**1**	**1**
	El-Asiret	7	2011	1	0	**2011**	**2**	**0**
	Beni Suef	8	2011	1	0			
Egyptian Revolution		10	2012	6	0	**2012**	**60**	**63**
	Fayoum	11	2012	3	46			
H.E.Mohamed Rasha El Matini	Manfalut	11	2012	51	17			
	Badrasheen	1	2013	19	120	**2013**	**19**	**120**

Figure 5: Deaths and Injured from Railway Collisions by Date, and Place, 1992-2013

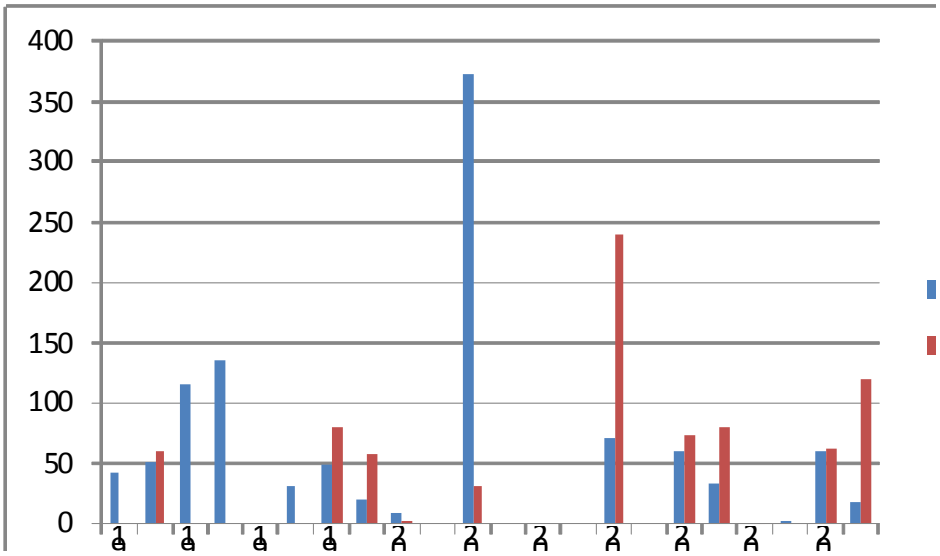

Figure 6: Number of Deaths and Injured, 1992-2013

SIL	PFD	RRF
1	0.1-0.01	10-100
2	0.01-0.001	100-1000
3	0.001-0.0001	1000-10,000
4	0.0001-0.00001	10,000-100,000

Figure 7: Safety Integrity Level (SIL) as a Function of Possibility of Failure on Demand (PFD) and Risk Reduction Factor (RRF)

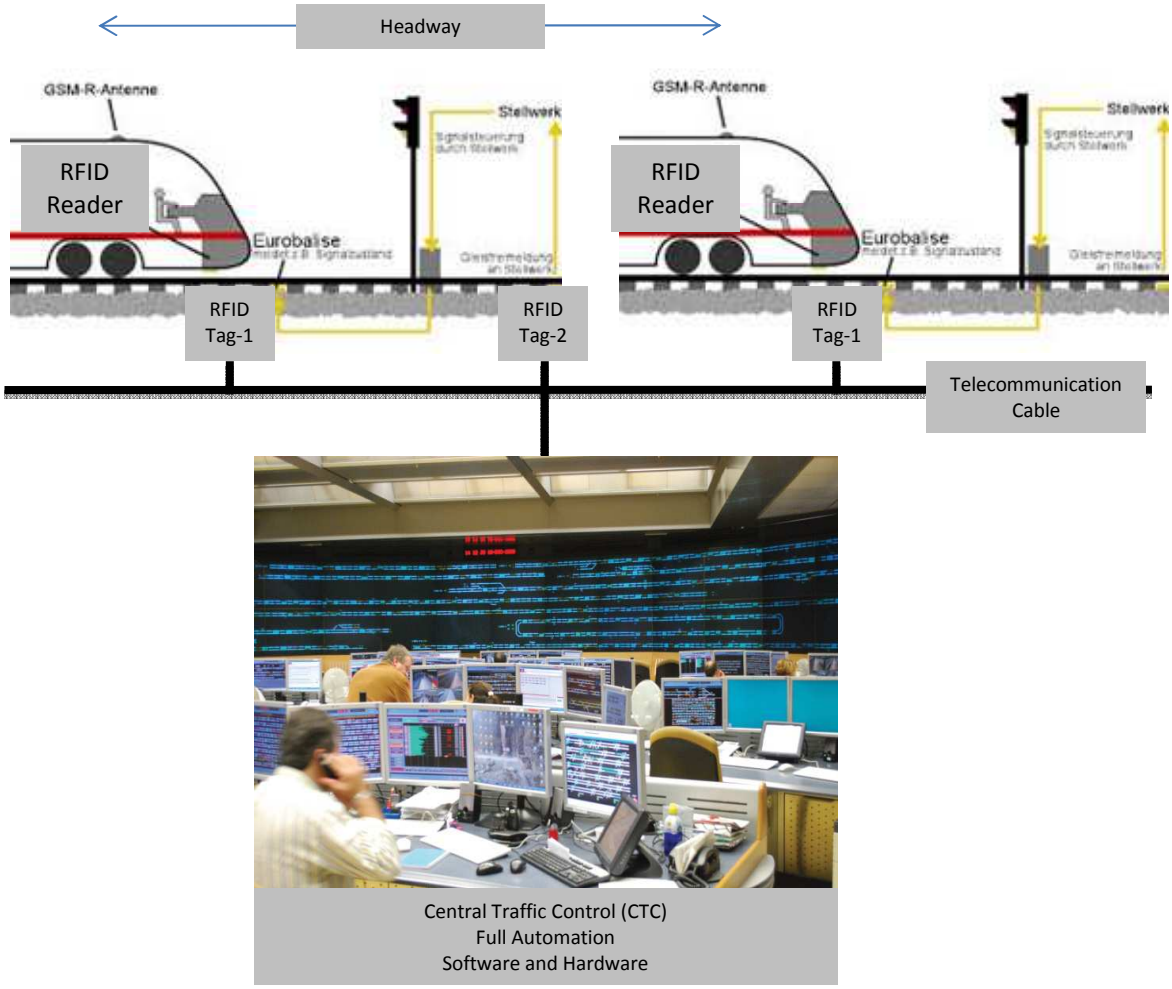

Figure 8: Fully Automated ICT ATP System

Conclusion

Egypt's railways continue to operate on a system that depends on human operations and very limited technological assistance that is generally ignored. The integration of ICT can tremendously improve the safety situation of Egypt's railway. It can save Egyptian lives by granting a very low probability of train collisions or derailments. With a technology that is capable of tracking operating trains on railway lines and coordinating train traffic, it is worth the major restructuration that can finally ensure safe travels on railway lines.

ENR can use the strategy proposed by by Alaa Fahmy when he was Minister of Transport in 2010 to reallocate the World Bank's loan to use ICT and to buy and use ATPS, to increase safety levels on the Egyptian railway. Long term strategies adopting the 'ICT based dynamic capabilities' model is expected to bring the required innovation, effectiveness and efficiency to the strategic management ecosystem of the transport sector.

Until then, Egypt can benefit from the ideas of "the clean kilometer" and "the empty block" adapted from the approaches of competitive forces and strategic conflict techniques for the competitive advantage. By making sure that all equipment works on trains and that no train can move until the preceding train arrives, simple logic dictates that the railway network would be

much safer than it is when it solely relies on human operations. Indeed, the strategy was implemented for a short period of time when Fahmy was Minister, and it led to minimal losses compared to the alarming numbers of previous and following years. Many are of the opinion that this strategy would have been, and can still be the safest strategy for restructuring Egypt's railway network.

References

1. Ahram Online. (2013, January 15). Egypt Salvation Front Holds Officials Responsible for Badrashin Accident. *Ahram Online*.

2. Baeumler, A. (2005). *Policy note 4: Restructuring Egypt's Railways.* International Bank for Reconstruction and Development/The World Bank.

3. BBC News. (2012, November 17). Egypt Bus Crash Kills 50 Children near Manfalut. *BBC News*.

4. BBC News. (2013, January 15). Cairo Train Derailment Leaves 19 Dead. *BBC News*.

5. Carbone, J. (2010). *Regulatory Standards for Safety-Critical Embedded Systems.* Express Logic, Inc.

6. Carbone, J. (2011). *Safety-Critical Systems in Rail Transportation.* Express Logic, Inc.

7. Carr, S., & Adam, M. (2014, May). Egypt's Railway sector Struggles Between Financial Woes and Promises of Modernization. *Egypt Independent*.

8. D'Ariano, A. (2008). *Improving Real-Time Dispatching: Models, Algorithms and Applications.* Delft University of Technology, Transport and Planning, Faculty of Civil Engineering and Geosciences.

9. El-Masry, S. (2013, May). Egypt's Railways: Past, Present and Future. *Daily News Egypt*.

10.Faber, J. (2005). *Verifying Real-Time Aspects of the European Train Control System.* University of Oldenburg.

11.Goldfinch, M. (2013). A Series of Disasters. *Egyptian Railways Diwan*.

12.Hayes, R., Wheelwright, S., & Clark, K. (1988). *Dynamic Manufacturing: Creating the Learning Organization.* New York: Free Press.

13.Kaplan, R. (2010). *Conceptual Foundations of the Balanced Scorecard.* Harvard University, Harvard Business School.

14.Ministry of Transport. (2013). Casuality Assessment Report. Ministry Senior Consultant for ICT.

15.Nasr-El-Din, A. N. (2006). Railroads in the Land of the Nile. *Young Scholars Conference.* Economic and Business History Research Center (EBHRC).

16.Nelson, R., & Winter, S. (1982). *An Evolutionary Theory of Economic change.* Cambridge, MA: Harvard University Press.

17.Organisation for Economic Co-operation and Development (OECD).(2006). Egypt. *African Economic Outlook* 2005-2006.

18.Penrose, E. (1959). *The Theory of the Growth of the Firm.* London: Basil Blackwell.

19.Porter, M. E. (1980). *Competitive Strategy.* Free Press, New York.

20.Prahalad, C. K., & Hamel, G. (1990). The core competence of the corporation. *Harvard Business Review, 68*(3), 79-91.

21.*Railway Gazette*. (2007, August 2). Egyptian Investment Will Raise Safety Standards.

22.Rumelt, R. P. (1984). Towards a strategic theory of the firm. In R. B. Lamb, *Competitive Strategic Management* (pp. 556-570). Englewood Cliffs, NJ: Prentice-Hall.

23.Schumpeter, J. A. (1942). *Capitalism, Socialism, and Democracy.* New York: Harper.

24.Shapiro, C. (1989). The theory of business strategy. *RAND Journal of Economics, 20*(1), 125-137.

25.Teece, D. J. (1976). *The Multinational Corporation and the Resource Cost of International Technology Transfer.* Cambridge, MA: Ballinger.

26.Teece, D. J. (1984). Economic analysis and strategic management. *California Management Review, 26*(3), 87-110.

27.Teece, D. J. (1986 a). Profiting from technological innovation. *Research Policy, 15*(6), 285-305.

28.Teece, D. J. (1986 b). Transactions cost economics and the multinational enterprise. *Journal of Economic Behavior and Organization, 7*, 21-45.

29.Teece, D. J. (1988). Technological change and the nature of the firm. In G. Dosi, C. Freeman, R. Nelson, G. Silverberg, & L. Soete, *Technical Change and Economic Theory* (pp. 256-281). New York: Pinter Publishers.

30.Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal, 18*(7), 509-533.

31.Thales Group. (2013, May 26). *Egypt: Thales Wins the First Section of the Ambitious Modernisation Programme for the Main Line Network.* Thales Group.

32.The Automatic Train Protection (ATP) Program. (2011, September). The Automatic Train Protection (ATP). *Heads Up*(2).

33.The World Bank. (2010). *Project Paper on a Proposed Additional Loan in the Amount of US$330 Million to the Arab Republic of Egypt for the Egypt National Railways Restructuring Project.* The World Bank, Sustainable Development Department, Middle East and North Africa Region.

34.UK Trade & Investment. (2010). *Sector Briefing: Railway Opportunities in Egypt.* UK Trade & Investment.

35.Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal, 5*(2), 171-180.