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The Impact of Information and Communications Technology (ICT) and Technology Intelligence (TI) on the Performance of the Lean, Agile and Leagile Supply Chains: A Comparative Study

A Thesis Submitted in Fulfilment of the Requirements for the Degree of

Doctor of Philosophy

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Abstract

The focus of this thesis is on higher education-industry supply chain management in Egypt. The purpose of this study was to investigate the direct and indirect effect of information and communication technology (ICT) on hybrid supply chain performance (HSCP) in terms of leanness, agility and leagility of the higher education institutions (HEIs) and automotive companies (ACs) in Egypt.

A conceptual framework developed based on the literature was proposed and tested using questionnaires, which were filled through face-to-face in-depth interviews. A mixed methods approach (triangulation) was used to obtain greater insights and better understanding of the research relationships. The researcher in this thesis developed and used a multi-item measurement scale to assess, and then suggest for improvement, the hybridized performance –in terms of leanness, agility and leagility– of the automotive and higher education supply chains (HESC) in Egypt as two examples of manufacturing and service industries. The target population of the automotive sector was 101 organizations in the Egyptian automotive industry throughout its three main sub-sectors (multiple nodes); namely manufacturers of auto-feeding and automotive industries and CBU distributors. A sample of 84 was obtained using probability random sampling technique (i.e., 83.16% response rate). Regarding the higher education sector, a total of 63 HEIs (universities and academies) were contacted, of which 41 accepted to participate (i.e., 65.08% response rate) also through using probability random sampling technique. Structural Equation Modeling was used to examine the proposed relationships. Different software packages (AMOS, SmartPLS, LISREL, and SPSS software) were used in conducting the research quantitative analysis. In addition to the 125 questionnaires (quantitative), 160 direct depth interviews (qualitative) were conducted with subject-matter-experts (SMEs) working in 129 organizations (86 (84 ACs + 2 stakeholders) + 43 (41 HEIs + 2 stakeholders)) from both sectors at 15 different governorates in Egypt.

In regard to the automotive industry, results showed that ICT employment positively and significantly affects both supply chain integration (SCI) and hybrid SCP, SCI positively and significantly affects supply chain information sharing (SCIS), and SCIS positively and significantly affects HSCP in terms of mass-customization and postponement. The three automotive sub-sectors are using a blended supply-chain strategy that hybridizes different attributes of each approach according to the position of the SC node. For the higher education sector, results indicated that ICT employment has a positive and significant effect on SCI, SCI has a positive and significant effect on SCIS, and ICT employment has a positive and significant effect on education HSCP. Regarding the moderation effect of technology intelligence (TI) on the ICT-SCI relationship, after adding the university-industry partnership (UIP) dimension to SCI, results revealed that TI positively and significantly affects SCI. Furthermore, the

interaction between ICT and TI is also significant, suggesting that the effect of ICT on SCI depends on the level of TI. Compared to automotive supply chain (ASC) results, conversely, there is a positive and significant effect of SCIS on HSCP. However, regarding the other aforementioned research relationships, there are insignificant differences among their coefficients between the two sectors. Therefore, it can be concluded that the empirical investigation of the research model relationships in the two sectors (serving as two examples of manufacturing and service industries in Egypt) yield very close measurement results. Thus, it can be further concluded that these results support the new hybridized strategy of SCP (leanness, agility and leagility) in both sectors as two examples of MFG/service industries in Egypt.

This thesis conceptually and empirically contributes to the literature of contemporary supply chain management (SCM) in many interdependent ways. First, it conceptually adds to the active debate on the applicability of the blended lean-agile SC strategy by integrating two main streamlines of prior MGT research; namely the leagility approach and the hybridized lean-agile MFG system, into one new hybridized SCM approach (leanness, agility and leagility). Second, to the best of the researcher's knowledge, this is the first research that empirically investigates the direct and indirect (via SCM and TI) impact of ICT on hybrid lean-agile SCP of multiple nodes in the automotive and higher education markets. Third, it is the first study that maps the Egyptian higher education SC integrated with the automotive industry SC as example of attractive yet unexplored contexts of SCM research. Fourth, it adds to the few detected attempts in the contemporary SCM research literature, which considers education management (EMgt) and SCM as interdependent fields. Furthermore, it is the first study in Egypt that developed a new higher education-industry SCM model suggested by the findings of this research to bridge the detected gap between HR/research supply and demand (academia-industry partnership). Fifth, it contributes to the contemporary management research literature that considers ICT and SCM as interdependent fields.

The results of this research give different ASC and HESC members in Egypt greater insights on how they can effectively/efficiently compete and maintain sustainable development in a dynamic globalized environment. Furthermore, this thesis highlights the importance of investing in ICT, which facilitates end-to-end SCI and SCIS, in addition to choosing the appropriate aspects of hybridized SC strategy (leanness, agility and leagility) based on the organization's position across its SC. Moreover, its findings have different implications for HEIs that help them in bridging the gap between HR/research supply and demand (Higher education-industry supply chain management in Egypt). Based on the research qualitative and quantitative data analysis, the researcher recommends applying the hybrid SCM approach (concept/philosophy of education supply chain) to the Egyptian higher education sector for improving the SCP of HEIs integrated with other industries in Egypt.

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List of Abbreviations

AABFS	Arab Academy for Banking and Financial Sciences
AASTMT	Arab Academy for Science Technology and Maritime Transport
AAV	Arab American Vehicles
ACs	Automotive Companies
ACU	Ahram Canadian University
AFICO	Automotive Filters Industrial Company
AGFI	Adjusted Goodness of Fit Index
AISC	Automotive Industry Supply Chain
AISCP	Automotive Industry Supply Chain Performance
AmCham	American Chamber of Commerce
AMIC	Automotive Marketing Information Council
AMOS	Asset Management Operating System
AMs	Automotive Manufacturers
AOI	Arab Organization for Industrialization
AOU	Arab Open University
ASC	Automotive Supply Chain
ASCP	Agile Supply Chain Performance
ASG	Aman and Safety Group

ASU	Ain Shams University
AUC	American University in Cairo
AVE	Average Variance Extracted
AVM	Al-Amal Company for Vehicles Manufacturing
BAG	Bavarian Auto Group
BES	British Egyptian Society
BMI	Business Monitor International
BMW	Bavarian Motor Works (Bayerische Motoren Werke)
BSAC	Business Studies and Analysis Center
BSC	Balanced Score-Card
BSU	Beni-Suef University
BU	Benha University
BUE	British University in Egypt
CAPMAS	Central Agency for Public Mobilization and Statistics
CBU	Completely Built Units
CBUM	Completely Built Units Market
CEI	Chamber of Engineering Industries
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CIC	Canadian International College

CKD	Completely Knocked Down
CPIM	Certified Production and Inventory Management
CPP	College Preparatory Program
CR	Cooperative/Collaborative Research
CR	Construct/Composite Reliability
CRM	Customer Relationship Management
CSCP	Certified Supply Chain Professional
CSF	Critical Success Factor
CU	Cairo University
CUHK	City University of Hong Kong
CV	Commercial Vehicles
DI	Downstream Integration
DIS	Downstream Information Sharing
DU	Damietta University
EAFA	Egyptian Auto-Feeders Association
EAFI	Egyptian Auto-Feeding Industry
EAM	Egyptian Automotive Manufacturing
EAMA	Egyptian Automobile Manufacturers Association
EATC	Egyptian Automotive and Trading Company
ECASTI	Egyptian Center for the Advancement of Science Technology and Innovation

EDI	Electronic Data Interchange
EEI	Egypt for Engineering Industries
EELU	Egyptian E-Learning University
e.g.	For Example (Exempli Gratia)
EGA	Egyptian German Automotive
EGES	Egyptian German Electric Systems
EHSCP	Education Hybrid Supply Chain Performance
EIM	Egyptian International Motors
EIs	Educational Institutions
EIT	Egyptian International for Trading
EIU	Economist Intelligence Unit
EM	Education Market
EMgt	Education Management
EMB	Egyptian Motorbikes and Bicycles
EMQS	Education Market Qualifications Supply
ENGIN	Engineering for Industries Company
ERP	Enterprise Resource Planning
ESC	Education Supply Chain
ESCI	Education Supply Chain Integration
e-SCN	Electronic Supply Chain Network

ESCP	Education Supply Chain Performance
ESCU	Egyptian Supreme Council of Universities
EU	European Union
FCBD	Faculty of Commerce Business Administration Department
FDI	Foreign Direct Investment
FIMCO	Feeding Industries Manufacturing Company
FIT	Future Industry and Trade
FU	Future University
GATT	General Agreement on Tariffs and Trade
GB	Ghabbour Auto
GCI	Global Competitiveness Index
GE	General Education
GEG	Gorica Egypt Group
GEIs	General Education Institutions
GFI	Goodness of Fit Index
GICO	Grants and International Collaboration Office
GII	Global Innovation Index
GIS	Geographical Information System
GM	General Motors
GNA	Giza National Automotive

GPA	Grade Point Average
GTI	General Techniques International
HDI	Human Development Index
HE	Higher Education
HEEP	Higher Education Enhancement Project
HEIs	Higher Education Institutions
HESC	Higher Education Supply Chain
HESCM	Higher Education Supply Chain Management
HESCP	Higher Education Supply Chain Performance
HR	Human Resources
HRC	Human Resources Capital
HSC	Hybrid lean-agile Supply Chain
HSCP	Hybrid Supply Chain Performance
HU	Heliopolis University
IAEMS	International Academy for Engineering and Media Science
ICEI	Industrial Control for Engineering Industries
ICT	Information and Communication Technology
IDA	Industrial Development Authority
IDACO	Industrial Development of Automotive Components
i.e.	That is (Id Est)

IFI	Incremental Fit Index
II	Intra-organizational Integration
IIS	Intra-organizational Information Sharing
IITs	Indian Institutes of Technology
ILCT	Interactive Learner Centered Teaching
ILOs	Intended Learning Outcomes
IMC	Industrial Modernisation Centre
INBAM	International Network of Business and Management Journals
INDE	Industrial Engineering Group
INTEROL	Inter-Organizational Level
INTRAOL	Intra-Organizational Level
IS	Information Sharing
ISI	International Supplementary Industries
ISIS	Integrated Student Information System
IT	Information Technology
ITAMCO	International Trade Agency and Marketing Company
JIT	Just In Time
JM	Job Market
JMQD	Job Market Qualifications Demand
JP	Joint Projects

JV	Joint Venture
KMO	Kaiser Meyer Olkin
KSA	Knowledge Skills Abilities/Attitudes
LEAGSCP	Leagile Supply Chain Performance
LISREL	Linear Structural Relations
LR	Literature Review
LSCP	Lean Supply Chain Performance
MC	Management Center
MCV	Manufacturing Commercial Vehicles
MENA	Middle East and North Africa
MFG	Manufacturing
MHE	Ministry of Higher Education
MOODLE	Modular Object-Oriented Dynamic Learning Environment
MSA	Modern Sciences and Arts
MUST	Misr University for Science and Technology
NFI	Normed Fit Index
NIC	National Information Center
NNFI	Non-Normed Fit Index
NRC	National Research Center
NSDP	National Suppliers Development Program

NTE	Nile Trading and Engineering
NU	Nile University
NUB	Nahda University in Beni-Suef
OBG	Oxford Business Group
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
OICA	International Organization of Motor Vehicle Manufacturers (Organisation Internationale des Constructeurs d'Automobiles)
O6U	October 6 University
PC	Passenger Cars
PIB	Promise Insurance Brokerage
PKD	Partly Knocked Down
PLS	Partial Least Squares
PUA	Pharos University in Alexandria
QA	Quality Assurance
R&D	Research and Development
RMR	Root Mean Square Residual
RMSEA	Root Mean Square Error of Approximation
ROI	Return On Investment
SAMS	Sadat Academy for Management Sciences
SC	Supply Chain

SCI	Supply Chain Integration
SCIS	Supply Chain Information Sharing
SCM	Supply Chain Management
SCOR	Supply Chain Operations Reference
SCP	Supply Chain Performance
SCT	Supply Chain Technology
SCU	Suez Canal University
S&D	Supply and Demand
SEM	Structural Equation Modeling
SKD	Semi Knocked Down
SM	Strategy Map
SMEs	Subject Matter Experts
SMs	Structural Measures
SPSS	Statistical Package for the Social Sciences
SPV	Special Purpose Vehicles
SSC	Service Supply Chain
SSCM	Service Supply Chain Management
3S	Showrooms Services and Spare parts
SU	Sinai University
SUV	Sport Utility Vehicle

SWOT	Strengths Weaknesses Opportunities Threats
SWT	Semantic Web Technology
TF	Technology Forecasting
TI	Technology Intelligence
TICO	Technology Innovation and Commercialization Office
TIS	Technology Intelligence System
TM	Technology Management
TPS	Toyota Production System
TQM	Total Quality Management
TRF	Technological Research Forecasting
TT	Technology Transfer
TTO	Technology Transfer Office
UI	Upstream Integration
UIC	United Industries Company
UIP	University-Industry Partnership
UIS	Upstream Information Sharing
UNESCO	United Nations Educational Scientific and Cultural Organization
VIF	Variance Inflation Factor
WM	Workforce Market
YTD	Year To Date
ZU	Zagazig University

CHAPTER ONE

Introduction to the Research

1.1. Introduction and Motivation

In the last decade, various supply chain (SC) strategies and performance paradigms have emerged to help organizations to better compete and maintain a sustainable development in a dynamic ever-changing globalized competitive environment (Lau, 2007; Al-Turki *et al.*, 2008). The growing interest in some of these SC strategies such as leanness, agility and leagility is apparent in different research work of many authors. Some researchers pointed out the importance of the lean thinking paradigm and lean SC (Womack and Jones, 1996; 2005; Naylor *et al.*, 1999), while the agility and agile supply chain performance (SCP) paradigm have received due attention from other scholars (Burgess *et al.*, 2002; Sherehiy *et al.*, 2007; Gunasekaran *et al.*, 2008; Khan and Pillania, 2008; Bottani, 2010; Ivanov *et al.*, 2010; Azevedo *et al.*, 2012). As for the leagility concept, after being coined by Naylor *et al.* (1999), it was highly advocated by many studies (Mason-Jones *et al.*, 2000; Towill and Christopher, 2002; Goldsby *et al.*, 2006; Chan and Kumar, 2009; Naim and Gosling, 2011). Meanwhile, Huang *et al.* (2002) called for using a hybrid lean-agile supply chain that balances between cost-reduction (leanness), responsiveness/availability (agility), and mass-customization and postponement (leagility). Similarly, Elmoselhy (2012) criticized choosing only one approach and suggested using a hybrid lean-agile framework that incorporates the main principles of leanness and agility together in one system linking the entire SC. To date, there is an active debate on the applicability of this blended lean-agile SC strategy. However, these and other different lines of contemporary management research asserted that competition nowadays has been witnessed to be among supply chains, rather than individual organizations (Towill and Christopher, 2002; Li *et al.*, 2006). Therefore, effective and efficient supply chain management (SCM) is needed in order to have one integrated coordinated system (Li *et al.*, 2006; Al-Turki *et al.*, 2008) that can better compete in the global market.

As an enabler for the development of this efficient and responsive SC system, information and communication technology (ICT) can be used in linking various SC members as one integrated entity, and coordinating all their performed activities in a seamless manner that overcomes time, physical and geographical boundaries (Kim and Im, 2002; Rao *et al.*, 2006). Practically, ICT facilitates both supply chain integration (SCI) and information sharing (IS) within each individual SC node and across different partners (Rao *et al.*, 2006). By this means, ICT can help in improving SCP through synchronizing and orchestrating different tangible and intangible SC flows (Kim and Im, 2002) that pass throughout many SC participants playing one symphony yet each player has a different role. Despite the abundance of studies which have discussed the importance of ICT in the field of production and operations management, there is a little empirical research that investigated the effect of ICT on SCP directly and indirectly through SCM. Additionally, there is a disharmony in the reported empirical findings (i.e., mixed results) of these few studies that directly/indirectly assessed the ICT-SCM-SCP relationship (Zhang *et al.*, 2011). Furthermore, as far as the literature has been investigated, there is a lack of studies that assessed its effect on hybrid SCP in terms of leanness, agility and leagility. Thus, the researcher was motivated to empirically investigate the direct effect of ICT and the mediation effect of SCM (i.e., SCI and SCIS) on hybrid lean-agile SCP.

As for the chosen context of this research, many reasons lie behind the selection of the Egyptian automotive emerging market that serves as an example of the manufacturing industries. First, the automotive industry is characterized by having a long and hierarchical supply chain that consists of multiple nodes and many tiers of suppliers (Kim and Im, 2002), which justifies the need for effective and efficient SCM. As a result, many researchers (e.g., Uttamrao and Rajashree, 2009; Xia and Tang, 2011) pointed out that managing supply chains efficiently and effectively in the automotive industry represents a challenge for auto-parts/automobile companies that seek a sustainable competitive advantage in the global market. Second, in addition to being hierarchical, Huang *et al.* (2002) and Turner and Williams (2005) indicated that the automotive industry supply chain (AISC) is a hybrid SC (i.e., it can be barely considered as either absolute efficient or responsive SC) that generates a hybrid product (e.g., vehicle) as it comprises a mixture of standard and innovative components produced via different industries. In this way, the need for a hybrid lean-agile automotive SCM is justified and can be detected in the literature of contemporary SCM. Third, many academics and practitioners have studied supply chain technology (SCT) and SCM as being independent rather than interdependent fields, and very few have realized the importance of their integration, especially in the automotive sector (Kamaruddin and Udin, 2009). Fourth, despite the abundance of research on different developed manufacturing sectors, the automotive emerging markets remain unexplored context of contemporary SCM research, especially those addressing the empirical issue of the applicability of hybrid lean-agile SC strategy. Fifth, such an industry in Egypt is a heterogeneous industry that comprises three main sub-sectors and each one has its own SC with multiple nodes. Besides, Egypt possesses one of the largest automotive markets in the MENA region (Oxford Business Group, 2011). Additionally, it was found by different OEMs as an attractive pool for their investments (Business Studies and Analysis Center, 2011). Hence, the Egyptian automotive emerging market was viewed to be an attractive context by the researcher.

Regarding the other chosen context of this thesis, many reasons lie behind the selection of the Egyptian higher education market that acts as one example of a service sector. First, following the studies of Lau (2007), Al-Turki *et al.* (2008), Kargaev (2008), Ang *et al.* (2010) and Abd-Elall *et al.* (2011) that discussed the importance of conducting education SCM (i.e., managing SC flow of HR) and collaborative research (i.e., managing SC flow of information) through universities-industries partnerships, the researcher considers the higher educational institutions (HEIs) as one of the strategic suppliers of information and HR to the automotive industry and many other sectors in Egypt. In this interdependent manner and through using effective and efficient education/research SCM, HEIs can bridge the gap between: (a) HR supply (i.e., supplied qualifications) and demand (i.e., needed qualifications) (Al-Turki *et al.*, 2008; Abd-Elall *et al.*, 2011); and (b) information/research supply (e.g., contemporary theories) and demand (e.g., successful practices) (Habib and Jungthirapanich, 2008; 2009a; 2009b). Second, despite the abundance of studies which have focused on applying SCM practices to different manufacturing industries, few studies were concerned about the application of contemporary SCM practices to the service sector; particularly the education sector (Habib and Jungthirapanich, 2009b) in spite of knowing that its SC affects either positively or negatively many other different sectors/industries. Additionally, SCM researchers conducted various models for improving the industrial sector and many business organizations, while they should be more motivated to target their researches for sustaining the development of their own educational institutions (Lau, 2007; Habib and Jungthirapanich, 2008; 2009a; 2009b). This way, HEIs in Egypt can maintain an active participation in promoting the required innovation in the society. The main objective is to provide education supply chain (ESC) stakeholders, including the society in large, an enhanced value through contributing by qualified graduates and community-based research output (Lau, 2007). Third, as far as the literature has been investigated, there is a lack of studies that empirically assessed the moderating effect of technology intelligence (TI) on education SCI and ICT-SCM-HSCP relationship in terms of leanness, agility and leagility in the context of higher education; especially in Egypt. Thus, the researcher was motivated to add by conducting this thesis to the few detected attempts in the contemporary SCM research literature, which considers education management (EMgt) and SCM as interdependent areas of research.

Based on the above-mentioned reasons, the current thesis: (1) developed a new hybridized lean-agile SC strategy, as it considered the area of SCM an interesting field of study yet in need for conceptual and empirical evolution; (2) used a multidisciplinary approach and added to the contemporary management research literature that considers SCM, technology management (TM) and EMgt as interdependent fields; and (3) regarded the emerging markets as value-adding yet uninvestigated context of contemporary SCM research and tested its suggested framework in two of them. Thus, according to the researcher's knowledge, this research pioneers the empirical investigation of the direct and indirect ICT/TI-SCM-HSCP relationship in automotive and higher education markets.

1.2. The Research Problem/Opportunity

Despite the abundance of studies which have discussed the importance of ICT in the field of production and operations management, there is a little empirical research that investigated the effect of ICT on SCP directly and indirectly through SCM. Additionally, there is a disharmony in the reported empirical findings (i.e., mixed results) of these few studies that directly/indirectly assessed the ICT-SCM-SCP relationship (Zhang *et al.*, 2011). Furthermore, as far as the literature has been investigated, there is a lack of studies that assessed its effect on hybrid SCP in terms of leanness, agility and leagility; especially in the automotive and education sectors. Thus, this thesis empirically investigates the direct effect of ICT and the mediation effect of SCM (i.e., SCI and SCIS) on hybrid lean-agile SCP of the automotive and higher education sectors (i.e., serving as two important examples of the manufacturing and service industries).

Regarding the higher education sector in Egypt, two main gaps/research problems were detected related to: (1) HR supply and demand: The existing gap between job market qualifications (KSA) demand and education market qualifications (KSA) supply, which emerges from the information invisibility (i.e., absence of information synchronization and information sharing) that harms the ESC performance as information sharing is key but difficult to achieve in the education sector; and (2) Research supply and demand: The current weakness in the universities-industries research relationships (e.g., technology-based researches related to different industries). Therefore, the researcher was highly motivated to empirically study the direct and indirect ICT-HSCP relationship via SCM (i.e., SCI and SCIS) and TI in the Egyptian education context; thus, adding to the contemporary SCM research literature that addresses bridging the gap between HR/research supply and demand.

1.3. Approach to the Problem

1.3.1. The Research Objectives

1) To empirically study the direct effect of information and communication technology (ICT) employment on hybrid supply chain performance (HSCP) in terms of leanness, agility and leagility (i.e., direct ICT-HSCP relationship) of the automotive companies (i.e., manufacturing) and higher educational institutions (i.e., service).

2) To empirically investigate the mediating effect of SCM (i.e., supply chain integration (SCI) and supply chain information sharing (SCIS)) on HSCP in terms of leanness, agility and leagility (i.e., indirect ICT-HSCP relationship via SCM) of the automotive companies and higher educational institutions.

3) To assess the moderating effect of technology intelligence (TI) on the relationship between information and communication technology (ICT) employment and supply chain integration (SCI).

1.3.2. The Research Importance/Value

This study contributes to the literature of contemporary supply chain management in many interdependent ways:

First, as a conceptual contribution, it conceptually adds to the active debate on the applicability of the blended lean-agile SC strategy by integrating two main streamlines of prior management research regarding this empirical issue; namely the leagility approach and the hybridized lean-agile manufacturing system, into one new hybridized approach. In other words, this thesis considers both lines of research as being complementary rather than competitive. It builds on the idea of having different attributes from each strategy (i.e., leanness and agility) in one organizational manufacturing system, which was revealed throughout the second line of research. However, it adds to this line of thinking the leagility component (i.e., in terms of mass-customization and postponement) and the impact of the organization position along the SC on the hybridized component/share of each strategy, which were extracted from the first streamline of research. As it was evident from the results of the quantitative and qualitative data analyses that the HEIs and the three main sub-sectors of AISC in Egypt –one example of the emerging markets– are using a blended strategy that hybridizes attributes of leanness (e.g., cost-minimization, waste-reduction, continuous improvement) together with that of agility (e.g., speed, flexibility, responsiveness) and leagility (e.g., mass-customization, postponement). In addition, after conducting multi-group/sub-sector analysis, the percentage of the hybridized lean component was found to be higher, upstream the AISC (i.e., automotive suppliers in the EAFI), than the agility component in the same sub-sector; compared to the SC market-interface (i.e., automotive distributors downstream the AISC), which operates in a more agile-manner.

Second as an empirical contribution, to the best of the researcher's knowledge, this research can be considered as the first attempt in the SCM literature to empirically investigate the direct and indirect impact of ICT on hybrid lean-agile supply chain performance of companies virtually located at different positions (i.e., multiple nodes) across the same AISC in Egypt as one example of an emerging automotive market.

Third, as far as the researcher knows, this is the first study that maps the Egyptian automotive industry SC in order to depict a holistic view of the nature of this important industry in an emerging market, which serves as an example of an interesting yet uninvestigated context of contemporary SCM research. In an interdependent manner, this thesis draws its main players and sub-sectors, based on the qualitative analysis of the collected data throughout 94 conducted in-depth interviews within 89 different organizations in Egypt (i.e., 89 interviews within 84 auto-parts/automotive companies + 5 interviews within 5 educational institutions and research centers supplying these automotive companies with information/HR).

Fourth, despite the fast growth of the SCM literature, there have been few trials –according to the researcher's knowledge– in the SCM literature to study the integration of ICT and SCM as two interdependent fields. Thus, this thesis contributes to the management research literature that tried to fill this knowledge gap from a seamless multidisciplinary perspective.

Finally, despite the abundance of studies which have focused on applying SCM practices to different manufacturing industries, few studies were concerned about the application of successful SCM practices to the service sector; particularly the education sector in spite of the fact that its SC affects either positively or negatively many other different sectors/industries. Moreover, as far as the literature has been investigated, there is a lack of studies that empirically assessed the ICT/TI-SCM-HSCP relationship in terms of leanness, agility and leagility in the context of higher education; especially in Egypt. Thus, this thesis adds to the few detected attempts in the contemporary SCM research literature, which considers education management (EMgt) and SCM as two interdependent fields.

1.4. The Suggested Framework and Research Model

1.4.1. Suggested Framework

The research constructs and measurements were developed based on what has been used in the prior research literature. ICT employment –the independent variable– is considered in two levels in this research following the study of Zhang *et al.* (2011); inter-organizational level (Byrd and Davidson, 2003; Rao *et al.*, 2006; Paulraj and Chen, 2007; Paulraj *et al.*, 2008; Li *et al.*, 2009; Azevedo *et al.*, 2011; Azevedo *et al.*, 2012; Prajogo and Olhager, 2012) and intra-organizational level (Rai *et al.*, 2006; Lee *et al.*, 2007; Swafford *et al.*, 2008; Kim, 2009; Li *et al.*, 2009).

Whereas, based on the studies of Boon-itt and Paul (2006), Kim (2009) and Koçoglu *et al.* (2011), the researcher measured SCI –the first mediating variable– in three dimensions: upstream integration with suppliers (Boon-itt and Paul, 2006; Li *et al.*, 2006; Kim, 2009; Ibrahim and Ogunyemi, 2012), downstream integration with customers (Boon-itt and Paul, 2006; Li *et al.*, 2006; Ibrahim and Ogunyemi, 2012) and intra-organizational integration (Boon-itt and Paul, 2006; Lee *et al.*, 2007; Kim, 2009; Koçoglu *et al.*, 2011). In addition, the researcher used the university-industry partnership (UIP) as a fourth dimension in measuring the SCI of the HEIs following the studies of Geiger and Sá (2005), Ponis and Koronis (2005), Om *et al.* (2007), Shultz (2007), Worasinchai and Bechina (2009, 2010), Habib and Jungthirapanich (2010), Habib (2011), Van Hoek *et al.* (2011), Pathik *et al.* (2012a, b), Varma (2012), Bak and Boulocher-Passet (2013) and Sohal (2013).

Concerning the measurement of SCIS, the second mediating variable, the researcher relied on the research of Koçoglu *et al.* (2011) and used three main aspects: upstream IS with suppliers (Li *et al.*, 2006; Sezen, 2008; Koçoglu *et al.*, 2011; Ibrahim and Ogunyemi, 2012), downstream IS with customers (Boon-itt and Paul, 2006; Li *et al.*, 2006; Paulraj *et al.*, 2008; Sezen, 2008; Kim, 2009; Koçoglu *et al.*, 2011; Ibrahim and Ogunyemi, 2012; Prajogo and Olhager, 2012) and intra-organizational IS (Boon-itt and Paul, 2006; Eng, 2006; Koçoglu *et al.*, 2011). As for the assessment of the technology intelligence (TI), the moderator, the researcher relied on the studies of Lichtenthaler (2003, 2004a, 2004b, 2004c, 2005, 2007), López-Ortega *et al.* (2004), Savioz (2004), Boon-itt and Paul (2006), Taskov (2008), Yoon (2008), Veugelers *et al.* (2010), Dang *et al.* (2011), Behkami and Daim (2012) and Yoon and Kim (2012).

Finally, based on the studies of Naylor *et al.* (1999), Huang *et al.* (2002) and Elmoselhy (2012), the researcher assessed HSCP –the dependent variable– in terms of leanness (Womack and Jones, 1996; 2005; Kahn and Mello, 2004-05; Melton, 2005; Lee *et al.*, 2007; Koçoglu *et al.*, 2011; Mohaghar and Ghasemi, 2011a; 2011b), agility (Li *et al.*, 2006; Swafford *et al.*, 2008; Koçoglu *et al.*, 2011; Mohaghar and Ghasemi, 2011a; 2011b; Azevedo *et al.*, 2012; Ibrahim and Ogunyemi, 2012) and leagility (Huang *et al.*, 2002; Turner and Williams, 2005; Li *et al.*, 2006).

Figure 1.1 presents the proposed framework, which shows the direct effect of ICT on hybrid lean-agile SCP –in terms of leanness, agility and leagility– and its indirect effect on HSCP through SCI and SCIS (i.e., mediation effect of SCM) and TI (i.e., moderation effect). In addition, Table 1.1 shows the research constructs and their main dimensions along with their conceptualization.

1.4.2. Research Graphical Model

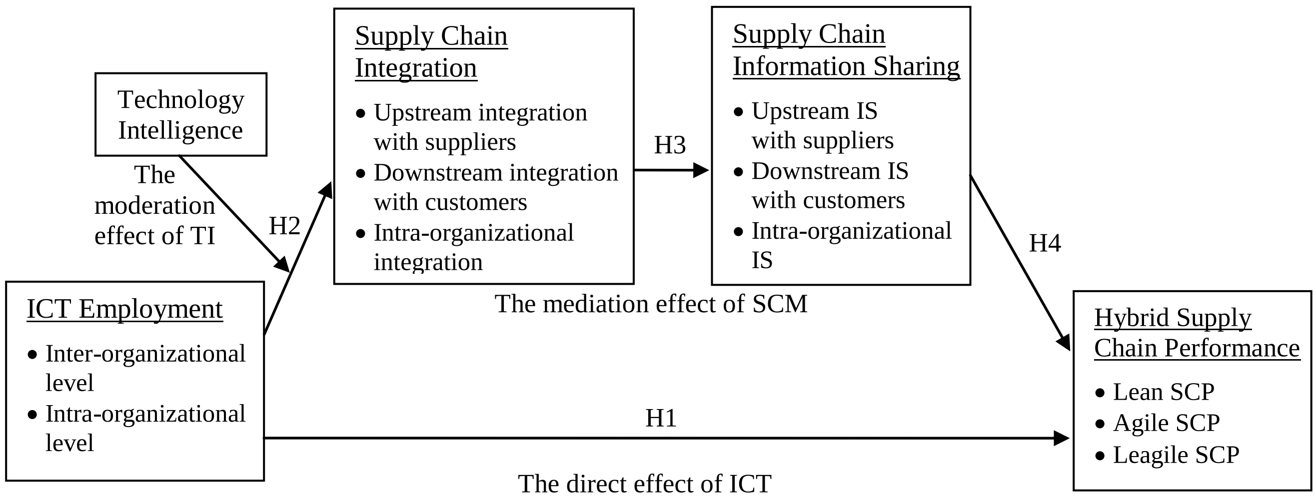


Figure 1.1. The Research Model-
The direct and indirect effect of ICT on hybrid lean-agile
SCP in terms of leanness, agility and leagility

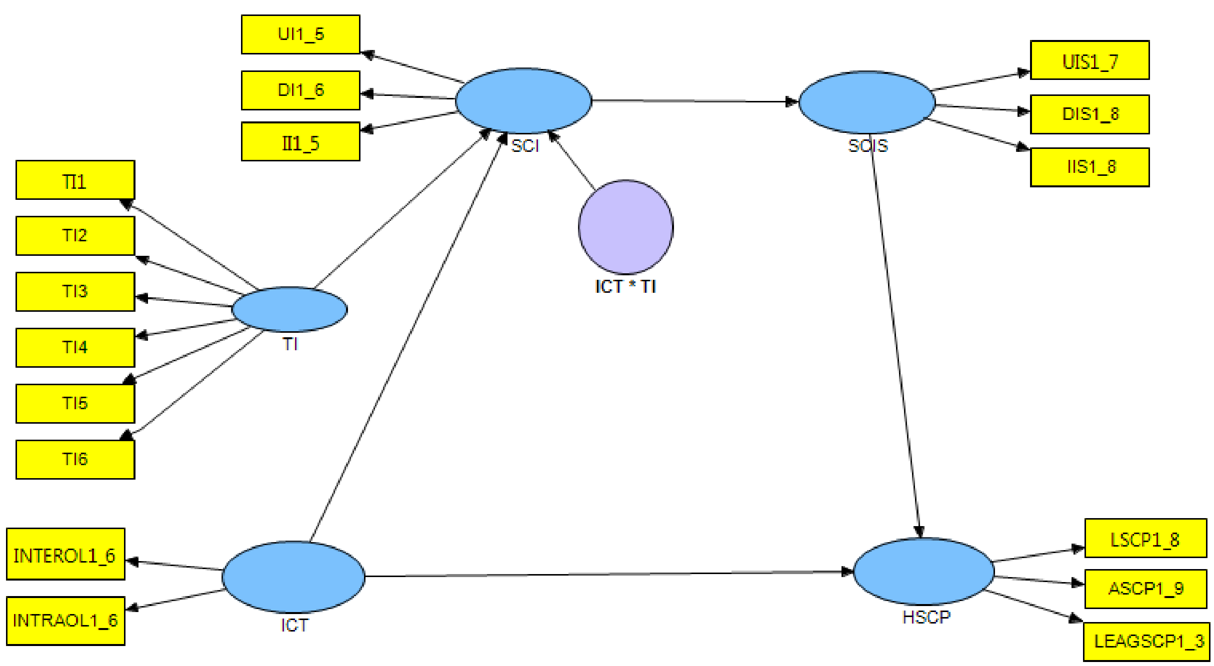


Figure 1.2. The Research Model drawn via SmartPLS software and its variables
were developed based on what has been used in the prior research literature

Table 1.1. Conceptualization of the main constructs and their dimensions

<table>
<tr><th colspan="2">Construct</th><th>Definition</th><th>Dimension</th><th>Definition</th></tr>
<tr><td colspan="2" rowspan="2">The independent variable:
Information and communication technology (ICT) employment</td><td rowspan="2">The convergence or combination of information technology and communication systems (Lyons, 2005).</td><td>Inter-organizational level of ICT employment (INTEROL)</td><td>A group of technologies (e.g., web-based, e-business, e-mail, EDI, fax) used to collect, process and communicate information across different SC players (Swafford et al., 2008; Zhang et al., 2011).</td></tr>
<tr><td>Intra-organizational level of ICT employment (INTRAOL)</td><td>A group of technologies (e.g., ERP) used to collect, process and communicate information within each individual SC node (Swafford et al., 2008; Zhang et al., 2011).</td></tr>
<tr><td rowspan="6">The mediating variables:</td><td rowspan="3">Supply chain integration (SCI)</td><td rowspan="3">The extent to which an organization is able to link and coordinate the performed activities internally within its departments and externally across its various SC participants (Li et al., 2009).</td><td>Upstream integration with suppliers (UI)</td><td>The extent to which an organization is able to link and coordinate the performed activities externally (Li et al., 2009) along with its various SC suppliers (Koçoglu et al., 2011).</td></tr>
<tr><td>Downstream integration with customers (DI)</td><td>The extent to which an organization is able to link and coordinate the performed activities externally (Li et al., 2009) along with its different SC customers (Koçoglu et al., 2011).</td></tr>
<tr><td>Intra-organizational integration (II)</td><td>The extent to which an organization is able to link and coordinate the performed activities internally within/across its departments (Li et al., 2009; Koçoglu et al., 2011).</td></tr>
<tr><td rowspan="3">Supply chain information sharing (SCIS)</td><td rowspan="3">The mutual information-based exchanges between different SC players, through using inter- and intra-organizational linkages (Koçoglu et al., 2011).</td><td>Upstream information sharing with suppliers (UIS)</td><td>The mutual information-based exchanges between the organization and its suppliers through using inter-organizational linkages (Koçoglu et al., 2011).</td></tr>
<tr><td>Downstream information sharing with customers (DIS)</td><td>The mutual information-based exchanges between the organization and its customers through using inter-organizational linkages (Koçoglu et al., 2011).</td></tr>
<tr><td>Intra-organizational information sharing (IIS)</td><td>The mutual information-based exchanges internally within/across its departments through using intra-organizational linkages (Koçoglu et al., 2011).</td></tr>
<tr><td colspan="2" rowspan="3">The dependent variable:
Hybrid supply chain performance (HSCP)</td><td rowspan="3">The extent to which a SC is using a blended approach that hybridizes the attributes of leanness (e.g., cost-minimization, waste-reduction, continuous improvement) together with that of agility (e.g., speed, flexibility, responsiveness) and leagility (e.g., mass-customization, postponement), and the percentage of each hybridized component varies according to the organization position along the SC.</td><td>Lean supply chain performance (LSCP)</td><td>The ability of a SC to achieve more (i.e., significant outcomes/benefits) with less (i.e., waste reduction/removal) (Naylor et al., 1999; Towill and Christopher, 2002; Scherrer-Rathje et al., 2009); in terms of efficiency/cost-reduction, removal of wastes and continuous improvement (Womack and Jones, 1996; Huang et al., 2002).</td></tr>
<tr><td>Agile supply chain performance (ASCP)</td><td>The ability of a SC to quickly and flexibly respond to changing customer demands; in terms of flexibility, speed and responsiveness (Naylor et al., 1999; Lin et al., 2006; Goldsby et al., 2006; Sherehiy et al., 2007).</td></tr>
<tr><td>Leagile supply chain performance (LEAGSCP)</td><td>The ability of a SC to maintain mass-customization and postponement (Naylor et al., 1999; Huang et al., 2002; Turner and Williams, 2005).</td></tr>
<tr><td colspan="2">The moderating variable:
Technology Intelligence (TI)</td><td colspan="3">The extent to which an organization is able to collect, analyze and communicate relevant information on recent technological trends to support technological and more general decisions of an organization (Lichtenthaler, 2004c; Savioz, 2004).</td></tr>
</table>

1.4.3. Research Verbal Model

This research hypothesized that information and communication technology (ICT) employment has a direct significant positive effect on hybrid supply chain performance (HSCP) in terms of leanness, agility and leagility (i.e., direct ICT-HSCP relationship) of the automotive companies (i.e., manufacturing) and educational institutions (i.e., service). Additionally, ICT has an indirect significant positive effect on HSCP in terms of leanness, agility and leagility (i.e., indirect ICT-HSCP relationship via the mediating effect of SCM in terms of supply chain integration (SCI) and supply chain information sharing (SCIS)) of the automotive companies and educational institutions. Moreover, TI moderates the relationship between ICT and SCI of the educational institutions (i.e., the strength and direction of ICT effect on SCI depends on the level of TI). Specifically, higher significant and positive effect of ICT employment on SCI depends on higher level of technology intelligence.

1.5. The Research Questions

This research specifically deals with the following questions:

A. Do inter- and intra-organizational levels of ICT employment significantly and positively affect hybrid supply chain performance in terms of leanness, agility and leagility?

B. Do inter- and intra-organizational levels of ICT employment significantly and positively affect supply chain integration in terms of upstream, downstream and intra-organizational integration?

C. Does higher significant and positive effect of ICT employment on SCI depend on higher level of technology intelligence (i.e., TI moderates the relationship between ICT and SCI)?

D. Do upstream, downstream and intra-organizational integration significantly and positively affect supply chain information sharing in terms of upstream, downstream and intra-organizational IS?

E. Do upstream, downstream and intra-organizational IS significantly and positively affect hybrid SCP in terms of leanness, agility and leagility?

1.6. The Research Hypotheses

In order to achieve the research objectives, the following hypotheses were developed:

H1. Inter- and intra-organizational levels of ICT employment will significantly and positively affect hybrid supply chain performance in terms of leanness, agility and leagility.

- H1a. Inter- and intra-organizational levels of ICT employment will significantly and positively affect lean SCP.
- H1b. Inter- and intra-organizational levels of ICT employment will significantly and positively affect agile SCP.
- H1c. Inter- and intra-organizational levels of ICT employment will significantly and positively affect leagile SCP.

H2. Inter- and intra-organizational levels of ICT employment will significantly and positively affect supply chain integration in terms of upstream, downstream and intra-organizational integration.

- H2a. Higher significant and positive effect of ICT employment on SCI depends on higher level of technology intelligence (i.e., TI moderates the relationship between ICT and SCI).

H3. Upstream, downstream and intra-organizational integration will significantly and positively affect supply chain information sharing in terms of upstream, downstream and intra-organizational IS.

H4. Upstream, downstream and intra-organizational IS will significantly and positively affect hybrid SCP in terms of leanness, agility and leagility.

- H4a. Upstream, downstream and intra-organizational IS will significantly and positively affect lean SCP.
- H4b. Upstream, downstream and intra-organizational IS will significantly and positively affect agile SCP.
- H4c. Upstream, downstream and intra-organizational IS will significantly and positively affect leagile SCP.

1.7. The Thesis Structure

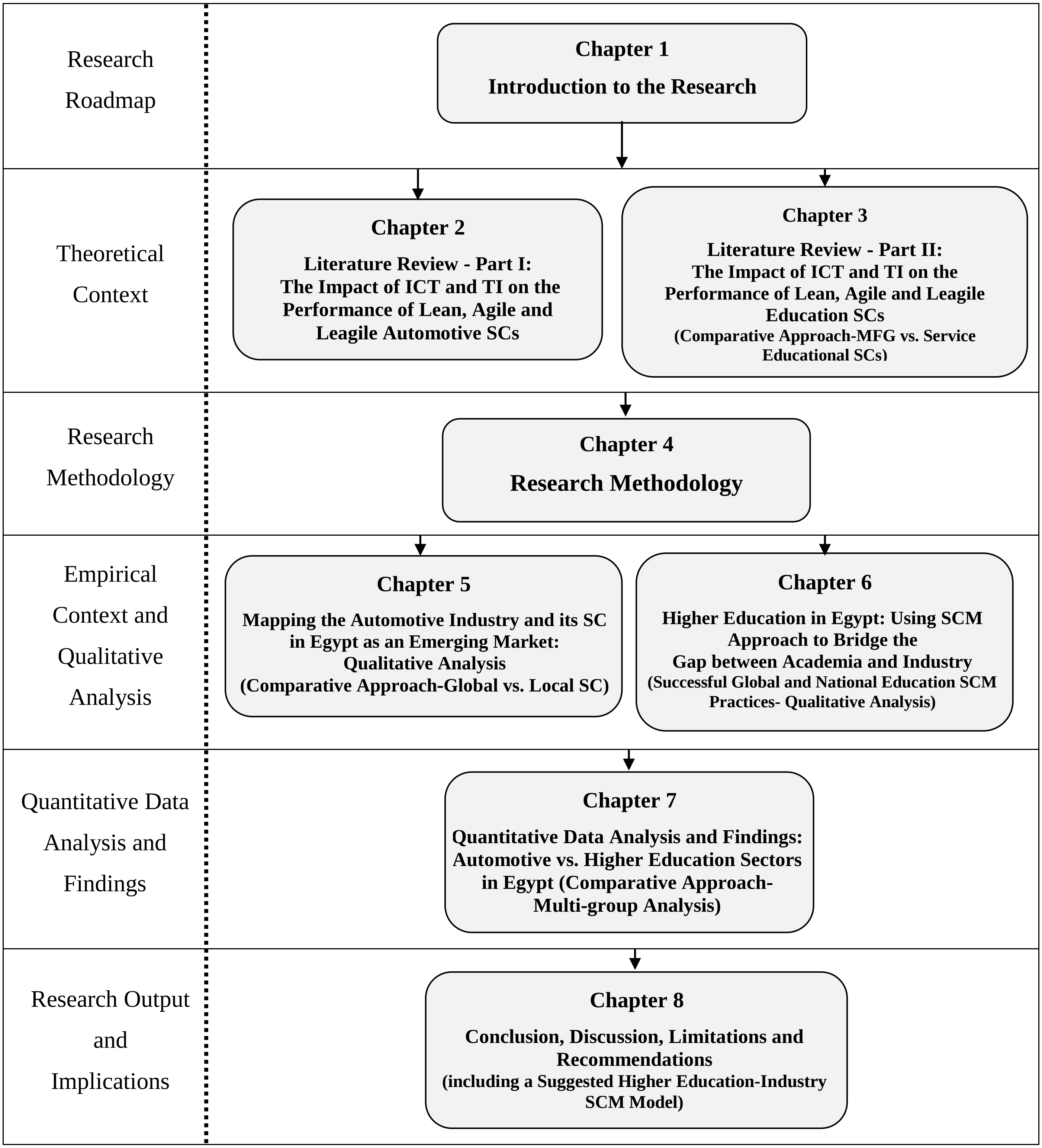


Figure 1.3. The Thesis Structure/Flowchart

The remainder of this thesis is organized as follows: Chapter two discusses the reviewed literature related to the main constructs; namely ICT, SCI, SCIS, HSCP and TI, and the relationship between them. It underscores the importance of using ICT and TI in enhancing the performance of automotive hybrid SCs in terms of leanness, agility and leagility in the previous literature. First, this chapter generally discusses the impact of effective and efficient SCM on sustaining organizations' competitiveness in a globalized environment. Then, it highlights the evolution of SC strategies through critically reviewing how researchers and scholars discussed its importance for more effective and efficient supply chain performance (SCP). While regarding applying SC approach to the automotive sector, ASC stakeholders' integration have received due attention throughout this chapter for the purpose of comparatively studying the similarities and differences between applying the SC approach to the global automotive SC and the local one in Egypt, which will be highlighted in chapter five. Finally, the impact of ICT (i.e., directly and indirectly via SCI and SCIS) and TI on the performance of lean, agile and leagile automotive SCs is critically and thematically reviewed from the prior literature.

In regard to applying SCM practices to the service industries, especially the educational sector, chapter three presents different attempts in the prior research literature, which focused on how higher educational institutions (HEI) can sustain an active participation in promoting the required innovation in the society through effectively and efficiently applying SC approach to their operations. In addition, the difference between manufacturing supply chain and service supply chain; especially education service supply chain was comparatively revealed in this chapter. Moreover, this chapter introduces various examples of profit and nonprofit HEIs, in different countries, that successfully applied SCM Practices. Furthermore, the impact of ICT and TI on the performance of lean, agile and leagile education SCs are critically and thematically reviewed in the previous literature.

With regard to chapter four, it introduces the used methodology. It pinpoints how the research questions were addressed via both qualitative and quantitative approaches (i.e., mixed methods approach). In the light of the prior research literature that was thematically scanned throughout chapter two and three, the boundary of this research was properly addressed to prevent irrelevant data collection and that is thoroughly discussed in this chapter. Accordingly, this chapter specifies the types and sources of the collected data in the area of SCM; especially ASCM, ESCM, ICT, TI and HSCP. In addition, this chapter indicates the research population and the sampling technique and data collection methods used throughout the research process.

Chapter five presents a background on the nature of the global automotive industry supply chain and maps out the Egyptian automotive emerging market. As this research can be characterized as a qualitative and quantitative research (i.e., using abductive approach), the researcher in this chapter provides an in-depth qualitative understanding of the nature of this important industry, which motivated the researcher to choose this context. More importantly, it ensures an accurate formulation of the research operationalization, which was used later on in the quantitative analysis. The qualitative analysis was performed by the researcher through conducting a comparative study between global automotive supply chain and Egyptian automotive supply chain. Thus, an in-depth qualitative understanding of the proposed relationships and description of the underlying causes of the research problem can be achieved.

Similarly but in the higher educational context, chapter six provides a background on the nature of the higher education sector in Egypt. It discusses various successful local and global SCM practices implemented in different HEIs operating in Egypt as well as abroad. Hence, this research can provide practical examples of using SCM approach to bridge the gap between academia and industry; thus, linking different higher education SC stakeholders together. Finally, it develops a new higher education SCM model and recommends its usage for improving the HSCP of HEIs operating in Egypt.

Afterwards, the researcher in chapter seven reveals that a quantitative research approach (Deductive) was carried out as primary data collected (using triangulation design) was partially based on interviews and partially on questionnaires. A quantitative statistical analysis was used in order to be able to analyze and interpret the collected data, and recommend final courses of actions. In other words, Chapter seven presents the data analysis and findings related to both sectors. Afterwards, the researcher comparatively investigated the differences of the measurement results between the two main sectors and the three sub-sectors of the automotive industry, which are presented in this chapter.

Finally, chapter eight summarizes the research findings and conclusions. Additionally, it discusses the main findings in the light of the conceptual and empirical contribution and managerial implications for both sectors. Moreover, this chapter presents a new higher education-automotive SCM model suggested by the findings of the current research to bridge the detected gap between HR/research supply and demand (academia-industry partnership). Furthermore, it points out the research limitations and suggestions for future research.

CHAPTER TWO

Literature Review - Part I:

The Impact of ICT and TI on the Performance of Lean, Agile and Leagile Automotive SCs

2.1. Introduction

This chapter discusses the reviewed prior research literature related to the current research main constructs; namely ICT, SCI, SCIS, HSCP and TI, and the relationship between them. It underscores the importance of using ICT and TI in enhancing the performance of automotive hybrid SCs in terms of leanness, agility and leagility in the prior literature. First, this chapter generally discusses the impact of effective and efficient SCM on sustaining organizations' competitiveness in a globalized environment.

Afterwards, it highlights the evolution of SC strategies through critically and thematically reviewing how researchers and scholars addressed its importance for more effective and efficient supply chain performance (SCP). While regarding applying supply chain (SC) approach to the automotive sector, ASC stakeholders' integration have received due attention throughout this chapter for the purpose of comparatively studying the similarities and differences between applying the SC approach to the global automotive SC and the local one in Egypt, which will be revealed in chapter five. Finally, the impact of ICT (i.e., directly and indirectly via SCI and SCIS) and TI on the performance of lean, agile and leagile automotive SCs is critically and thematically reviewed from the prior research literature.

2.2. The Impact of Effective Supply Chain Management on sustaining Organizations' Competitiveness in a Globalized Environment

Supply chain management and globalization are interrelated concepts. Effective supply chain management (SCM) should include formulating, implementing and evaluating the right strategies in order to compete effectively and efficiently in an ever changing globalized fierce environment through sustaining various competitive advantages.

Li *et al.* (2006) pointed out that effective SCM has turned out to be a value-adding means of sustaining various competitive advantages and enhancing the institutional performance as competition nowadays has been witnessed to be amongst entire SCs, rather than individual organizations (Towill and Christopher, 2002; Li *et al.*, 2006).

As for sharing a common language for conceptually understanding the relationship between supply chain management (SCM), competitive advantage and globalization, some concepts/terms (e.g., globalization, core competence, competitive advantage and SCM) are needed to be clarified first.

2.2.1. What's meant by Supply Chain Management, Competitive Advantage and Globalization?

Globalization, as defined by Hosseinzadeh (2010), is a process that deals with the integration/linkage between governments, organizations and individuals of various countries. In addition, it addresses the relationship between global markets for multiple products (e.g., flows of goods, ideas, services, money and HR).

Moreover, it impacts the worldwide communities in terms of their social, political, economical, technological and competitive environments in an interdependent manner (Hosseinzadeh, 2010).

One can trace another definition of globalization by Curzen (2001) in Hosseinzadeh (2010), who viewed it as an interaction of economies related to individual countries forming one global economy.

In regard to a study outlined by Malmström (2002), the needs and expectations of customers and other stakeholders are ever-changing; thus, competitive advantages can be difficultly maintained on the long-term. For that reason, maintaining long-term competitive advantages needs strategic plans for investing in tangible and intangible resources.

Hence, it is important to assert that "competence" –as elaborated by Malmström (2002) – is a prerequisite resource for sustaining competitiveness in stochastic ever-changing technological and customers demands. In other words, consider a competitive advantage (e.g., innovation) as a fruit; then, the competence (e.g., the ability of an organization to generate creative ideas/patents) represents the cultivated root for the sustainability of such fruit.

Similarly, one can find out a further conceptual meaning for competence by Sanchez *et al.* (1996) and core competence by Prahalad and Hamel (1990) in Malmström (2002), as the first term refers to the strength/power of accomplishing; whereas a core one can be represented by a sustainable point of strength of a competing organization.

Building on this definition, Malmström (2002), after consolidating the prior research literature, pointed out that a core competence generates a distinctive competitive advantage (e.g., through differentiation, cost-leadership, frequent developments of new products) that cannot be easily replicated by rivals.

Besides, he contended that organizations –after investing in developing their key competencies– are more capable in maintaining a strategic competitive edge over their rivals.

Afterwards, Malmström (2002) mentioned that different quality dimensions of a new product (e.g., reliability and distinctiveness) show the organizational ability (i.e., competence) in satisfying its changing customers' demands. Furthermore, a strategic competitive advantage can't be gained from constant reserve of competencies but it can be developed from non-stop investment in the knowledge, skills and abilities (KSA) possessed by an organization that act as obstacles towards any replication efforts by its rivals (Reed and DeFillippi, 1990; cited in Malmström, 2002).

Accordingly, dynamically accumulated competencies lead to competitiveness; thus, investing in developing the organizational KSA (i.e., competencies acquirement) is crucial for sustaining a competitive edge in the marketplace. As a consequence, such organization can quickly and flexibly respond/adapt to varying market conditions (Moreau, 2000; Durand and Quelin, 2000; cited in Malmström, 2002).

In respect to supply chain management, as maintained by Kainuma and Tawara (2006), is a business concept that was recently coined then received increasing attention from academics and practitioners.

Integrated SCM refers to the process of managing all the functions related to transforming and flowing a certain product (e.g., from raw-materials to a final product) across different nodes/partners (e.g., suppliers, manufacturers, distributors and customers) in one coordinated chain (Bowersox and Closs, 1996; Huang *et al.*, 2002; Kainuma and Tawara, 2006).

Specifically, the management term pinpoints the criticalness of having systematic inter- and intra-integration of such nodes and their coordinated functions (Bowersox and Closs, 1996; Kainuma and Tawara, 2006).

Likewise, Lummus and Vokurka (1999) indicated that the SC is related to the entire activities accompanied with developing a final product from different resources until it reaches its end-users (i.e., encompassing supplying of needed materials/information, MFG and assembling, distributing) (cited in Al-Turki *et al.*, 2008) while moving across different SC members.

According to those above-mentioned definitions, the SC nodes/participants/members include the manufacturers/assemblers or the service providers and their up-stream multiple tiers of suppliers, down-stream distribution networks, and customers (i.e., B2C consumers and B2B business organizations) (Kainuma and Tawara, 2006).

In a similar research vein, the SC –as was contended by Naylor *et al.* (1999) – is a linking system of interdependent parties (e.g., suppliers, manufacturers, distributors and users) connected altogether by means of feed-flow (i.e., forward starting up-stream the SC and backward from down-stream the SC) of various tangible/intangible resources.

Afterwards, Simchi-Levi *et al.* (2003) viewed SCM as a group of strategies used in efficiently linking different players (e.g., suppliers and suppliers-of-suppliers, producers and retailers/wholesalers) together; thereby, a product is delivered on time to the required place with the required amount while reducing different costs and meeting customers' expectations (cited in Al-Turki et al., 2008).

The main objective of conducting SCM, as was confirmed by Al-Turki *et al.* (2008), is achieving a unified system that operates along a whole SC. Furthermore, they added that SCM entails synchronizing the flow of different resources (e.g., information, materials, and capital) throughout harmonized processes, which are carried out internally at each node and externally between its different stakeholders.

From a practical standpoint, SCM approaches and practices have received due escalating attention lately due to the importance of using them while optimizing favorable opportunities and overcoming detected obstacles in a changing marketplace (Al-Turki *et al.*, 2008). In this sense, Al-Turki *et al.* (2008) ascertained that considering the business organizations and their external environments as a supplier-customer network/chain represents the essence of such integrated philosophy.

2.2.2. The Relationship between Supply Chain Management, Competitive Advantage and Globalization

Li *et al.* (2006) promoted that in the last two decades international cutthroat competition increased the roadblocks and obstacles related to the on-time efficient delivery of a product (e.g., good and service) to where it should be distributed. They added that, later on, companies became more aware of the importance of not only enhancing the efficiency of each institution but also boosting the performance of its entire SCs. Accordingly, applying the SCM principles to different sectors is a vital requirement for maintaining a sustainable development and maximizing the profitability of each SC member.

The Council of Logistics Management (CLM) (1991) used the "logistics" term throughout its definitions instead of "physical distribution MGT" concept; afterwards, CLM (2000) viewed that the SCM concept refers to the deliberate sustainable synchronization of the performed activities at each organization (i.e., internally) and among entities along the entire SC (i.e., externally) in order to enhance the performance of each SC node as well as its entire upstream and downstream SC players (cited in Bowersox and Closs, 1996; cited in Li *et al.*, 2006).

Thus, it is obvious that the aforesaid definition of supply-chain MGT considers the long term inter-organizational linkages among various SC participants and focuses on the ultimate goal of SCM, which is boosting both the organization and its SC performance via orchestrating the tangible/intangible up- and down-stream SC flows smoothly; thereby, sustaining competitiveness (Childhouse and Towill, 2003; Feldmann and Müller, 2003; cited in Li et al., 2006).

Li *et al.* (2006), after consolidating the prior literature, contended that the supply-chain MGT research gained much popularity from academics as well as practitioners, which forced different industries to appreciate its role as a means for maintaining long term competitiveness over its rivals in an ever-changing globalized business environment (Jones 1998; cited in Li *et al.*, 2006).

2.2.3. The Impact of SCM Practices on improving Organizational Performance, through sustaining Organizations' Competitive Advantages

Competition nowadays has been witnessed to be among supply chains, rather than individual organizations (Towill and Christopher, 2002; Li *et al.*, 2006).

Therefore, the supply chain management (SCM) term has been defined in many different attempts in the literature to build a shared understanding of this important concept among researchers and practitioners.

SCM refers to the systematic integration and coordination (Sheffi and Klaus, 1997; Li *et al.*, 2006) of all the activities related to the transformation and flow of a certain product across different nodes/partners in one chain, including suppliers, manufacturers, distributors and customers (Bowersox and Closs, 1996; Huang *et al.*, 2002; Kainuma and Tawara, 2006), which are linked together via a seamless dynamic flow of materials, information (Bowersox and Closs, 1996; Naylor *et al.*, 1999; Huang *et al.*, 2002; Kainuma and Tawara, 2006; Li *et al.*, 2006; Al-Turki *et al.*, 2008), finance (Huang *et al.*, 2002) and HR that moves within and among these integrated entities (Al-Turki *et al.*, 2008).

In the light of this consolidated definition, the goal of effective and efficient SCM is that the entire system is viewed as one integrated coordinated system (Li *et al.*, 2006; Al-Turki *et al.*, 2008).

Li *et al.* (2006) developed a model that revealed the indirect impact of SCM on performance through sustaining various aspects of a competitive advantage. Furthermore, they identified five main factors of assessing SCM practices: strategic supplier partnership, long-term customer relationship, the level as well as the quality of information sharing, and postponement.

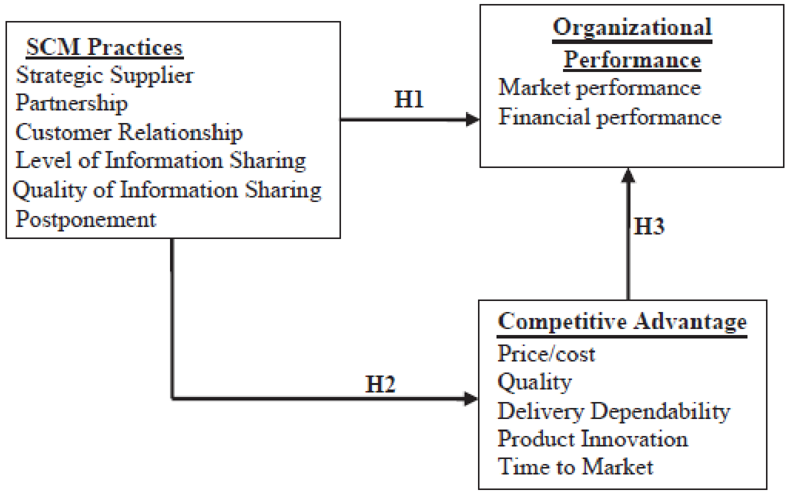


Figure 2.1. Factors of Supply Chain Management
Source: Li *et al*., 2006

2.3. The Evolution of Supply Chain Strategies

Various supply chain strategies and performance paradigms have emerged in the last decade for the purpose of helping organizations to better compete and maintain a sustainable development in a dynamic ever-changing globalized competitive environment (Lau, 2007; Al-Turki *et al.*, 2008). The growing interest in some of these SC strategies such as leanness, agility and leagility can be seen in the works of many researchers.

Some scholars pointed out the importance of the lean thinking paradigm and lean SC (Womack and Jones, 1996; 2005; Cagliano *et al.*, 2004; Melton, 2005; Scherrer-Rathje *et al.*, 2009; Azevedo *et al.*, 2012), while the agility and agile SCP paradigm have received due attention from other researchers (Power *et al.*, 2001; Burgess *et al.*, 2002; Lin *et al.*, 2006; Paulraj and Chen, 2007; Sherehiy *et al.*, 2007; Gunasekaran *et al.*, 2008; Khan and Pillania, 2008; Swafford *et al.*, 2008; Bottani, 2010; Ivanov *et al.*, 2010; Azevedo *et al.*, 2011; Azevedo *et al.*, 2012).

As for the leagility concept, after being coined by Naylor *et al.* (1999), it was highly advocated by many studies (Mason-Jones *et al.*, 2000; Towill and Christopher, 2002; Prince and Kay, 2003; Stratton and Warburton, 2003; Turner and Williams, 2005; Agarwal *et al.*, 2006; Goldsby *et al.*, 2006; Chan and Kumar, 2009; Naim and Gosling, 2011).

2.3.1. Lean Supply Chains

Before discussing the development of lean supply chains, we should first build a shared understanding of what's meant by lean thinking and lean supply chains. Then, this part of the research discusses how lean principles can be applied to the supply chains, which results in a more effective and efficient SCM process.

Lean paradigm involves eliminating waste "muda" (Womack and Jones, 1996; 2005; Naylor *et al.*, 1999; Towill and Christopher, 2002; Kahn and Mello, 2004-05; Melton, 2005; Goldsby *et al.*, 2006; Scherrer-Rathje *et al.*, 2009) and synchronizing continuous improvement efforts to drive efficiency across the entire value-chain (Huang *et al.*, 2002; Kahn and Mello, 2004-05; Melton, 2005; Goldsby *et al.*, 2006).

In other words, leanness is about achieving more (i.e., significant outcomes/benefits) with less (i.e., waste reduction/removal) (Naylor *et al.*, 1999; Towill and Christopher, 2002; Scherrer-Rathje *et al.*, 2009). Available literature (Womack and Jones, 1996; 2005; Towill and Christopher, 2002; Stratton and Warburton, 2003; Melton, 2005; Goldsby *et al.*, 2006; Chan and Kumar, 2009; Scherrer-Rathje *et al.*, 2009) reported that lean philosophy, which gained much attention from the automotive industry especially after Toyota production system (TPS) was developed by Ohno (1988), promises prominent benefits in terms of elimination of wastes.

According to Ohno (1988) and Womack and Jones (1996), waste in production is any non value-adding activity or element of production, and its main forms/types are: defects/errors, unneeded production and excessive processing, needless/repetitious movement of information and people, unnecessary transport of raw materials and products, excessive inventory and waiting time (Ohno, 1988, Goldsby *et al.*, 2006; Chan and Kumar, 2009). Reduced/eliminated wastes can be translated into more financial savings, streamlined processes (Melton, 2005) and increased efficiency (Goldsby *et al.*, 2006).

Figure 2.2. Types of Wastes/Muda
Source: Ohno, 1988; Melton, 2005

Accordingly, such benefits that are seen within different industries, particularly the automotive industry, are well recognized in the prior literature (Melton, 2005). For example, decreased lead times for customers, reduced inventories for manufacturers, improved knowledge management, and more robust processes (measured by less errors; thus, less rework). Further, various outcomes are generated from applying the lean approach to different processes along the whole SC; for example, improving the response rate (i.e., efficiency) of performing a process. Additionally, better/efficient linkage of processes along the whole SC leads to considerable financial benefits to every organization/node along that SC (Melton, 2005).

Figure 2.3. The Benefits of Lean Thinking

Source: Melton, 2005

At this point it is important to mention that in this study, the researcher focuses on lean SCP in terms of efficiency, removal of wastes and continuous improvement.

Despite the abundance of research on the benefits of applying lean approach to different industries (e.g., automotive industry), changing market/customer needs forced many SCs –even Toyota the "lean thinking" inspirer/pioneer– to search for other strategies that enable them to flexibly and quickly respond to these varying requirements (Towill and Christopher, 2002; Goldsby *et al.*, 2006; Chan and Kumar, 2009; Elmoselhy, 2012).

2.3.2. Agile, Adaptive and Responsive Supply Chains

This part is divided into two sections; the first one focuses on discussing the agile supply chain model, while the second one introduces the distinguishing attributes between lean and agile supply.

2.3.2.1. Agile Supply Chains

Agility in SCM was defined as the ability of a supply chain to quickly and flexibly respond to changing customer demands (Naylor *et al.*, 1999; Goldsby *et al.*, 2006; Lin *et al.*, 2006; Sherehiy *et al.*, 2007). In other words, Goldsby *et al.* (2006), after building on prior studies, discussed the difference between lean and agile supply chains by pointing out that lean management advocates process efficiency (i.e., generating the maximum output from effective usage of input through wastes reduction); whereas, agility is about effective, rapid and flexible accommodation of changing customer/market demands. Additionally, one can trace the definition of an agile organization of Naylor *et al.* (1999) in Goldsby *et al.* (2006), which refers to the one that utilizes market knowledge and the benefits of virtuality in taking advantage of profitable opportunities throughout a stochastic changing market.

It is important to note that agility characteristics/attributes/capabilities, drivers and pillars/enablers have been widely reported in literature (Bottani, 2010). Despite the differences, many studies (Naylor *et al.*, 1999; Prince and Kay, 2003; Lin *et al.*, 2006; Paulraj and Chen, 2007; Sherehiy *et al.*, 2007; Gunasekaran *et al.*, 2008; Swafford *et al.*, 2008; Bottani, 2010; Ivanov *et al.*, 2010) suggested that “flexibility”, “speed/quickness” and “responsiveness” are the most important dimensions/aspects of agility and agile SCP.

This research relies heavily on these three dimensions in developing the item measures for the ASCP factor. Lin *et al.* (2006), while measuring the agile SCP of a Taiwanese company, developed a SC agility evaluation model and identified four agile “capabilities” or “attributes” as being called by Sherehiy *et al.* (2007): “flexibility”, “responsiveness”, “speed” and “competency”. Sherehiy *et al.* (2007) discussed the main characteristics of agility which can be applied to all aspects of a supply chain: flexibility, responsiveness, speed, culture of change, integration and low complexity, high quality and customized products, and sustainable core competencies.

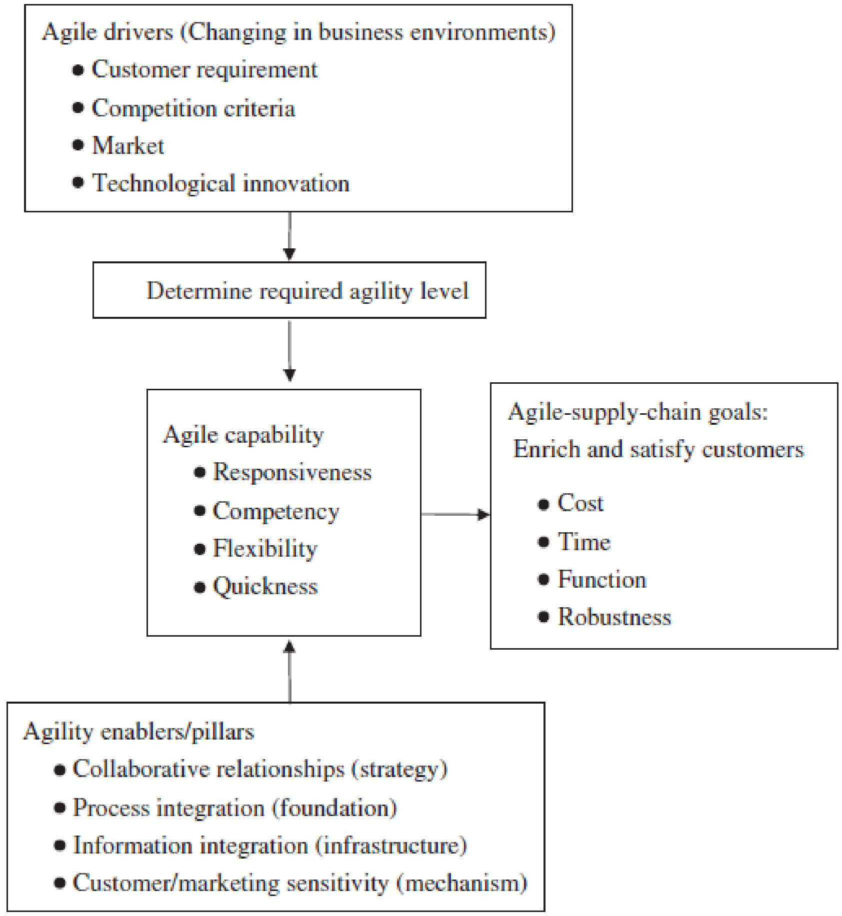


Figure 2.4. The Agile Supply Chain Model

Source: Lin *et al.*, 2006

However, other studies considered technology and cost as crucial aspects of agility. For example, Gunasekaran *et al.* (2008), while introducing an integrated framework for developing a responsive SC, added “cost-effective” element to “speed” and “flexibility”. Moreover, they analyzed an automotive case experience and discussed how Nissan used ICT in improving their agile SCP.

Similarly, Bottani (2010), after consolidating the literature on agility and developing a multi-dimensional questionnaire to empirically investigate the agile paradigm of 189 companies, found out that ICT can be considered as one of the most relevant agile attributes.

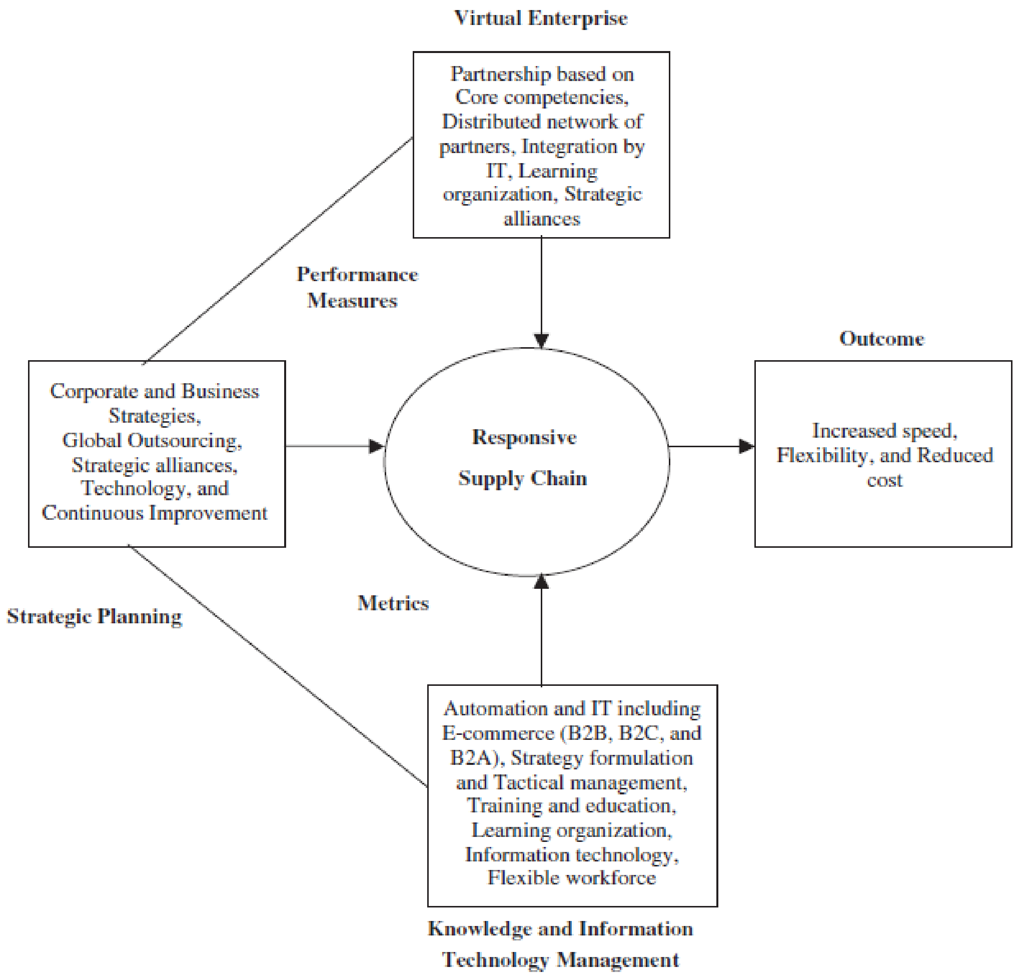


Figure 2.5. The Responsive Supply Chain Management Framework

Source: Gunasekaran *et al.*, 2008

In a similar vein but with more concentration on the importance of ICT in adaptive SCM, Ivanov *et al.* (2010) presented a multi-structural framework where ICT plays a value-adding role in making SCs more flexible, responsive, cost-effective and adaptable to internal and external environmental changes.

Technology was also found to be a critical success factor in agile SCM after Power *et al.* (2001) empirically investigated the effect of technology and other independent variables on agile SCP. Prior research literature (e.g., Khan and Pillania, 2008) studied SC agility in different manufacturing sectors (e.g., pharmaceuticals, textiles, automobiles).

However, Khan and Pillania (2008) recommended that further studies should be conducted based on collected data from multiple nodes along the SC of each industry; thus, providing deeper insights regarding its applicability. Thus, the current research assessed the SC agility (as one dimension of hybrid lean-agile SCP) of multiple SC members/nodes (i.e., supplier, manufacturer and distributor) representing three main sub-sectors of the same industry (i.e., automotive) in an emerging market.

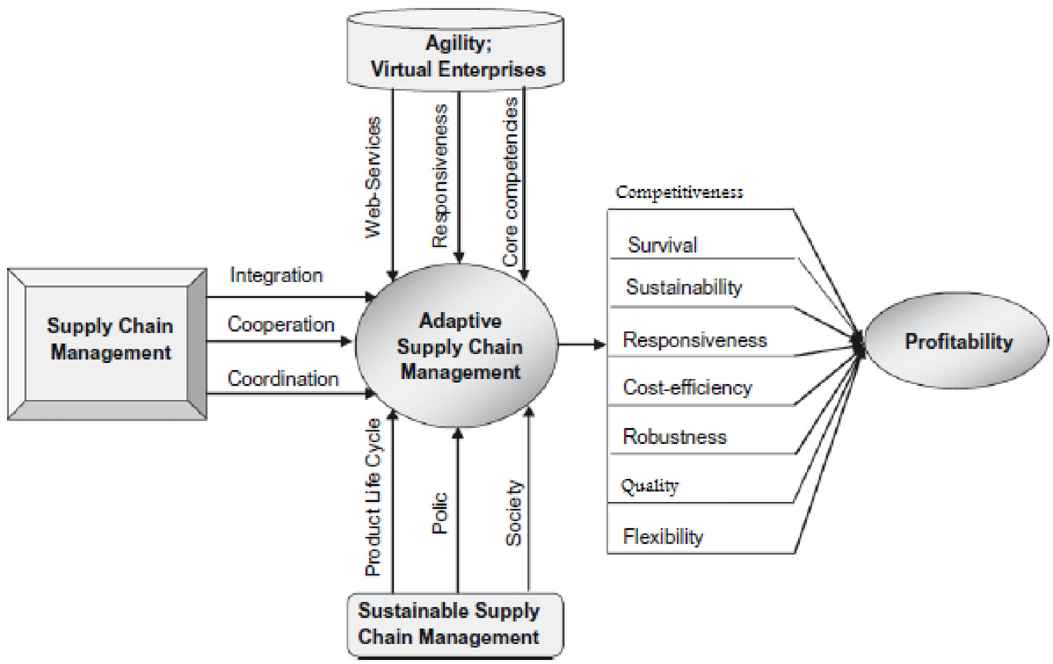


Figure 2.6. The Adaptive Supply Chain Management Framework
Source: Adapted from Ivanov *et al.*, 2010

2.3.2.2. The Distinguishing Attributes between Lean and Agile Supply

Mason-Jones *et al.* (2000) emphasized the distinguishing features of each concept, after building on the definitions developed by Naylor *et al*. (1999). They described the Agility concept as the ability of using market knowledge and a virtual corporation to exploit profitable opportunities in a volatile marketplace. While, Leanness means developing a value stream to eliminate all waste, including time, and to ensure a level schedule. They noted that what may be regarded as "Waste" in lean production may conversely be essential in agile production. As McHugh *et al.* (1995) have emphasized, one example, which is the issue of capacity requirements. In lean production, the customer buys specific products, whereas in agile production the customer reserves capacity that may additionally need to be made available at very short notice (cited in Mason-Jones *et al.*, 2000).

Table 2.1. The Distinguishing Attributes between Lean and Agile Supply

Distinguishing attributes	Lean supply	Agile supply
Typical product	Commodities	Fashion goods
Market placed demand	Stable	Unstable
Product variety	Low	High
Product life cycle	Long	Short
Mfg task	Low cost	Delivery speed
Delivery penalties	Long term contractual	Loss of order

Source: Mason-Jones *et al.*, 2000 modified;
cited in Stratton and Warburton, 2003

Later on, Chan and Kumar (2009) discussed these differences by arguing that the implementation of the lean supply chain in an organization results in an improvement in terms of increased flexibility, reduced cost, high inventory turnover, shorter lead time, and defect prevention. These benefits have induced enterprises to upgrade their supply chain according to lean principles. Although the lean supply chain has reduced production costs, the supply chain model has failed to be flexible to demand. This has motivated the development of the agile supply chain model, which emerged as the alternative to lean supply. But the lean concept remains the prerequisite for the agile supply chain. The requirement for enterprises to become highly responsive to fluctuations in demand, in terms of volume and variety, to respond rapidly to customers, and the desire to become market winners has motivated them to shift from lean to agile strategies. The agile supply chain is basically guided by four principles (Goldman *et al.*, 1995): (a) delivering value to customers, (b) becoming adaptable to changes, (c) giving value to human knowledge and skill, and (d) the formation of virtual enterprises. The successful implementation of an agile manufacturing system in an organization requires enterprise level integration, which includes design integration, process planning, and scheduling. The delicacies inherited in the agile supply chain have enabled manufacturing enterprises to handle demand uncertainty and product variety more efficiently (cited in Chan and Kumar, 2009).

2.3.3. From "Lean or Agile" Supply Chains To "Leagile" and "Hybrid Lean-Agile" Supply Chains

2.3.3.1. Leagile Supply Chains

Recent research (Naylor *et al.*, 1999; Huang *et al.*, 2002; Prince and Kay, 2003; Turner and Williams, 2005; Elmoselhy, 2012) has considered lean and agile SCP paradigms as being "mutually supportive" and "complementary" rather than "mutually exclusive" and "competitive". The growing interest in bringing together the two paradigms within the same SC emerged from the need to balance between efficiency and continuous improvement (leanness), responsiveness, flexibility and speed (agility) (Huang *et al.*, 2002; Elmoselhy, 2012) along with mass-customization and postponement (leagility) (Huang *et al.*, 2002) while competing in today's globalized ever-changing business environment.

However, regarding this blended lean-agile strategy, two main approaches/streamlines of research have been detected in the literature. The first line (Naylor *et al.*, 1999; Mason-Jones *et al.*, 2000; Towill and Christopher, 2002; Prince and Kay, 2003; Stratton and Warburton, 2003; Agarwal *et al.*, 2006; Towill and Christopher, 2007; Chan and Kumar, 2009) advocated decoupling the "leagile" SC via the customer-order/product-differentiation point (i.e., postponement strategy) so that lean attributes (e.g., efficiency and continuous improvement) are adopted up to that decoupling point (upstream) whereas the agile features/practices (e.g., speed, flexibility and responsiveness) are implemented after that point (downstream).

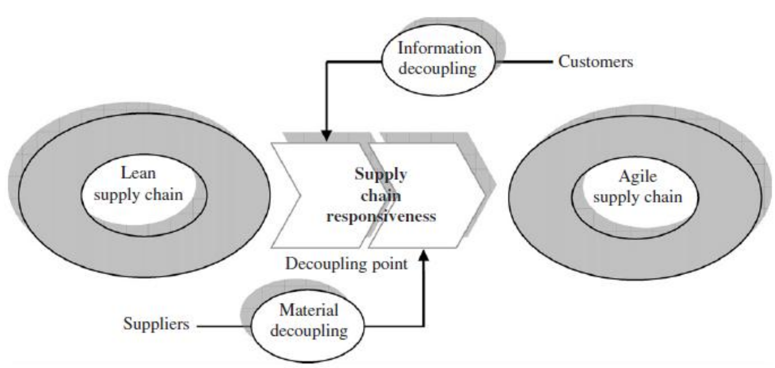


Figure 2.7. Leagile Supply Chain Model and the Decoupling Point
Source: Chan and Kumar, 2009

Thereby, the entire SCP can be improved through merging the salient principles of leanness and agility (Chan and Kumar, 2009). Thus, the best of both strategies could be obtained in what is called "leagile" SC (Mason-Jones *et al.*, 2000; Naim and Gosling, 2011).

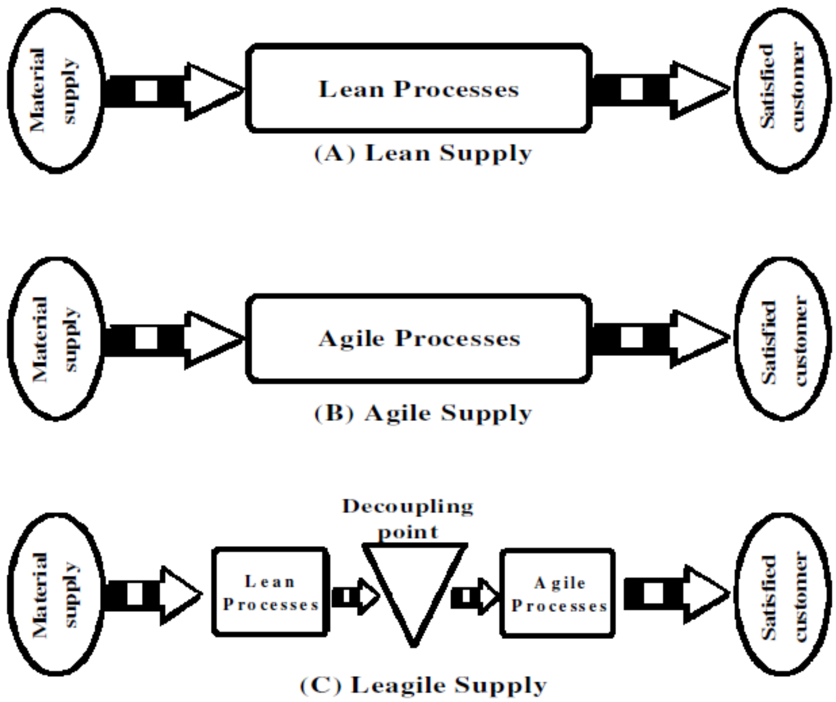


Figure 2.8. Lean, Agile and Leagile Supply
Source: Mason-Jones *et al.*, 2000

Practically, Towill and Christopher (2002), after drawing on the earlier work of Naylor *et al.* (1999) (who coined that "leagility" concept), proposed two other options for encapsulating lean and agile approaches in one site by:

(a) Operating separate lean and agile processes for different products at the same time according to the Pareto (80/20) rule by volume and predictability; and
(b) Practicing lean approach to accommodate certain demand of a product, then facing an unexpected demand of the same product in an agile manner. Afterwards, this approach along with its three options has been supported by Goldsby *et al.* (2006).

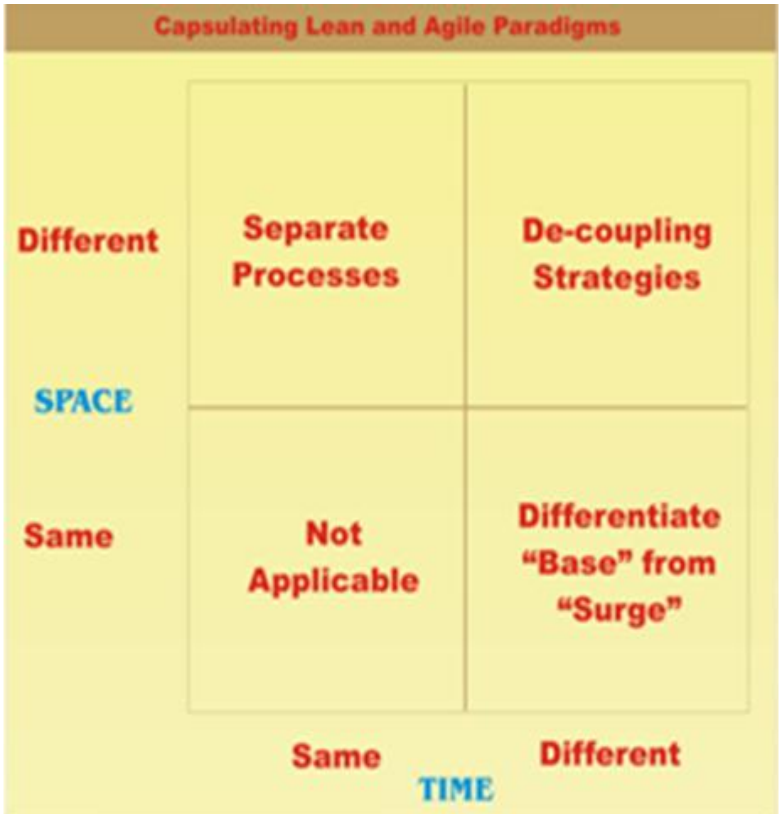
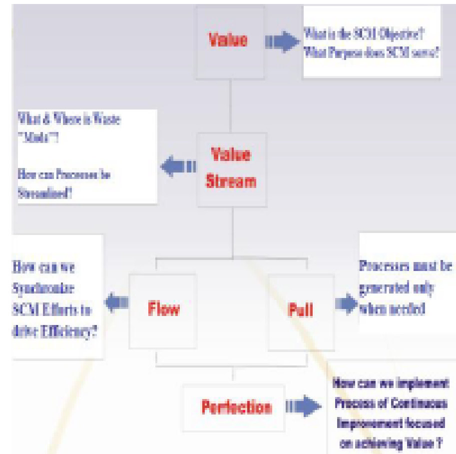
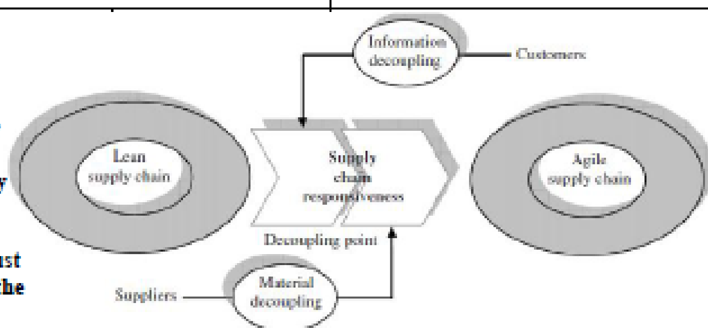
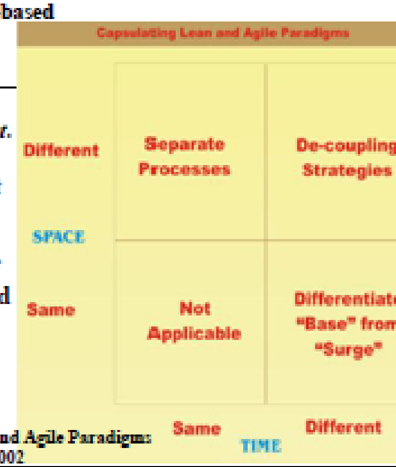


Figure 2.9. Practical Ways of encapsulating Lean and Agile Paradigms
Source: Towill and Christopher, 2002

Since, the automotive industry SC can be barely considered as either absolute lean or agile (Huang *et al.*, 2002; Turner and Williams, 2005). Therefore, the importance and applicability of the blended leagile approach to the automotive industry have been pointed out in the literature (Towill and Christopher, 2002; Turner and Williams, 2005; Goldsby *et al.*, 2006; Naim and Gosling, 2011; Azevedo *et al.*, 2012).

A similar, yet uncommon, paradigm to leagility is the "agilean", which was described by Towill and Christopher (2007) as the approach that applies agility to the upstream of the SC and leanness to the downstream of the SC.

Table 2.2. Lean, agile and leagile SCM implementation

SCP Paradigm	WHY (Its Importance)	HOW (Implementation)
Lean SC	 Figure 2.3. The Benefits of Lean Thinking Source: Melton, 2005 **Doing more with less (e.g., less time, inventory, space, labor, and money) (Towill and Christopher, 2002)**	**<u>Principles of lean SC (Womack and Jones, 1996; 2005; Melton, 2005):</u>** ☑ **Identifying the value** ☑ **Eliminating/reducing wastes/muda** ☑ **Generating flow (value-adding to the customer)** **<u>Requirements for successful lean SCM implementation (Scherrer-Rathje *et al.*, 2009):</u>** ☑ **Observable management commitment** ☑ **Formal mechanisms not only to incentivize but also support autonomy** ☑ **Communicate lean goals with transparency** ☑ **Methods/approaches for sustainable implementation of leanness (e.g., JIT, TQM)** ☑ **Communicate successful lean practices to the whole supply chain** ☑ **Continuous process of evaluation to the implementation of lean practices**  **Figure 2.10. Five Steps to Lean Thinking** **Source: Adapted from Kahn and Mello, 2004-05**
Agile SC	**<u>Agility Goals (Lin *et al.*, 2006):</u>** **Delight customers through different competitive dimensions:** ☑ **Time** ☑ **Robustness** ☑ **Function** **<u>Agility Aspects (Lin *et al.*, 2006):</u>** ☑ **Responsiveness** ☑ **Flexibility** ☑ **Speed**	**<u>Agility Drivers (Lin *et al.*, 2006):</u>** ☑ **Stakeholder/Customer requirements** ☑ **Competitive globalized environment** ☑ **Technological innovations and Market changes** **<u>Agility Enablers/Pillars (Lin *et al.*, 2006):</u>** ☑ **Collaborative partnerships** ☑ **Information sharing** ☑ **Customer order-based** ☑ **Integration**
Leagile SC	**Capitalizing on the benefits of both paradigms; thereby, getting the best of both worlds (Mason-Jones *et al.*, 2000; Naim and Gosling, 2011). Leagility is about encapsulating both lean and agile features (i.e., more robust strategy incorporating the salient features of both lean and agile principles) (Chan and Kumar, 2009).**  **Figure 2.7. Leagile Supply Chain Model and the Decoupling Point** **Source: Chan and Kumar, 2009**	**Decoupling the SC is through using the concept of *Postponement*. In other words, implement lean practices up to a decoupling point "customer order" by maximizing efficiencies -through standardization and economies of scale- and afterwards, be agile and highly responsive to actual demand after that point/order (Naylor *et al.*, 1999; Chan and Kumar, 2009).**  **Figure 2.9. Practical Ways of encapsulating Lean and Agile Paradigms** **Source: Towill and Christopher, 2002**

2.3.3.2. Hybrid Lean-Agile Manufacturing System

As for the second approach/line of research, Huang *et al.* (2002) and Elmoselhy (2012) called for using a hybrid lean-agile supply chain that balances between cost-reduction (leanness), responsiveness/availability (agility), and mass-customization and postponement (leagility).

The difference between leagile SC (i.e., first approach) and hybrid lean-agile manufacturing system (i.e., second approach) was discussed by Elmoselhy (2012), who suggested using a hybrid lean-agile framework that incorporates the main principles of leanness and agility together in one system linking the entire SC.

Additionally, after conducting a case-study approach to review and examine GM production system, he verified the usefulness and applicability of his hybridized manufacturing framework to only one successful automotive SC, then recommended that further research can be conducted regarding this hybridized strategy.

However, he disregarded the position of each node in the SC that affects the hybridized component/share of each strategy (i.e., leanness and agility), which was suggested by the findings of this thesis.

A similar view was expressed by Huang *et al.* (2002), but it was proposed to the hybrid products only. As the name implies, a hybrid product (e.g., automobiles) comprises a mixture of standard and innovative parts/components, which are produced via different industries that use both lean and agile strategies (Huang *et al.*, 2002). Then, they are assembled-to-order (i.e., postponement), and finally sold in an agile-manner (Huang *et al.*, 2002).

This way, the need for a hybrid SC is justified (Huang *et al.*, 2002) and can be detected in the literature of contemporary SCM.

2.3.3.3. A New Hybrid Lean-Agile SC Approach was generated as a Conceptual Contribution for the Current Research

The observations of the second approach (i.e., hybrid lean-agile manufacturing system) are again evident in the results of the current study, as the AISC in Egypt –along with its three main sub-sectors– was found to be using a blended strategy that hybridizes the attributes of leanness (e.g., cost-minimization, waste-reduction, continuous improvement) together with that of agility (e.g., speed, flexibility, responsiveness) and leagility (e.g., mass-customization, postponement).

However, the findings of the current thesis do not exhibit any contradiction with the first line of research (i.e., leagility approach) especially after conducting multi-group/sub-sector analysis, which will be shown in chapter seven. As after the SCP of the Egyptian automotive industry has been investigated, the results of the quantitative and qualitative data analyses showed that the percentage of the hybridized lean component is higher, upstream the AISC (i.e., automotive suppliers in the EAFI), than the agility component in the same sub-sector; compared to the SC market-interface (i.e., automotive distributors downstream the AISC), which operates in a more agile-manner.

Thus, the present study considers both lines of research, namely the leagility approach and the hybridized lean-agile manufacturing system, as being complementary rather than competitive.

In other words, it builds on the idea of having different attributes from each strategy (i.e., leanness and agility) in one organizational manufacturing system, which was revealed throughout the second line of research (e.g., Elmoselhy, 2012). However, it adds to this line of thinking the leagility component (i.e., in terms of mass-customization and postponement) and the impact of the organization position along the SC on the hybridized component/share of each strategy, which were extracted from the first streamline of research.

Therefore, as a conceptual contribution, it conceptually adds to the active debate on the applicability of the blended lean-agile SC strategy by integrating these two aforementioned main streamlines of prior management research regarding this empirical issue; namely the leagility approach and the hybridized lean-agile manufacturing system, into one new hybridized approach (i.e., new hybrid lean-agile SC approach).

2.4. Applying SC Approach to the Automotive Sector: Automotive SC Stakeholders Integration

While, regarding the application of the SCM practices to different manufacturing sectors, especially the automotive industry; and the reason behind the choice of the researcher to the ASCs operating in Egypt –as an example of the manufacturing sector- lies in the importance of this industry to Egypt. As according to the study of American Chamber of Commerce in Egypt (AmCham) (Business Studies and Analysis Center, 2011) and the report of Oxford Business Group (OBG) (2011), Egypt possesses one of the largest automotive markets in the MENA region. In addition, there are 20 operating ASCs in Egypt (Egyptian Auto-feeders Association, 2010) that produce/assemble different international brands (e.g., Chevrolet, BMW, Mercedes Benz, Nissan, Toyota and Hyundai) (Business Studies and Analysis Center, 2011; Oxford Business Group, 2011). In fact, Egypt's automotive market is mainly based on the vehicle assembly.

At the same time, Uttamrao and Rajashree (2009) discussed how supply chain management plays a very important role in the auto industry. Additionally, the automotive industry is changing its business model with innovative supply chain to reduce cost, enhance customer delight and improve quality (Uttamrao and Rajashree, 2009). Thus, the supply chain performance (SCP) has become key important factor for success of automobile companies (Uttamrao and Rajashree, 2009). Moreover, the SCM Practices can be thoroughly observed in a long hierarchical SC, as according to Kim and Im (2002); since, a car is a system product that consists of 20,000 parts on average. Therefore, the automobile industry has a long and hierarchical supply chain. Kim and Im (2002) defined the hierarchical supply chain as a supply chain that has several levels of suppliers (i.e., the manufacturer out-sources part modules (e.g. dashboard and seats) from primary suppliers who out-source the sub-parts from secondary suppliers, and many others).

Whereas regarding the relationship between the information and communication technology (ICT), supply chain integration (SCI), information sharing (IS) and the automotive SCP –which will be discussed later in this chapter– Kamaruddin and Udin (2009) argued it through studying the supply chain technology adoption in the Malaysian automotive companies. They first defined the supply chain technology (SCT) as a technology or a system that is used in coordinating and integrating information flows electronically throughout the supply chain network of trading partners and customers in both directions so as to generate effective and efficient business transactions, quick access to information, allow better customer service, reduce paperwork, allow better communication, increase productivity and save time.

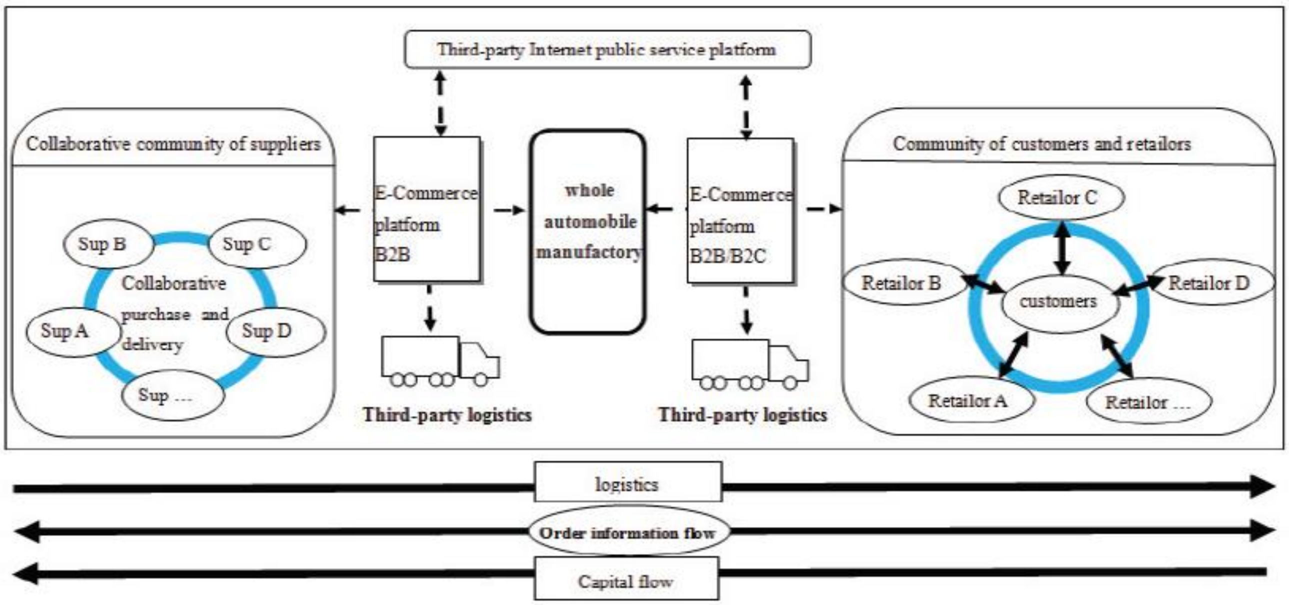


Figure 2.11. Automotive Supply Chain using SCT

Source: Chilin and Li, 2012

Hence, technology plays an important role in the success of SCM. Previously with no internet application companies having difficulty to obtain information because they were not able to receive or to send updates, feedback, or other important information in a timely manner (Power and Simon, 2004; cited in Kamaruddin and Udin, 2009). Consequently, to keep on competition, firms within those supply chains were routinely communicating with each other. While, the development of SCM requires that members of the chain should co-ordinate their production and logistics activities. Thus, this type of co-ordination can be facilitated by different types of SCT.

Finally, Kamaruddin and Udin (2009), after conducting their research in Malaysian automotive companies, they found out that there are high percentages of organizations that have already adopted SCT, and Malaysian automotive suppliers are moving forward to improve the effectiveness and efficiency of their operations. In respect to Patterson *et al.* (2004), innovative technologies facilitate the transfer of more accurate and up-to date information with results of better visibility of demand and inventory throughout the supply chain (cited in Kamaruddin and Udin, 2009). Thus, Kamaruddin and Udin (2009) concluded that SCT is the cord of contemporary SCM.

In a similar vein, Kim and Im (2002) elaborated that in an automobile hierarchical supply chain, information sharing takes long time and causes frequent errors if it is done through fax or paper documents. Furthermore, the hierarchical structure has the bull-whip effect, which occurs when the fluctuation in inventory level is amplified along the supply chain. Therefore, the long and hierarchical supply chain in automobile industry causes inefficiencies in various areas (e.g., design, development, procurement, manufacturing, and logistics) throughout the supply chain.

Thus, automobile industry has a high potential for (B2B) and (B2C) electronic business (e-business) (Kim and Im, 2002). In US, the automobile industry is one of the first industries where B2B electronic supply chain networks are being utilized (Kim and Im, 2002). Kim and Im (2002) defined electronic supply chain network (e-SCN) as a network structure that enables, using IT, electronic transactions and information exchange between manufacturers and suppliers in a virtual space. As a result, through B2B e-SCNs, the participants of a supply chain can exchange and share information that is critical for the efficiencies of the supply chain (Kim and Im, 2002).

Whereas in regard to the importance of conducting technology intelligence (TI) approaches in the automobile manufacturing companies –which will be critically discussed later within this chapter– Lichtenthaler (2003, 2004a, 2004b, 2004c, 2007) pointed out that TI is very crucial for automotive R&D activities. He concluded that by establishing effective technology intelligence processes, automotive companies may react to radical trends in time which is a prerequisite for coping with technological change. Lichtenthaler (2004c) and Savioz (2004) defined TI as a process that encompasses organizational activities related to the collection, analysis and communication of relevant information on technological trends (i.e., technological factors that represent opportunities and threats) to support technological and other general decisions.

While in relation to the importance of having universities-industries partnerships (i.e., cooperative university-industry research relationships) for achieving effective and efficient automotive R&D, Rasiah and Govindaraju (2009), Clemson University International Center for Automotive Research (2007) and Worasinchai and Bechina (2009, 2010) revealed the importance of maintaining universities-industries collaboration/partnerships/relationships with different channels of information for sustaining successful R&D in different automotive firms in Malaysia and Thailand.

2.5. The Direct and Indirect Impact of Information and Communications Technology (ICT) on Automotive Industry Supply Chain Performance

2.5.1. From Information Technology (IT) to Information and Communication Technology (ICT)

Information and communication technology (ICT) was defined by Berce *et al.* (2008) as the integration of “software”, “hardware” and “communication facilities”. Similarly, Lyons (2005) viewed ICT as the convergence or combination of information technology and communication systems. While in terms of a performance-related perspective, ICT refers to a group of technologies used to collect, process and communicate information; thus, acting as a mechanism for facilitating the performance of individuals, organizations and SCs (Swafford *et al.*, 2008; Zhang *et al.*, 2011).

With respect to SCM, Rao *et al.* (2006) considered ICT as a crucial strategic and operational success factor in SCM as it acts as a facilitator for effective and efficient SCI and IS both within each individual SC node and across different partners. Practically, ICT enables the development of an efficient, responsive, fast and flexible system, which links various SC stakeholders/parties as one integrated entity and coordinates all their performed activities in a seamless manner that overcomes time, physical and geographical boundaries (Kim and Im, 2002; Rao *et al.*, 2006). By this means, ICT can help in improving the entire SCP through synchronizing and orchestrating different tangible and intangible SC flows (Kim and Im, 2002) that pass throughout many SC participants playing one symphony yet each player has a different role.

ICT in SCM was regarded in the literature from different perspectives. For example, Shapiro (2001) classified IT into transactional IT (i.e., it is used in collecting, processing and sharing data, about the organization and its SC, across various SC nodes and managers, e.g., ERP) and analytical IT (i.e., it helps SC managers in supporting problem solving and decision making processes through using descriptive and normative models). One can trace these two IT categories of Shapiro (2001) in Rao *et al.* (2006), who underscored the importance of using these information technologies, in addition to other web-based applications, for more effective and efficient SCM.

From another standpoint, Zhang *et al.* (2011) categorized ICT employment in SCs into inter- and intra-organizational technologies. In this thesis, the researcher focuses on ICT in terms of its inter- and intra-organizational levels of employment (i.e., within each individual SC node and across different players).

2.5.2. The Relationship between ICT, Supply Chain Integration (SCI), Information Sharing (IS) and Hybrid Supply Chain Performance (HSCP)

Despite the abundance of studies which have discussed the importance of ICT in the field of production and operations management, there is a little empirical research that investigated the effect of ICT on SCP directly and indirectly through SCM. Additionally, there is a disharmony in the reported empirical findings (i.e., mixed results) of these reviewed studies that directly/indirectly assessed the ICT-SCM-SCP relationship (Zhang *et al.*, 2011).

Furthermore, as far as the literature has been investigated, there is a lack of studies that assessed its effect on hybrid SCP in terms of leanness, agility and leagility. Zhang *et al.* (2011), after reviewing the research papers that used surveys in investigating ICT-SCM-SCP relationships, found that there are four main models describing these relationships. In this study, after scanning the existing literature that focuses on ICT-SCM-SCP relationships, the researcher detected three more models showing other possible relationships (directly and/or indirectly) between ICT, SCM and performance.

Altogether, these seven above-mentioned models can be summarized according to its different purposes as follows:

(1) To measure the effect of ICT –as an indicator/item-measure of SCM practices– on SCP (i.e., SCM-SCP relationship and ICT used only as an indicator). In other words, some studies (e.g., Boon-itt and Paul, 2006; Lee *et al.*, 2007; Kim, 2009) assessed the joint effect of SCM and ICT as one factor, instead of using two separate constructs, on firm/SCP;

(2) To investigate the effect of ICT (as a separate factor) on SCP (i.e., direct ICT-SCP relationship) (Zhang *et al.*, 2011). However, Zhang *et al.* (2011) pointed out

that some of these studies used aggregated items (without differentiating between intra- and inter-organizational technologies) while measuring ICT (e.g., Swafford *et al.*, 2008), or focused only on one level of ICT employment, such as intra-organizational technologies (e.g., Rai *et al.*, 2006) yet the inter-organizational technologies received much more research attention (Zhang *et al.*, 2011);

(3) To investigate the indirect effect of ICT on SCP through a mediator (i.e., SCM) (Zhang *et al.*, 2011) without taking into consideration direct ICT-SCP relationship (e.g., Paulraj and Chen, 2007; Paulraj *et al.*, 2008; Prajogo and Olhager, 2012);

(4) To test the direct relationship between ICT and organizational or SC performance but not in terms of hybrid performance (i.e., leanness, agility and leagility) (e.g., Dowlatshahi and Cao, 2006; Jeffers *et al.*, 2008; Li *et al.*, 2009);

(5) To examine the mediation effect of SCM between ICT and firm performance (i.e., ICT-SCM-performance relationship) without explicitly differentiating between its different practices (e.g., SCI and IS) (e.g., Byrd and Davidson, 2003);

(6) To assess the effect of ICT on performance while using SCM as a moderator (e.g., Jeffers *et al.*, 2008) as being revealed by Zhang *et al.* (2011); and

(7) To investigate the relationship between SC practices/characteristics and firm/SCP while using ICT as a moderator (e.g., Paulraj and Chen, 2007), or as a control variable (e.g., Sánchez and Pérez, 2005).

Zhang *et al.* (2011), after investigating the disharmony in the reported empirical findings of the reviewed studies and also in their used constructs and measures of the three aforementioned concepts (ICT, SCM and SCP), found out that most of these studies concluded that ICT has a positive direct or indirect effect on SCP. However, to the best of the researcher’s knowledge, there is a lack of research that empirically assessed ICT-SCM-SCP relationship in terms of hybrid lean-agile SCs.

In relation to the automotive industry, as it has been discussed in earlier parts of the present study, ICT was found to have a crucial role in positively improving SCP of automotive companies, especially those operating in a more agile manner. In addition, Kim and Im (2002) pinpointed that ICT has a very important role in enhancing automotive SCP in terms of mass-customization (leagility) and cost-minimization (leanness).

Further, not only DaimlerChrysler (2000) pointed out the importance of using ICT for the purpose of electronically linking different SC nodes together efficiently, but also the two merged auto-companies explicitly incorporated different ICT elements while designing their automotive supply system framework. Thus, the current study empirically investigated the direct and indirect impact of ICT on hybrid lean-agile SCP of companies located at different positions along the automotive SC in Egypt as one example of a manufacturing industry.

2.5.3. The Mediating Effect of SCM in terms of SCI and SCIS on HSCP

After a thorough investigation about the stated definitions for the supply chain integration (SCI), the researcher found that the SCI term has yielded a number of various attempts in the prior literature. For example, according to Li *et al.* (2009), SCI can be defined as the extent to which an organization is able to link and coordinate the performed activities internally within its departments and externally across its various SC participants. With respect to the importance of external SCI with suppliers, Xia and Tang (2011) suggested that maintaining a strong supply-base and developing strategic relationship with key suppliers will lead to better agile automotive SCP through enhancing suppliers' loyalty, increasing the level of flexibility and adaptability to changing market conditions, and sustaining cooperative technological research.

As for the present study and based on the conducted in-depth interviews, sustainable quality-based supplier-manufacturer relationship was found to be a critical success factor in hybrid lean-agile SCM of the Egyptian automotive sector.

Concerning its relationship with information sharing (IS), prior SCI studies outlined by Power (2005) stated that better integration and linkage of SC processes and activities, which can be achieved through using IT and effective infrastructure that allows supplier-customer partnerships, will facilitate better communication and information exchange between various SC stakeholders in more efficient and effective way.

Likewise, supply chain information sharing (SCIS) was defined by many scholars. For instance, Koçoglu *et al.* (2011), after scanning the SCIS literature, contended that SCIS refers to the mutual information-based exchanges between different SC players, through using inter- and intra-organizational linkages.

These two aforementioned concepts (i.e., SCI and SCIS) were studied in the prior research literature from different perspectives. In the current study, SCI was investigated –the first mediating variable– in terms of three dimensions: intra-organizational integration (Boon-itt and Paul, 2006; Kim, 2009; Koçoglu *et al.*, 2011), upstream integration with suppliers and downstream integration with customers (Boon-itt and Paul, 2006; Li *et al.*, 2006; Kim, 2009; Koçoglu *et al.*, 2011). As for the measurement of SCIS, the second mediating variable, the researcher relied on the research of Koçoglu *et al.* (2011) and used three main aspects: upstream IS with suppliers (Sezen, 2008; Koçoglu *et al.*, 2011; Prajogo and Olhager, 2012), downstream IS with customers (Sezen, 2008; Koçoglu *et al.*, 2011) and intra-organizational IS (Eng, 2006; Koçoglu *et al.*, 2011).

However, Zhang *et al.* (2011), after consolidating the literature on the ICT-SCM-SCP relationship, pinpointed a very important issue that some studies investigated differently labeled factors/constructs while using similar item measures. Additionally, they noticed that other research papers studied similarly labeled factors while using different measures (Zhang *et al.*, 2011). Another related concern was raised by Koçoglu *et al.* (2011), in respect to SCM-SCP relationship, when they discussed that both concepts (i.e., SCI and SCIS) were integrated together while being studied by different scholars as one factor, and that a very few researchers (e.g., Koçoglu *et al.*, 2011) explored the effect of SCI on SCIS, which in turn will lead to an enhanced SCP. For example, Boon-itt and Paul (2006) and Kim (2009) investigated the same labeled construct "supply chain integration" while using different observed indicators, which also include measures of IS and ICT without separating them as different factors.

On the other side, Lee *et al.* (2007) studied differently labeled factors "supplier, customer and internal linkages" through using explicit items of IS and ICT similar to those used by Boon-itt and Paul (2006) in measuring "supply chain integration". Other studies (e.g., Ibrahim and Ogunyemi, 2012) focused on external SCI in terms of "supplier and customer linkages" and "level and quality of IS" –following the study of Li *et al.* (2006)– as separate factors; however, they ignored internal SC integration and IS in addition to any involvement of ICT measures. Similarly, Sezen (2008) disregarded both the internal aspect of SCIS and ICT; however, the author studied SCI as a separate independent factor from SCIS. Meanwhile, SCM factor was used differently by researchers who went for exploring the possible SCM-SCP relationships. Some of these scholars used it as an independent variable (e.g., Sezen, 2008; Koçoglu *et al.*, 2011) and/or a mediator (e.g., Li *et al.*, 2009; Koçoglu *et al.*, 2011). For example, Koçoglu *et al.* (2011) studied the played role by the intangible/soft SCM practices in improving SCP. Specifically, they investigated the direct and indirect effect of SCI on SCP through IS.

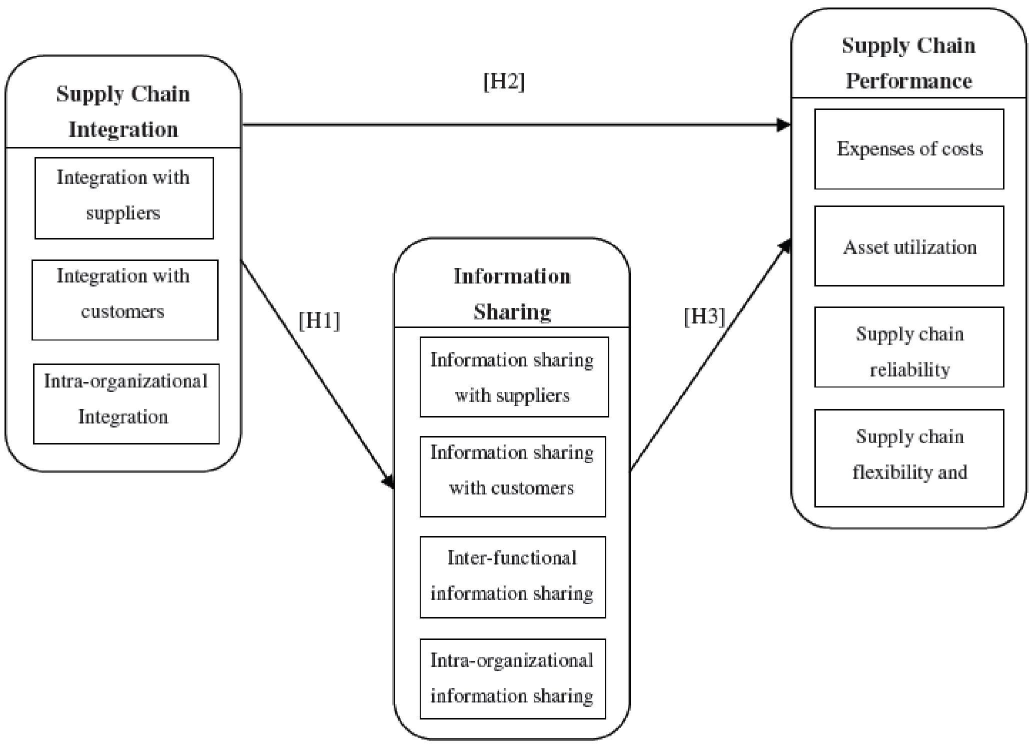


Figure 2.12. The Impact of SCI on IS and SCP

Source: Koçoglu *et al.*, 2011

Finally, they confirmed the existence of positive and significant SCI-IS-SCP relationships and concluded that SCI –via better IS– can lead to improved SCP in terms of minimized SC costs, enhanced supplier-customer relationships, facilitated SC flows and improved rate of customer-order fulfillment (Koçoglu et al., 2011).

From a different perspective, in regard to the indirect relationship between ICT and SCP via SCM, Li *et al.* (2009) studied the impact of IT implementation on SCP through using SCI as a mediator. They concluded that IT implementation has a positive and significant effect on SCP through the mediation effect of SCI as it helps in sharing real-time and accurate information.

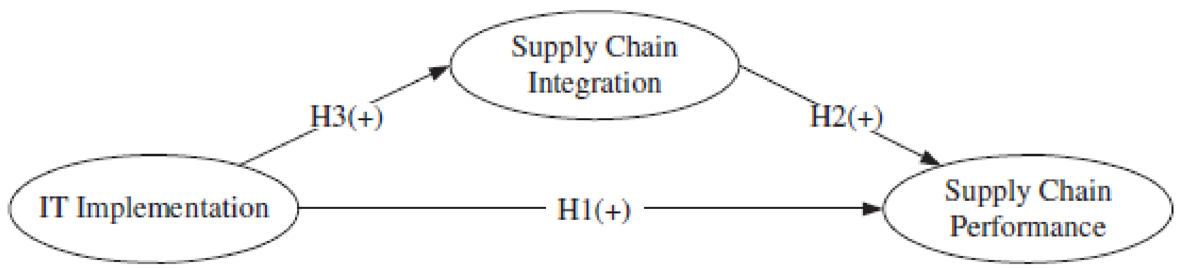


Figure 2.13. The Impact of IT Implementation on SCI and SCP

Source: Li *et al.*, 2009

Regarding the degree of distinctiveness that differentiates SCI from SCIS, the suggested frameworks and reported findings –after establishing the discriminant validity– of Sezen (2008) and Koçoglu *et al.* (2011) asserted that SCI and SCIS are conceptually and empirically distinctive/different concepts. At the same time, Li *et al.* (2009) found that IT, as a different construct, enhances rather than replaces SCI, since the latter adds the crucial aspect of peopleware. For these three studies, the discriminant validity was established after proving that each of these latent constructs (i.e., IT, SCI, SCIS) in each measurement model possesses a degree of distinctiveness that differentiates it from any other latent construct in the same model (Li *et al.*, 2009; Hair *et al.*, 2010). Although these few studies investigated the ICT-SCM-SCP relationship in a variety of contexts, to the best of the researcher's knowledge, this is the first research that assessed the mediation effect of SCM (i.e., SCI and SCIS) on HSCP in terms of leanness, agility and leagility (i.e., indirect ICT-HSCP relationship via SCM) in an emerging automotive market.

2.6. The Impact of Technology Intelligence (TI) on Automotive Industry Supply Chain Performance (AISCP)

Regarding the importance of conducting technology intelligence (TI) approaches in the automobile manufacturing companies, Lichtenthaler (2003, 2004a, 2004b, 2004c, 2007) pointed out that TI is very crucial for automotive R&D activities. He concluded that by establishing effective TI processes, automotive companies may react to radical trends in time which is a prerequisite for coping with technological change. But, first we need to know what's meant by technology intelligence (TI), and the relationship between TI and research and development (R&D) especially in automotive manufacturing companies.

2.6.1. The Relationship between Technology Intelligence (TI) and Research and Development (R&D)

Yoon and Kim (2012) discussed how modern economies emphasize the role of research and development (R&D) that promotes the creation, diffusion and accumulation of intellectual properties within economic systems. Prior study outlined by Yoon and Kim (2012) defined R&D as the creative work carried out on a regular basis to enhance the level and utilization of knowledge for the purpose of creating new applications. Yoon and Kim (2012) were concerned about how technology intelligence (TI) was developed as a method to improve the effectiveness of R&D activities. They revealed that TI has been introduced to plan technology development and formulate technology strategies.

One can trace the technology intelligence (TI) definition of Kerr *et al.* (2006) in Veugelers *et al.* (2010), Dang *et al.* (2011) and Yoon and Kim (2012), who defined it as the process of collecting and disseminating the technological information in order to create awareness of the favorable technological opportunities and unfavorable technological threats.

In a similar vein, Lichtenthaler (2004c) and Savioz (2004) viewed TI as a process that encompasses organizational activities related to the collection, analysis and communication of relevant information on technological trends (i.e., technological factors that represent opportunities and threats) to support technological and other general decisions. According to Lichtenthaler (2004c, 2005) and based on this definition, TI includes the observation and analysis of technological trends related to competitors, universities and start-up companies. Thus, the goal of TI is to exploit potential opportunities and to defend against potential threats through on time delivery of relevant information about technological trends in the environment of an organization.

Lichtenthaler (2004b) and Yoon and Kim (2012) indicated that TI includes technology monitoring, technology assessment, and technology forecasting. Accordingly, Yoon and Kim (2012) demonstrated that as technology lifecycles shorten and business environments become more globalized, technology intelligence capabilities have become increasingly important for experts (e.g., researchers, practitioners and R&D policy makers).

Practically speaking, Yoon (2008) and Yoon and Kim (2012) pointed out that technology intelligence tools have several advantages, including the capability of:

A. Analyzing large amount of information which cannot be assessed by humans alone.
B. Monitoring technology trends and providing technological insights. In regard to the content analysis of different sources, many TI tools have been used for tracing technological trends.
C. Generating much useful information which humans cannot produce (e.g., they can visualize the relationship between technology and companies, and analyze the characteristics of technology using statistical analysis).
D. Assisting experts to make strategic technology plans.
E. Improving the decision making processes through providing relevant information about technology evaluation and technology estimation/forecasting.

2.6.2. Using TI in the Automotive Industry and Universities-Industries Partnerships for enhancing AISCP

As mentioned before earlier in this chapter, Lichtenthaler (2003, 2004a, 2004b, 2004c, 2007) pointed out that TI is vital for automotive research activities. Further, Lichtenthaler (2004b) and Yoon and Kim (2012) revealed the relationship between TI and technology forecasting (TF) while stating that TI encompasses technology monitoring, technology assessment, and technology forecasting. TF is the process of identifying and predicting important research and technology trends and TI is the key to estimating technological opportunities and threats (Behkami and Daim, 2012), which can affect positively or negatively the organizational/SC performance.

In addition, Behkami and Daim (2012) declared that using technology intelligence is used to successfully forecast technology and understand its social impact. Moreover, the exponential growth of internet and electronic communication has led to an increasing number of data sources that can be useful for gathering TI. Furthermore, having the proper information technology tools to collect, analyze, and act on this data is of critical importance to users of technology intelligence (Behkami and Daim, 2012).

However, Zhu and Porter (2002) indicated that empirical technology forecasting (TF) is not well utilized in technology management. They added that there are three factors that could enhance managerial utilization: (1) capability to exploit huge volumes of available information, (2) ways to do so very quickly, and (3) informative representations that help manage emerging technologies.

At the same time, Norling *et al.* (2000) pointed out that companies lack TI capabilities, through stating that business leaders agreed upon that TI is important to support R&D. However, most industrial research institute member companies reported their TI capabilities as lacking.

Stated another way, Geiger and Sá (2005) articulated that firms engage in R&D to acquire competitive advantage in the form of improved products or processes. Hence, research-based innovation is a beneficial social outcome that generates economic returns to producers (i.e., through creating/sustaining competitive advantage) and consumers (i.e., through getting cost-effective and quality-featured products). However, Firms are constrained in their ability to invest in basic research, as returns from basic research are long term and carry a high degree of uncertainty.

Consequently, Geiger and Sá (2005) focused on the importance of the active participation of higher education institutions to promote the required innovation. As a result, scholars have generated a growing literature on university-industry partnerships, technology transfer, systems of innovation, and the economics of university research (Geiger and Sá, 2005).

From a more detailed and practical perspective, Geiger and Sá (2005) discussed the relationship between collaborative/cooperative research (CR) and universities-industries partnerships (UIP) beyond the technology transfer (TT), through giving various and different examples on how American universities have long had close relations with industry, via two approaches either through linking technology creation with job creation or through collaborative research (CR) that aimed at specific technological developments.

In summary, a technology intelligence system (TIS) can be used by university-industry partnerships (UIP) in identifying the trends for research and investments and proposing new development areas (R&D). As TI was proven to be useful in technological research forecasting (TRF), UIP can use it for more effective and efficient technology creation and development. TIS can be used by UIP in identifying developments in different types of ICT that can represent new opportunities or potential threats to various industries (e.g., automotive industry). Thus, effective and efficient ICT employment will be able to enhance SCI and facilitate SCIS, and finally improve the entire SCP (e.g., AISCP) as a whole.

2.6.3. Technology Intelligence System (TIS)

Yoon and Kim (2012) pinpointed the importance of technology intelligence systems as vital components for technology development planning and technology strategies formulation. Boghani *et al.* (2008) indicated that using a technology intelligence system can be extremely beneficial in detecting developments in emerging technologies that could lead to new opportunities to be exploited or posed threats to be overcome. However, the effectiveness of such a system is dependent on deciding on what technologies to track, how to track them, and how to implement it to derive high value for the organization.

Regarding the relationship between managing technology intelligence processes and better reacting in situations of radical technological change, Lichtenthaler (2007) emphasized that by establishing effective TI processes, companies may react to radical trends in time which is a prerequisite for coping with technological change.

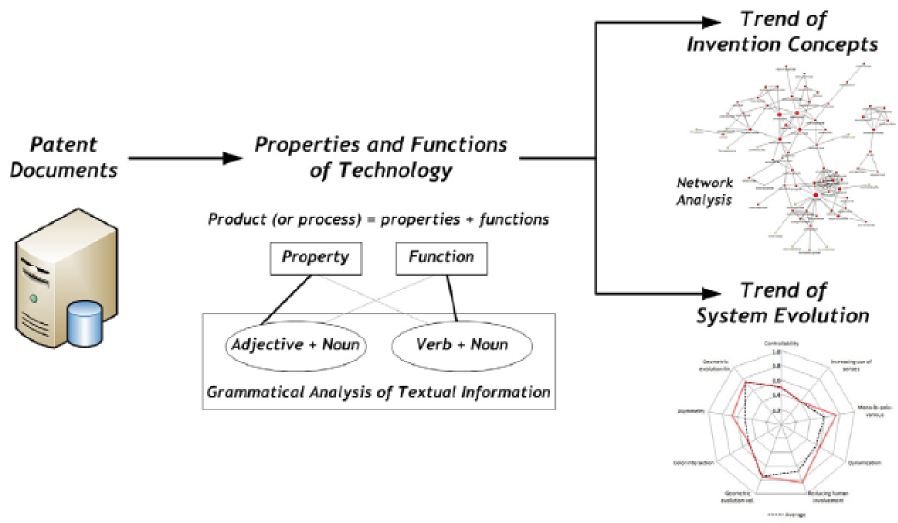


Figure 2.14. Basic concepts of TrendPerceptor
Source: Yoon and Kim, 2012

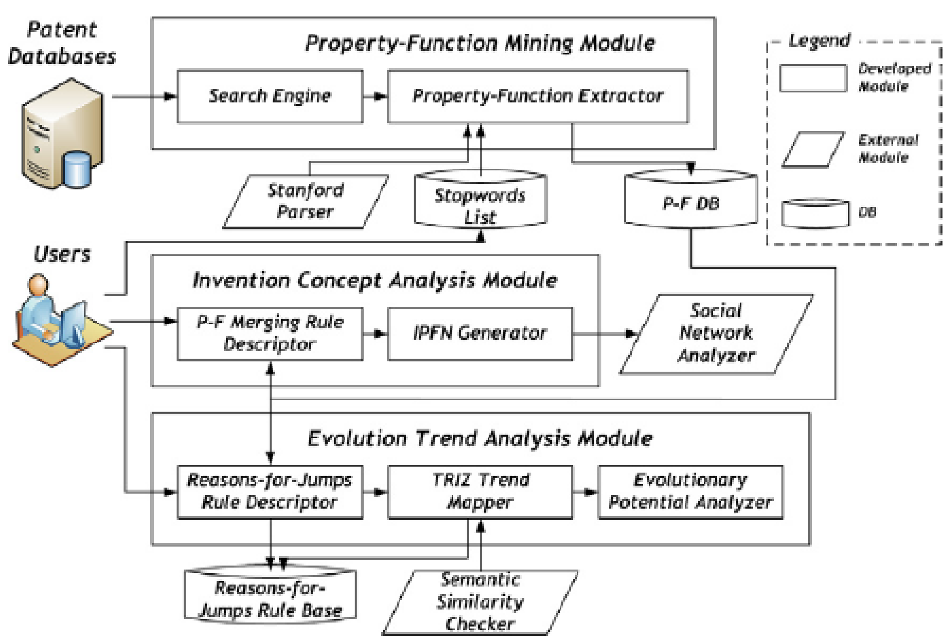


Figure 2.15. Architecture of TrendPerceptor: A property–function based
Technology Intelligence System for identifying Technology Trends from patents
Source: Yoon and Kim, 2012

Lichtenthaler (2004a) articulated that the importance of TI is widely accepted in theory and practice. However, existing research is contradictory on how this process should be coordinated; thus, Lichtenthaler (2004a) conducted a study on the different forms of coordination of technology intelligence processes.

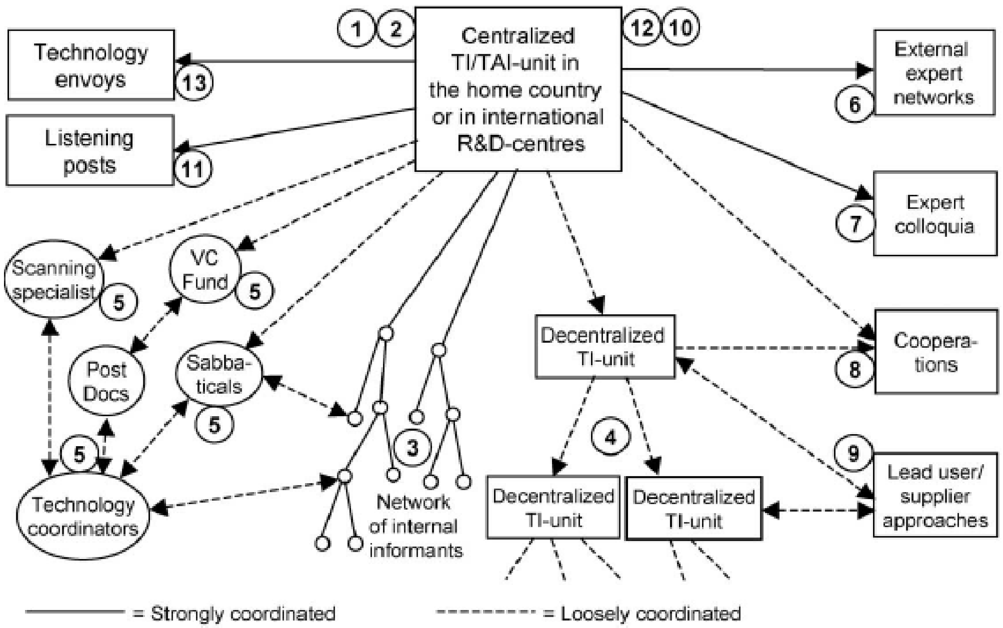


Figure 2.16. Elements of the Structural Coordination of TI processes

Source: Lichtenthaler, 2004a

In summary, effective and efficient TI Systems can be used by universities-industries research centers for technological research forecasting, in order to strengthen the universities-industries relationships, through enhancing collaborative research processes for finally improving the overall SC performance. These universities-industries relationships can be developed via two main approaches either through linking technology creation with job creation, which entails direct investment in carefully targeted fields, or through collaborative research (CR) that aimed at specific technological developments (Geiger and Sá, 2005).

2.7. Measuring Automotive Industry Supply Chain Performance

The related studies to measuring SC performance in the current literature (e.g., Brewer and Speh, 2000; Rao *et al.*, 2006) revealed that one of the obstacles for effective and efficient SCM is the inability to formulate, use and assess reliable and valid SCP measures. From an organizational perspective, Wilcox and Bourne (2003) argued that the traditional measures of performance that arose along with the development of cost accounting cannot be considered now as reliable indicators for evaluating financial and nonfinancial organizational performance.

In relation to SCM, prior studies outlined by Brewer and Speh (2000) added that these traditional single measures are inadequate for measuring the effectiveness and efficiency of applying various SCM practices (e.g., SCI and management of SC information flows) along the whole SC. This view was supported by Saad and Patel (2006) who contended that using only traditional financial measures in the process of SCP evaluation while disregarding any non-financial aspects of such performance is contradicted with the philosophy of supply-chain management and its "holistic" nature. Hence, many organizations in different industries used multi-dimensional frameworks for monitoring performance (Wilcox and Bourne, 2003). Later, Kaplan and Norton (1996, 2000) asserted the importance of using the balanced scorecard (BSC) approach and the strategy mapping in different manufacturing (e.g., automotive sector (Amini and Bavil, 2012)) and service companies for more balanced performance evaluation.

However, Saad and Patel (2006), after studying the applicability of using different models and frameworks in measuring automotive SCP in developing countries (e.g., India), concluded that some SCP measurement models (e.g., SCOR and BSC) are infeasible in the Indian automotive context.

As for measuring SCP (in terms of leanness, agility and leagility), Naim and Gosling (2011) suggested that future research should be conducted empirically to discover new "types" of leagility approach and assess different SCP paradigms using questionnaires, which are more able to collect data on a large-scale.

Similarly but from an organizational perspective, Yang and Liu (2012) after drawing upon their reviewed studies contended that using questionnaires with item-measures that assess managerial rather than financial performance is more feasible in case of firms that don't disclose its financial data.

For the current study and based on the review of the prior literature, the questionnaire was found to be a more appropriate instrument for collecting Hybrid lean-agile SCP data on a large-scale (i.e., multiple nodes across the entire automotive SC in an emerging market).

Since, performance evaluation is considered as a crucial strategic and operational success factor in SCM, for not only measuring the progress of performing different SC activities but also supporting continuous improvement efforts along the entire SC (Rao *et al.*, 2006). At the same time, many studies (e.g., Paulraj and Chen, 2007; Swafford *et al.*, 2008) focused on only one paradigm (e.g., agility) while assessing SCP, and ignored the hybrid SCP that includes different aspects of each paradigm.

Additionally, as far as the literature has been investigated, very few researchers took into consideration this hybridized performance paradigm, yet their work involved some limitations. For example, Elmoselhy (2012) measured such a hybridized lean-agile blend, but he used a case study approach on only one automotive SC and disregarded the leagility component in terms of mass-customization and postponement and the impact of the organization position along the SC on the hybridized component/share of each performance paradigm. Likewise, Azevedo *et al.* (2012) used Agilean index in measuring the SCP of four automotive companies in terms of leanness and agility; however, they also ignored crucial leagility attributes (i.e., mass-customization and postponement) and collected SCP data on small-scale, which made their research less generalizable.

Thus, one of the contributions of this research relates to the measurement of hybrid lean-agile automotive SCP. Accordingly, the researcher used multi-item measurement scale, in order to measure and then suggest for improvement, the effectiveness and efficiency of such a hybrid performance carried out by 84 automotive organizations in Egypt that serves as an example of a manufacturing industry. Based on the studies of Naylor *et al.* (1999), Huang *et al.* (2002) and Elmoselhy (2012), HSCP was measured –the dependent variable– in terms of leanness (Womack and Jones, 1996; 2005; Kahn and Mello, 2004-05; Melton, 2005; Lee *et al.*, 2007; Koçoglu *et al.*, 2011; Mohaghar and Ghasemi, 2011), agility (Li *et al.*, 2006; Swafford *et al.*, 2008; Koçoglu *et* *al.*, 2011; Mohaghar and Ghasemi, 2011; Azevedo *et al.*, 2012; Ibrahim and Ogunyemi, 2012) and leagility (Huang *et al.*, 2002; Turner and Williams, 2005; Li *et al.*, 2006). Specifically, lean SCP was assessed in terms of cost-minimization, removal of wastes and continuous improvement; then, agile SCP was measured in terms of flexibility, speed and responsiveness; and finally, leagility was evaluated using two aspects: mass-customization and postponement.

2.8. Conclusion

In the last decade, various supply chain (SC) strategies and performance paradigms have emerged to help organizations to better compete and maintain a sustainable development in a dynamic ever-changing globalized competitive environment (Lau, 2007; Al-Turki *et al.*, 2008). The growing interest in some of these SC strategies such as leanness, agility and leagility is apparent in different research work of many authors. Some researchers pointed out the importance of the lean thinking paradigm and lean SC (Womack and Jones, 1996; 2005; Naylor *et al.*, 1999), while the agility and agile supply chain performance (SCP) paradigm have received due attention from other scholars (Burgess *et al.*, 2002; Sherehiy *et al.*, 2007; Gunasekaran *et al.*, 2008; Khan and Pillania, 2008; Bottani, 2010; Ivanov *et al.*, 2010; Azevedo *et al.*, 2012). As for the leagility concept, after being coined by Naylor *et al.* (1999), it was highly advocated by many studies (Mason-Jones *et al.*, 2000; Towill and Christopher, 2002; Goldsby *et al.*, 2006; Chan and Kumar, 2009; Naim and Gosling, 2011). Meanwhile, Huang *et al.* (2002) called for using a hybrid lean-agile supply chain that balances between cost-reduction (leanness), responsiveness/availability (agility), and mass-customization and postponement (leagility). Similarly, Elmoselhy (2012) criticized choosing only one approach and suggested using a hybrid lean-agile framework that incorporates the main principles of leanness and agility together in one system linking the entire SC.

To date, there is an active debate on the applicability of this blended lean-agile SC strategy. However, these and other different lines of contemporary management research asserted that competition nowadays has been witnessed to be among supply chains, rather than individual organizations (Towill and Christopher, 2002; Li *et al.*, 2006). Therefore, effective and efficient supply chain management (SCM) is needed in order to have one integrated coordinated system (Li *et al.*, 2006; Al-Turki *et al.*, 2008) that can better compete in the global market.

This thesis conceptually adds to the active debate on the applicability of the blended lean-agile SC strategy by integrating two main streamlines of prior management research regarding this empirical issue; namely the leagility approach and the hybridized lean-agile manufacturing system, into one new hybridized approach. In other words, this thesis considers both lines of research as being complementary rather than competitive.

Despite the abundance of studies which have discussed the importance of ICT in the field of production and operations management, there is a little empirical research that investigated the effect of ICT on SCP directly and indirectly through SCM. Additionally, there is a disharmony in the reported empirical findings (i.e., mixed results) of these few studies that directly/indirectly assessed the ICT-SCM-SCP relationship (Zhang *et al.*, 2011). Furthermore, as far as the literature has been investigated, there is a lack of studies that assessed its effect on hybrid SCP in terms of leanness, agility and leagility. Thus, the researcher was motivated to empirically investigate the direct effect of ICT and the mediation effect of SCM (i.e., SCI and SCIS) on hybrid lean-agile SCP.

CHAPTER THREE

Literature Review - Part II:

The Impact of ICT and TI on the Performance of Lean, Agile and Leagile Education SCs

3.1. Introduction

Al-Turki *et al.* (2008) pointed out that SCM concepts and practices have evolved in the previous decade as a long-term approach to cope with recent challenges in an ever changing globalized competitive environment. In addition, business stakeholders of a certain product are considered –by SCM philosophy– as nodes of one chain that includes tiers of suppliers, manufacturers/service providers, and customers. Moreover, contemporary MGT practices are used to better plan and control such network for the benefit of every SC participant/member.

From an educational perspective, Al-Turki *et al.* (2008) studied the application of SCM approach to the higher education (HE) sector. They first portrayed and analyzed a higher educational SC along with its main nodes. Then, they pinpointed its characteristics that act as drivers/obstacles towards SCM implementation. Further, they conducted a framework for HE SC nodes integration/coordination, which considers such characteristics. Furthermore, they scanned the current HE SCM practices (i.e., partial ESCM implementation); then, suggested other new value-adding educational SCM practices.

In regard to the down-stream ESC integration, Al-Turki *et al.* (2008) discussed how HE has been facing different obstacles (e.g., detected gap between EMQS and JMQD), which are widening as a result of globalization and nowadays fierce competition. They revealed that organizations/employers (i.e., down-stream the ESC) are required to attract qualified individuals for the purpose of accommodating with changing market demands.

On the other side (i.e., up-stream the ESC), they indicated that higher education institutions (HEIs) are slowly responding to changing stakeholders' demands (Al-Turki *et al.*, 2008). However, since, HEIs have once revolutionized –years ago after the industrial revolution to cope with new market demands of mass production– from using individual/group learning approach to a mass learning one (i.e., applying the mass production concept coined by MFG industries) (Al-Turki *et al.*, 2008). Therefore, it can be concluded that HEIs can also introduce other contemporary MGT approaches (e.g., SC philosophy) (Al-Turki *et al.*, 2008) with its different performance paradigms (i.e., lean, agile and leagile SCP) to its sector.

In addition, Al-Turki *et al.* (2008) argued that during the new industrial era –with the accelerated developments in MFG and ICT– contemporary MGT practices (e.g., push and pull production systems, just in time (JIT), benchmarking, enterprise resource planning (ERP), total quality management (TQM) and quality assurance (QA)) are created to enable organizations to sustain a competitive advantage in an ever changing environment. They revealed that some of such aforementioned approaches (e.g., ERP, TQM and QA) (Al-Turki *et al.*, 2008) are used by HEIs. Moreover, according to Rompelman and Graaff (2006), HEIs also used systems engineering along with its design methodology in analyzing its current educational system and developing its programs (cited in Al-Turki *et al.*, 2008). Furthermore, Al-Turki *et al.* (2008) elaborated on how the progress witnessed in technology and the business environment lead to the appearance of different MGT concepts (e.g., SC, SCM and SCI) (Al-Turki *et al.*, 2008).

At the same time, according to Al-Turki *et al.* (2008), SCM approach has not been widely applied to educational institutions (EIs). Fitzsimmons and Fitzsimmons (2004) indicated that SCM practices are formulated in the MFG sector; while, the service industries are slowly using such practices due to the nature of its products (cited in Al-Turki *et al.*, 2008), especially HEIs that act as knowledge/educational service providers because of the features of such service (e.g., long lead-time) in addition to their core values (Al-Turki *et al.*, 2008).

However, with regard to Al-Turki *et al.* (2008), several HEIs are currently implementing a number of SCM practices (e.g., training and curricula design) to bridge the gap between their organizations and employers (i.e., matching the supplied knowledge, skills and abilities (KSA) with the demanded KSA by the job market (JM)). Since, SCM principles are the key towards coordinating the performed functions by up-stream and down-stream SC nodes. Therefore, a number of such principles are required by different accreditation institutions. Practically speaking, other different contemporary SCM implemented practices by the MFG industries can be beneficial to the service ones (Al-Turki *et al.*, 2008).

Despite the played role by supply-chain MGT practices that can aid HEIs in bridging the detected gap between its output and JM demand, only few studies can be found in the prior research literature that focus on ESC (Al-Turki *et al.*, 2008).

In this sense, O'Brien and Deans (1996) introduced the concept of educational supply chain (ESC) at the University of Strathclyde in U.K. They investigated how employers (i.e., JM/customers), HEIs (i.e., service providers in terms of students and university staff), and schools (i.e., suppliers) can collaboratively work via networks to satisfy all of the stakeholders' demands.

In a similar vein, Selen (2001) articulated how SCM practices in terms of intra-organizational integration inside business faculties (e.g., theory/curricula building) and inter-organizational integration with practitioners/practice via using the supply-demand approach.

At the same time yet in a practical standpoint, Dealtry (2000, 2001) underscored the importance of "Corporate University" that is related to a specific corporation and supplying its employees with the required training level (cited in Al-Turki *et al.*, 2008). Later on, Yen (2005) conceptually proposed a tailored geographical information system (GIS) education model while using supply chain approach (cited in Al-Turki *et al.*, 2008).

Afterwards, Al-Turki *et al.* (2008) used a case-study approach to describe and summarize an experience conducted in Saudi Arabia that represents partial implementation of SCM in the context of higher education. They studied the managerial implications of applying SCM approach to the education sector. Thus, this attempt can help in bridging the gap between the JM, community and the HEIs, which will flexibly and quickly act towards satisfying its stakeholders' demand.

In a similar stream line of research, Kargaev (2008) studied the existing higher education system in Kyrgyzstan from a supply-demand (S&D) perspective. He found out that the main cause behind facing structural unemployment in Kyrgyzstan is due to the absence of education-industry relationship. Therefore, JM demand remains unsatisfied by the education market (EM) supply; thus, graduates (i.e., the main output of HEIs) are facing one of two scenarios: become unemployed or employed at openings to which they are over/under-qualified.

Kargaev (2008), after using a quantitative approach (i.e., questionnaire) in investigating the aforementioned research problem, recommended that a "Pull" SC approach should be applied to the operation system of these HEIs to be able to satisfy the JM demand through maintaining the required education-industry relationship (Kargaev, 2008).

In a similar harmony, Abd-Elall *et al.* (2011), after building on an earlier work of Al-Turki *et al.* (2008), declared that three main ESC nodes/stakeholders (i.e., EIs, HR departments at the JM, and students/graduates) will benefit from bridging the EM-JM qualifications gap. Thus, the demanded courses with the needed value-adding curricula, and training packages could be well designed at both sides. Accordingly, Abd-Elall *et al.* (2011) proposed an agile model –based on semantic web framework– for linking EMQS together with JMQD, to which its updated data input will supply the above-mentioned interested parties with real-time qualifications S&D. As suggested by Abd-Elall *et al.* (2011), Job announcements developed by HR departments at the JM represent the JMQD while the intended learning outcomes (ILOs) planned by EIs represent the EMQS.

Similarly, but with using different research approach, Comm and Mathaisel (2008) investigated challenges (e.g., escalating costs) facing public EIs in U.S.A. and concluded that applying SCM principles to HE sector can lead to more effective and efficient ESCP in U.S.A.

In view of that, Comm and Mathaisel (2008) explored Wal-Mart's successfully applied SCM principles through scanning the prior research literature, which revealed that such implemented principles can be classified into three main groups (i.e., collaboration, outsourcing, and technology) that can be customized to the HE sector. Hence, based on Comm and Mathaisel (2008) findings, various learned lessons from Wal-Mart SCM can help in sustaining lean ESCP in U.S.A. (e.g., reducing its costs and minimizing its wastes).

Additionally, but in the HE context of Hong Kong, Lau (2007) suggested the application of SCM philosophy/approach to the HE sector; thus, presenting innovative MGT strategies in the area of education management (EMgt). For this reason, he used a case study qualitative approach –at the City University of Hong Kong– via interviewing SMEs working at the SC department and analyzing secondary data obtained from that university. In summary, that research paper detected and proposed five main SCs needed to be effectively/efficiently managed at that university: (a) student, (b) research, (c) commodity, (d) special requested and (e) outsourcing SCs.

From a conceptual standpoint, Lau (2007) introduced a contemporary MGT approach to the HE context, which linked EMgt with SCM. From an empirical angle, his study offered HEIs' leaders greater insights on how SCM practices can positively affect the organizational performance of the CUHK (Lau, 2007).

However, as one of the revealed limitations by the paper of Lau (2007), depending only on a case study approach (i.e., not using objective quantitative indicators) to investigate/assess the ESCP has a negative impact on its generalization ability to the entire education sector.

At this point, it's important to mention that the researcher in the current thesis will use multi-item measurement scale in order to measure, and then suggest for improvement, the effectiveness and efficiency of hybrid SC performance of the HEIs operating in Egypt. Moreover, in-depth interviews will be used to critically review and analyze their blended educational performance according to its different SCP paradigms (i.e., lean, agile and leagile ESCP).

3.2. Applying Supply Chain Approach to the Educational Sector: Higher Education Supply Chain (HESC) Stakeholders Integration

3.2.1. The Difference between Manufacturing Supply Chain and Service Supply Chain; especially Education Service Supply Chain

Despite the abundance of studies which have focused on applying SCM practices to different manufacturing industries along with the increasing level of importance of different services, few studies were concerned about the application of contemporary SCM practices to the service sector (Ellram *et al.*, 2004; Habib and Jungthirapanich, 2009b; Lin *et al.*, 2010; Giannakis, 2011); particularly the education sector (Habib and Jungthirapanich, 2009b) in spite of knowing that the ESC affects either positively or negatively many other different sectors/industries.

The service supply chain (SSC) is a net/chain of suppliers, service providers, other parties and customers, through which different resources are used in providing services to various customers (Lin *et al.*, 2010).

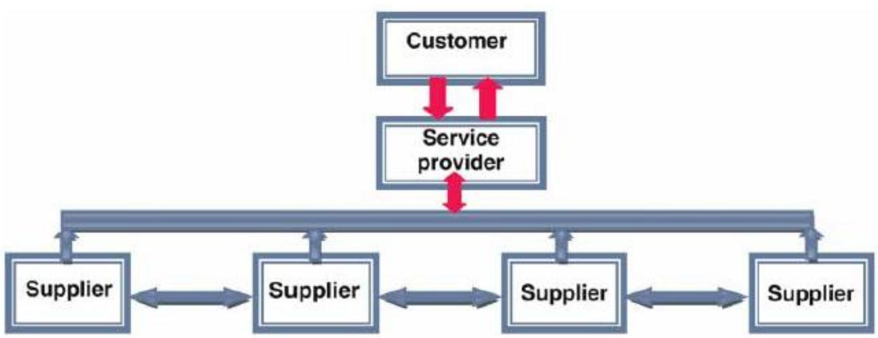


Figure 3.1. The Service Supply Network

Source: Giannakis, 2011

In regard to the concept of service supply chain management (SSCM), it was defined by Lin *et al.* (2010) as the effective management of tangible and intangible resources (e.g., information) as well as different processes across different nodes/partners of the entire SSC from the suppliers till the customers.

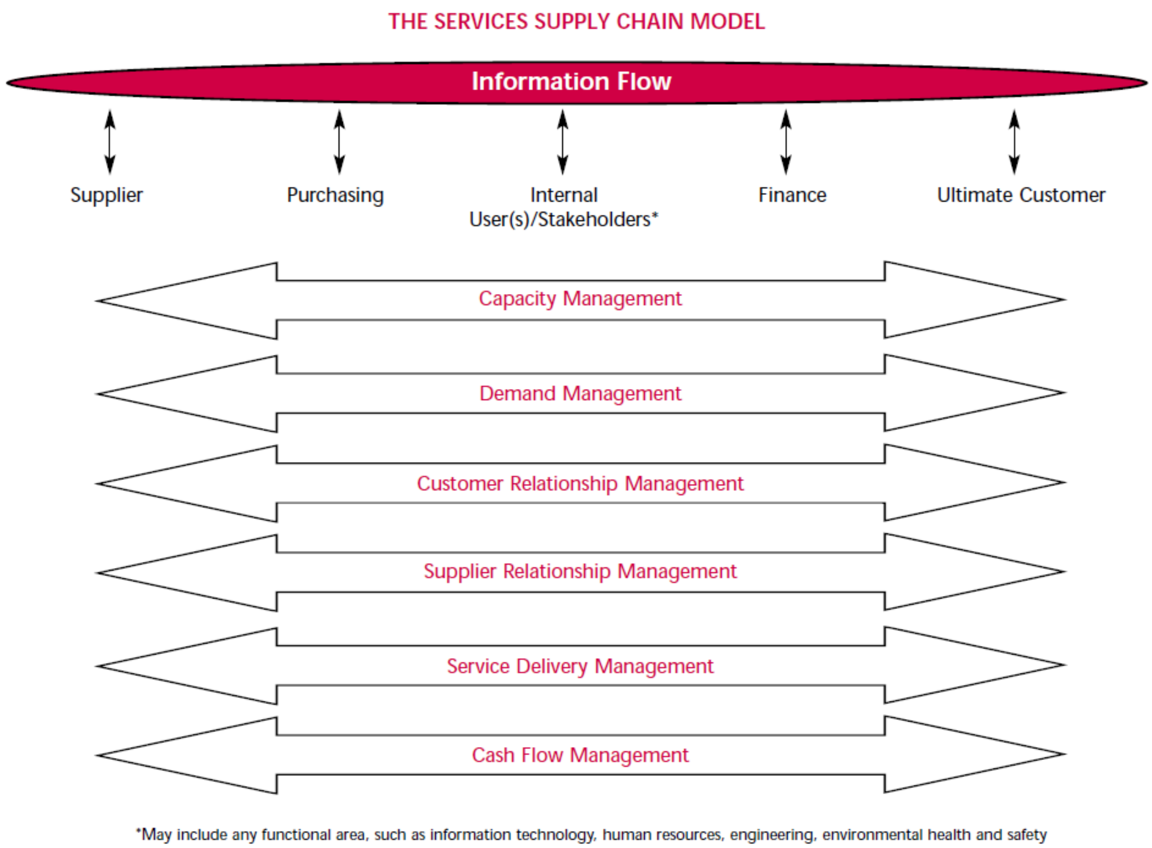


Figure 3.2. The Service Supply Chain

Source: Ellram *et al.*, 2004

As for comparing the MFG SC with the SSC, Al-Turki *et al.* (2008) argued many points of differences between them both, which impact the type of mutual beneficial exchange throughout such S&D chains. They indicated that providing services can be regarded as operating for intangible outputs (e.g., individuals and their intellectual/informational properties). Moreover, compared to tangible goods, services can't be reserved as stock; thereby, requiring their providers to have more capacity than they actually need. As elaborated by Al-Turki *et al.* (2008), SSCs are not lengthy with the service provider operating at the middle between suppliers and customers, taking the shape of a "hub". Conversely, the input (i.e., supply) to such SSCs is characterized by having different levels of quality; thus, acting as an obstacle for service providers (i.e., operators) (Al-Turki *et al.*, 2008).

In relation to the education service, Al-Turki *et al.* (2008) and Abd-Elall *et al.* (2011) viewed the education as a provided service that adds value to the intellectual property of individuals, who act as being inputs/outputs to EIs/service-providers/suppliers (e.g., HEIs/schools) as well as being consumers/stakeholders.

Whereas regarding the demand side, JM/employers act as customers to those EIs (Abd-Elall *et al.*, 2011). From a more detailed perspective, HEIs possess unique features –compared to other service providers– that need a customized approach to apply SC philosophy to its operations (Al-Turki *et al.*, 2008).

The first feature, as summarized by Al-Turki *et al.* (2008), lies in the large number of stakeholders (e.g., alumni, parents, graduates/students, administrative/teaching staff, public institutions, and various MFG/service industries/employers) and their diversified needs.

Second, with regard to the main objective of higher educational institutions, stakeholders possess different standpoints related to whether such institutions have to produce knowledgeable individuals only or should also supply them with the required qualifications by the JM. For example, Pascail (2006) questioned the extent to which EIs can provide its potential graduates with the expected levels of "skills" that are demanded by their prospective employers (cited in Al-Turki *et al.*, 2008).

Third, the required lead time to provide an output/graduate (e.g., needed time between registering and graduating ranges from 4-6 years for the undergraduate programs) is longer. Additionally, without SCIS between EM and JM, higher educational institutions can spend those years providing its potential graduates with unneeded KSA by the corresponding JM after their employment (Al-Turki *et al.*, 2008).

Fourth, higher educational institutions have special financial systems especially the public/non-profit ones, which requires customized application of SCM practices to its operations (Al-Turki *et al.*, 2008).

Finally, from a cultural perspective, such institutions were characterized by being conservative towards any changes imposed by outside parties (e.g., practitioners); however, an increasing number recently are trying to balance the tradeoff between sustaining its own academic independence and maintaining the required interdependence with other nodes' ever changing expectations (Al-Turki *et al.*, 2008).

In summary, those aforementioned features of the ESC can act as challenges that need to be considered while applying SCM practices to the higher education context, especially in the Egyptian education SC as will be elaborated throughout chapter six. However, as was pinpointed by Al-Turki *et al.* (2008), integrating and linking EM with the JM node become an important demand by different HESC stakeholders especially with the emergence of ICT, which makes it more feasible and facilitates the required coordination across all parties/members.

3.2.2. The Evolution of the Education Supply Chain (ESC): Shifting from the Traditional ESC Model to the Modified ESC Model in the Education Sector

Education SCs evolved, as pointed out by Al-Turki *et al.* (2008), forming two main ESC models/frameworks: (1) the traditional ESC model (i.e., representing the current problem in Egypt), where workforce market is located at the centre of the ESC; whereas (2) the proposed ESC model (i.e., representing the suggested solution), where HEIs are located at the centre of the ESC. Al-Turki *et al.* (2008) elaborated on the traditional ESC model, through analyzing its main players; namely general education institutions (GEIs), higher educational institutions, JM and workforce/labor-force market. They added that the “workforce market” (WM) represents the available knowledge, skills and abilities (KSA) of individuals searching for employment; while the “job market” (JM) represents the required/demanded knowledge, skills and abilities (KSA) of the current job openings offered by the employers (Al-Turki *et al.*, 2008; Abd-Elall *et al.*, 2011).

Further, the integration/communication among such players (i.e. GEIs, HEIs, WM and JM) can be considered as an educational SC or a network of educational stakeholders (Al-Turki *et al.*, 2008; Abd-Elall *et al.*, 2011). The traditional ESC model −as shown in Figure 3.3− describes the feed-forward flow of skilled/semiskilled/unskilled HR from GEIs to the HEIs, WM (i.e., located at the SC centre) and then to JM (Al-Turki *et al.*, 2008; Abd-Elall *et al.*, 2011). On the other hand, a feedback flow of HR from the JM back to educational institutions and universities represents the continuing/professional education/training and KSA enhancement (Al-Turki *et al.*, 2008; Abd-Elall *et al.*, 2011).

One can trace the elaboration of ESC model of Al-Turki *et al.* (2008) in Abd-Elall *et al.* (2011). They articulated that the SC HR flow via the traditional model −as shown in Figure 3.3−

is similar to the “push production system”, through which the above-mentioned educational institutions supply the WM with graduates/HR possessing KSA possibly would be demanded and may or may not match the required KSA by the JM.

Thereby, HR/individual is viewed as the main input to these EIs; afterwards, qualified HR represents the final product/output as well as acting as customers for such EIs /service providers (Al-Turki *et al.*, 2008; Abd-Elall *et al.*, 2011). Accordingly, up-stream the ESC, graduates/outputs of GEIs act as inputs to HEIs after registration and being accepted throughout various interviews/exams, then these HEIs involve them in many standardized educational courses (i.e., not customized ones) (Al-Turki *et al.*, 2008; Abd-Elall *et al.*, 2011).

By this means, supplied HR/graduates to the WM begin the journey of jobs hunting and possibly ending with structurally unemployed. Whereas, down-stream the ESC, employers/organizations look for the most suitable HR that fit their demanded KSA through scanning various Curriculum Vitae (CVs) and conducting interviews and/or tests for the available KSA at the WM (Al-Turki *et al.*, 2008; Abd-Elall *et al.*, 2011).

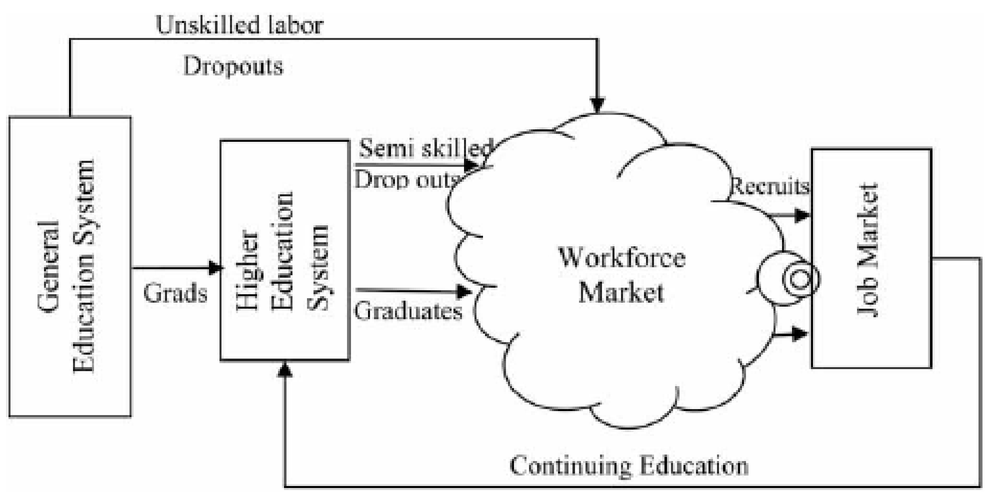


Figure 3.3. Traditional ESC Model (Push production system), where workforce market is located at the centre of ESC

Source: Al-Turki *et al.*, 2008

Consequently, Al-Turki *et al.* (2008) and Abd-Elall *et al.* (2011) argued that this traditional ESC model that is using a push production system will possibly face a situation of structural unemployment (KSA gap among demanded KSA by JM, available KSA at the WM and the supplied KSA by the EM).

In this sense and after a while, the ESC stakeholders will not be able to achieve an “all-win” situation as all parties’ (i.e., HR, JM and the community in large) KSA demands will remain unmet (Al-Turki *et al.*, 2008; Abd-Elall *et al.*, 2011). As a result, the potential unfavorable consequences will be reflected in unemployed HR, recycled KSA, social/economical/political instability and job openings left without qualified HR (Al-Turki *et al.*, 2008; Abd-Elall *et al.*, 2011).

Hence, Al-Turki *et al.* (2008) proposed the contemporary ESC model, where HEIs are positioned at the centre of the SC practically the same as many modern MFG organizations that applied the “pull” approach to its operations; in other words, coping with changing market needs and stakeholders’ demands. Therefore, the sizes of both the WM and JM will be minimized (i.e., neither having unemployed HR nor leaving job openings without suitable placements) (Al-Turki *et al.*, 2008). Thus, this suggested ESC Model −as shown in Figure 3.4− can help in reducing the gap between the supplied KSA and the demanded KSA through applying SCM practices to the education sector.

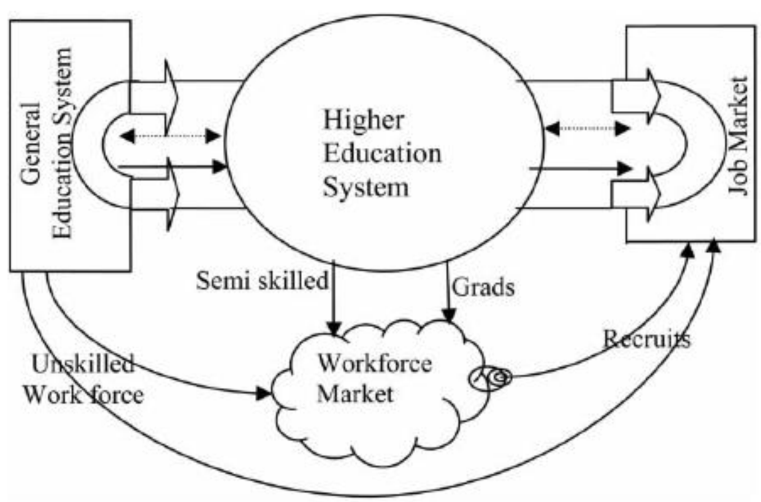


Figure 3.4. Proposed ESC Model (Pull production system), where HEIs are located at the centre of ESC

Source: Al-Turki *et al.*, 2008; Abd-Elall *et al.*, 2011

From a practical perspective, ESC nodes/participants −demonstrated in that aforementioned ESC model− can collaboratively coordinate their performed functions through information exchange/sharing (IS) (i.e., graphically illustrated as links between SC parties), which can be facilitated by ICT (e.g., ERP) (Al-Turki *et al.*, 2008). In so doing, higher educational institutions will be located at the centre of one coordinated integrated network through which different tangible/intangible SC flows (e.g., HR, information, finance, and other resources) are moving (Al-Turki *et al.*, 2008).

More importantly, the JM is investing in their potential human resources capital (HRC) through sharing, with HEIs, the responsibility of enhancing their KSA earlier (e.g., via training, internships, scholarships, involved in conducting their academic curricula) before being hired in order to get qualified HR/graduates who meet their expectations/demands (Al-Turki *et al.*, 2008). In this manner, HR (i.e., one of the ESC streams) can be moving up/down-stream throughout three ways: (a) funded HR/student by particular organization where he/she will be hired after graduation; (b) graduates at the WM looking for a job opening at the JM; and at the same time there are, (c) funded HR/students (i.e., forming qualification pools) by a number of small and medium-sized enterprises (SMEs), which they share the investments (i.e., risks pooling/sharing) in those expected graduates and each graduate will be hired at one enterprise (Al-Turki *et al.*, 2008). Based on the findings of Al-Turki *et al.* (2008) and Abd-Elall *et al.* (2011), SCM practices if being customized to fit the educational sector can help HEIs in reducing effectively and efficiently the current detected gap between the KSA D&S of both the JM and EM.

3.2.3. Applying Supply Chain Management (SCM) Principles to Profit and Non-Profit ESCs in Different Countries

Lau (2007) underscored the importance of applying SCM practices to nonprofit organizations (e.g., public universities) as well as profit organizations (e.g., private universities) in order to help these organizations in improving their performance.

From a managerial conceptual standpoint, Lau (2007) demonstrated that prior studies on SCM can be aggregated according to four main MGT contexts: (a) strategic MGT (e.g., studies on partnerships and strategic alliances); (b) production and operations MGT (e.g., papers on SCI, outsourcing and capacity planning); (c) management information systems (e.g., researches related to e-business, CRM and ERP); and (d) knowledge MGT (e.g., researches on knowledge exchange and sharing) (Lau, 2007). However, Lau (2007) revealed that despite the abundance of studies that explored SCM implementation at profit institutions for many purposes (e.g., value creation and wastes elimination); SCM at nonprofit organizations remain unexplored context for MGT researchers.

As a consequence, it’s important to pinpoint the importance of applying contemporary MGT practices to non-profit organizations to help them in attaining their goals (Drucker, 1992; cited in Lau, 2007), especially SCM which was proven to be crucial for their organizational sustainability (Steven, 1989; Mentzer, 2001; cited in Lau, 2007).

With regard to the educational context, Lau (2007), after using a case-study approach to investigate the application of SCM practices to one of the public universities (i.e., City University of Hong Kong), contributed to the management research literature that tried to fill the knowledge gap between SCM in profit organizations and non-profit ones.

Based on reviewing the prior research literature, some studies introduced different ESC models that represent various experiences in applying SCM concepts and practices to the educational sector. The current research will introduce some of these ESC models conducted by different authors from different countries and developed in various profit and non-profit higher educational institutions to describe and summarize some successful experiences of ESCM implementation.

3.2.3.1. Lean Education Supply Chains

3.2.3.1.a. Applying Wal-Mart's SCM Practices to American Public Lean ESCs

Comm and Mathaisel (2008) pointed out that the American HE is facing new challenges. They indicated that in spite of the increasing demand on higher education in U.S.A., the government is reducing its finance to the public EIs. On the other hand, other governments are striving to enhance the performance of their EIs in order to sustain competitive advantages internationally (Comm and Mathaisel, 2008).

As a result, various public EIs boosted their prices consequently after the abovementioned reduction in their funds; therefore, they in return have to provide enhanced services, improved facilities, and more quality-based interactive education (Comm and Mathaisel, 2008). On the contrary, as was clarified by Comm and Mathaisel (2008), many of these institutions started to downsize number of its teaching and administrative staff, and postponed/omitted some of its required developments. Moreover, Comm and Mathaisel (2008) discussed how the HR/inputs (i.e., students) are not only seeking education and research but are also using other quality indicators (e.g., comfortable accommodation/housing services, modern facilities and ICT systems) when they choose their target EI. However, the rising costs of providing and sustaining such qualified educational and supporting services forced their fees to be considerably high to compensate for that increase, which further escalated the expectations of stakeholders for more value (Comm and Mathaisel, 2008).

In a similar vein, Immerwahr and Johnson (2007) contended that escalating costs represent one of the EMgt challenges that faces the educational service providers (i.e., EIs) as well as being an issue to other stakeholders (i.e., educating individuals and who finance them) (cited in Comm and Mathaisel, 2008).

In an earlier yet related study by Comm and Mathaisel (2005), after using a quantitative approach (i.e., questionnaire) in investigating the extent of applying the lean philosophy to 18 public and private universities in U.S.A, they concluded that many successful practices (e.g., advanced technological systems and outsourcing) were implemented for cutting costs in order to operate in a more lean and efficient manner.

Accordingly, from a cost control perspective, HE should learn from the successfully applied SCM practices at the business sector (e.g., Wal-Mart) that were mainly used in wastes removal and efficiency enhancement purposes via employing various ICT applications (Comm and Mathaisel, 2008). In this sense, building on prior studies −outlined by Comm and Mathaisel (2008) − that focused on educational costs minimization at 630 EIs, three main SCM principles were found to be useful for public/private HEIs to improve their lean SCP. According to Comm and Mathaisel (2008), such three crucial SCM practices are: (A) technology, (B) outsourcing, and (C) collaboration.

A. Technology

Comm and Mathaisel (2008) asserted the emergence of IT employment into the educational and learning processes. However, Comm and Mathaisel (2008) were specifically concerned about the effective and efficient usage of IT systems at the EIs. Similarly, Green (2007) was interested in how IT applications can be used in accomplishing the organizational mission (cited in Comm and Mathaisel, 2008). Afterwards, they contended that IT facilitated an efficient information exchange for HEIs stakeholders (Comm and Mathaisel, 2008), as ICT was proven to provide an effective/efficient way to track information throughout the SC and share information with various ESC nodes. Furthermore, different educational, learning and assessment activities (e.g., e-searching, online registration, and electronic grading) are conducted electronically (Comm and Mathaisel, 2008). In addition, Comm and Mathaisel (2008) revealed that e-learning programs are now being accredited causing increased demand by new segments to different HEIs.

However, HEIs have to pay in return for IT implementation (e.g., purchasing and maintenance costs related to such technology-based services) (Comm and Mathaisel, 2008), which will finally increase the tuition fees. Further, they gave examples on IT implementation challenges through pointing out that teaching/administrative staff training on (a) utilizing an integrated student information system (ISIS) in both the electronic registration and grading processes as well as (b) conducting e-learning programs −at the Massachusetts state− were found to be costly and need more time (Comm and Mathaisel, 2008). However, they asserted what was found to be overwhelming during the prior years, can now be better controlled.

Additionally, as will be discussed later in this chapter, Lichtenthaler (2004c), Dang *et al.* (2011) and Yoon and Kim (2012) specified different affordable sources that can be used in tracing and collecting information about technology in order to create awareness of the new technological favorable opportunities found in the field or used by competitors (i.e., technology intelligence tools). Also, Comm and Mathaisel (2008), building on Kaganoff (1998) discussion, pinpointed that new studies on cost-benefit analysis have concluded that IT implementation is a valuable and reasonable investment especially when an educational institution is targeting sustainability in an ever changing competitive environment.

From a cost-benefit analysis angle, Comm and Mathaisel (2008) confirmed the lack of unified indicators of HEIs efficiency (i.e., leanness). More importantly, Johnstone (1997) promoted that a cost-per-student (i.e., individual measure) acts as a commonly used item/variable of efficiency due to the ease of measuring it rather than its adequacy for assessing the organizational performance of the HEI (cited in Comm and Mathaisel, 2008).

Thus, the researcher in this research will use a multi-item measurement scale –as pinpointed in chapter one and will be shown in chapter seven− in measuring the hybrid SC performance (i.e., in terms of leanness as one of the main SCP dimensions) of the HEIs operating in Egypt.

Practically speaking, ICT unquestionably provides feasible ways for facilitating the balanced evaluation of entire EIs' output (Comm and Mathaisel, 2008).

At this point, it's important to mention that the researcher in the current study will use different types of software packages (e.g., AMOS software, SmartPLS software, LISREL software, and SPSS software) to quantitatively assess the higher educational hybrid lean-agile SC performance.

B. Outsourcing

Jeffries (1996) discussed that outsourcing in education can be used by EIs in the form of giving the advantage to third-party/suppliers to provide a supporting service/activities at these EIs (e.g., food, cleaning and janitorial, bookstores and stationeries, part-time teaching, and security) (cited in Comm and Mathaisel, 2008; Lau, 2007). Thereby, the EI can pay for the provided supporting services and cut the expenses that could have been paid to full timers performing non-primary activities then distribute the saved amounts to other primary value-adding activities (Comm and Mathaisel, 2008).

Regarding the outsourcing limitations, Lau (2007) and Comm and Mathaisel (2008) notified that there is a probable risk when the EI focuses on offering part-time jobs instead of maintaining adequate amount of full-time opportunities as it may negatively affect the institution's ability in sustaining its accreditation, as well as not achieving the satisfactory level of commitment/belongingness among the part-timers.

C. Collaboration

For the purpose of maintaining lean ESCP, Comm and Mathaisel (2008) suggested that EIs can collaborate/cooperate with other EIs/nodes/stakeholders in the ESC to maximize the aspects of leanness and sustainability and learn lessons from other service sectors (e.g., retail organizations: Wal-Mart creates partnerships with its key suppliers to enhance the value and minimize the waste).

From an empirical perspective, Comm and Mathaisel (2008) summarized various experiences on the implementation of lean SCI in the education sector:

a. Various HEIs provide interdisciplinary and multidisciplinary programs where they can depend on a common team of teaching staff among different faculties in an interdependent manner of sharing their experiences in interrelated fields.
b. Numerous small-to-medium sized EIs using one integrated system of health insurance for labor to minimize the cost.
c. Private EIs of small-to-medium sizes having collaborative teaching/administrative staff health insurance strategies.
d. Ten public campuses of the University of California, and each one has its unique culture, conduct a conference every year to maintain a state of interdependence among them (e.g., in terms of creating awareness regarding their common policies).
e. Different public HEIs carry out centralized decision making processes of purchasing for its entire faculties to reduce costs.

f. Thirteen private HEIs in Boston cooperatively integrate for the purpose of reducing their administrative expenses and exchanging the successful MGT practices regarding health insurance and other fringe benefits among them.

In summary, Comm and Mathaisel (2008) concluded that HE can learn from the successfully applied SCM practices at the business sector (e.g., technological, outsourcing, and collaboration practices). ESCs include many stakeholders (e.g., teaching/administrative staff, students, alumni/graduates, materials/equipment suppliers, JM, schools, HEIs, WM, public institutions, third-party businesses, society in large, and other various nodes) (Lau, 2007; Comm and Mathaisel, 2008; Al-Turki *et al.*, 2008; Abd-Elall *et al.*, 2011). However, several ESC participants/members are playing for the sake of achieving only their individual goals rather than regarding the effectiveness/efficiency of the entire SCP (i.e., lean ESCP), which aided in maximizing the MGT costs of HE at the United States of America (Comm and Mathaisel, 2008). Consequently, the ESC stakeholders can apply customized SCM practices to their operations to improve the whole SCP and delight the society in large.

3.2.3.1.b. Lean ESCM for Non-Profit Tertiary Higher Education Institution (HEI): City University of Hong Kong (CUHK)

Lau (2007) suggested the application of SCM philosophy/approach to the HE sector; thus, presenting innovative MGT strategies in the area of education management (EMgt). For this reason, he used a case study qualitative approach –at the City University of Hong Kong– via interviewing SMEs working at the SC department and analyzing secondary data obtained from that university. In summary, that research paper detected and proposed five main SCs needed to be effectively/efficiently managed at that university: (a) commodity; (b) special requested; (c) outsourcing; (d) student; and (e) research SCs.

A. Lean Commodity Supply Chain

The commodity SC is related to the operations of purchasing commodity while aiming lower costs (e.g., administrative cost minimization). It operates all the processes of obtaining the frequently needed raw materials, which possess a low cost per unit (e.g., stationeries supplied to all organizational units on a timely basis and need centralized purchasing decisions) (Lau, 2007).

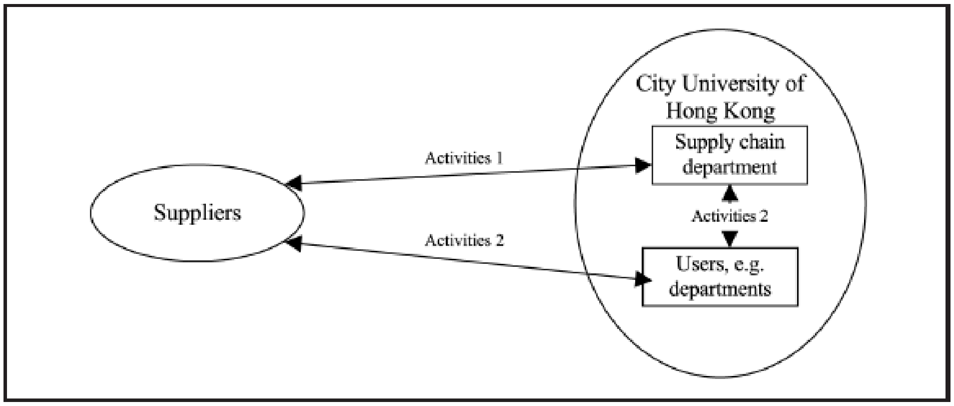


Figure 3.5. Lean Commodity Supply Chain in CUHK
Source: Lau, 2007

B. Lean Special Requested Supply Chain

With a similar lean paradigm yet a different product, the special requested SC focuses on the operations related to special requests (e.g., specialized research/labs' tools) of interested consumers/units only (e.g., teaching staff or departments/units) (Lau, 2007). Since, such SC deals with products of high cost per unit; thus, the SC department/specialist should make individual decisions per request. Conversely, such SC differs from the aforementioned commodity one in the indicators of the purchasing decision among the different alternatives, which cover the aspects of quality as well as the entire perceived value (Lau, 2007).

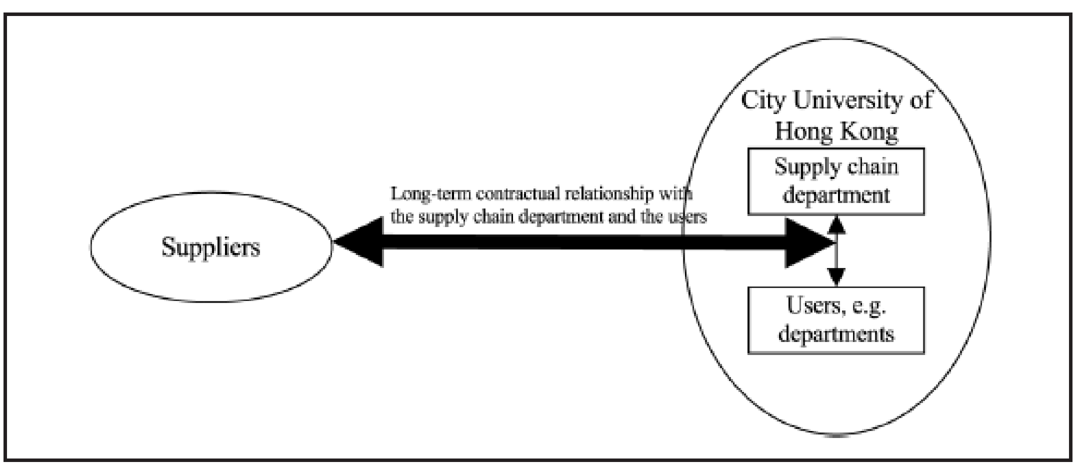


Figure 3.6. Lean Special requested Supply Chain in CUHK
Source: Lau, 2007

C. Lean Outsourcing Supply Chain

As for the outsourcing lean SC, it deals with the outsourcing of non-primary services provided by external suppliers/organizations (Lau, 2007; Comm and Mathaisel, 2008). But first, the EI should identify which activities can be considered as non-primary/supporting services that can be outsourced (e.g., bookstores or stationeries, IT support, security and cleaning services) and which services are considered as primary activities (e.g., academic advising and teaching) that should be in-sourced (Lau, 2007; Comm and Mathaisel, 2008).

Outsourcing versus in-sourcing decision has its own advantages and disadvantages. As for the detected pros and cons by Lau (2007), the first one offers more flexibility and enhanced efficiency, whereas the latter enables better quality assurance and guarantees more commitment that helps in gaining a sustainable competitive advantage (e.g., quality).

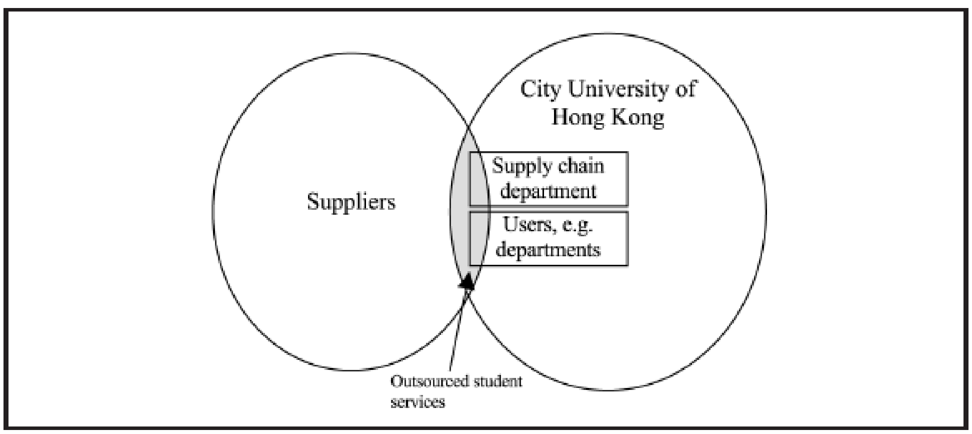


Figure 3.7. Lean Outsourcing Supply Chain in CUHK

Source: Lau, 2007

3.2.3.2. Leagile Education Supply Chains

3.2.3.2.a. Saudi Arabian Leagile ESC Model

In relation to the leagility, Al-Turki *et al.* (2008) asserted that it is important for ESCs to perform in terms of late-differentiation and mass-customization, which are considered to be crucial dimensions for achieving a new paradigm of SCP (i.e., leagile SCP).

From an empirical perspective, as elaborated by Al-Turki *et al.* (2008), employers (i.e., downstream the ESC) can search for their potential talented, yet unqualified, HR capital upstream the ESC at the general and higher educational institutions. Accordingly, these organizations along with their educational partners can design career path planning programs for these students/potential-graduates, in addition to customized academic packages that are synchronized with their future professional tracks. Practically speaking, mass-customization −as an important dimension of leagility− demands maintaining a certain level of flexibility, by such EIs, while adapting their standardized courses to satisfy the entire ESC stakeholders' needs (Al-Turki *et al.*, 2008).

Moreover, Al-Turki *et al.* (2008) suggested that these abovementioned packages should include prerequisite empirical coursework (e.g., real-life projects, professional training, and internships) that can be conducted at the facilities of these sponsors. Consequently, those learners can be exposed to real-life practices and early professional experience even before their graduation and employment.

With regard to late-differentiation/postponement, this aspect of leagile ESCP −that is similar to the leagility of MFG industries− can be implemented at EIs throughout two phases: (1) learners at the general education (GE) should be supplied, not only with the required amount of knowledge but also, with the needed skills (e.g., scientific thinking and problem solving skills, verbal and non-verbal communication skills, presentation and interviewing skills) and abilities (e.g., stress MGT and time/self MGT) that are demanded by various specializations/fields at the HEIs (Al-Turki *et al.*, 2008). At this phase, EIs should be flexible enough (e.g., American EIs) to equip its learners with the demanded KSAs at the HEIs/JM; thus, lessening the negative effect of having students that are trapped at a certain specialization even prior to their tertiary education (Al-Turki *et al.*, 2008).

In order to portray the adoption of leagile ESC paradigm from different perspectives, Al-Turki *et al.* (2008) demonstrated that: (2) learners at the HE phase should be supplied with inter/multidisciplinary courses (i.e., standardized courses integrating different fields) throughout most of their academic period while postponing their specialization at the senior year shortly before their graduation. In respect to empirically applying postponement/late-differentiation along with mass-customization across the ESC, customized academic programs should be adapted, in terms of the requirements of the ESC stakeholders/JM, at the senior year (i.e., postponement) so that learners would be able to declare their major according to the JM demand. Effective and efficient SC integration, information sharing, and participative curricula design reflecting current JM demand are crucial for achieving integrated coordinated ESC (Al-Turki *et al.*, 2008).

As for a partial application of the ESCM in Saudi Arabia, Al-Turki *et al.* (2008) summarized the findings of a case-study conducted at Saudi Aramco (i.e., public multinational enterprise for petroleum products employing around 50,000 individuals), which provides HE scholarships for graduates (300 per year since the 80's) of GEIs following an internship year of a college-preparatory program (CPP). Practically speaking, such organization –after recruiting its scholars according to interviews/tests– prepare them for their potential customized undergraduate programs at various HEIs (e.g., King Fahd University) according to the JM needs (Al-Turki *et al.*, 2008). Academically, those scholars should sustain an agreed upon minimum of grade point average (GPA) at those HEIs; whereas professionally, they should apply their projects at the organization's facilities. As a result, they gain an early working experience parallel to their education track as well as guaranteeing their employment exactly after being graduated (Al-Turki *et al.*, 2008).

In fact, as a fruitful outcome of such continuous program, its graduates represent a high percentage of that aforementioned organization's HR (Al-Turki *et al.*, 2008). Thereby, they recommended that further employers together with other GEIs/HEIs can jointly apply such ESC framework at different developed/emerging markets.

At a more holistic angle, they promoted the application of SCM practices to be generalized on a larger scope –based on a leagility ESCP paradigm in terms of mass-customization and postponement– in order to lessen the WM size; thus, lowering the structural unemployment rate after closing the detected KSA gap between JM demand and EM supply along the entire ESC.

3.2.3.2.b. Leagile Student SC in City University of Hong Kong (CUHK)

Lau (2007) proposed a student SC to be conducted at the CUHK, at which each individual/student acts as the main input to such SC and, after graduation, each graduate can be considered as its key output/outcome (Lau, 2007; Ang and Griffin, 2008).

In that case, the HEI/service-provider produces qualified graduates through delivering an educational service; at the same time, the teaching and administrative staff act as its main operators (i.e., internal customers/stakeholders) that work on delivering this intellectual outcome (i.e., graduate/final product) (Lau, 2007).

Similarly yet from a holistic perspective, Habib and Jungthirapanich (2009b), Habib and Jungthirapanich (2010) and Pathik *et al.* (2012b) applied the educational SC to a HEI, where schools and other non-educational institutions act as its suppliers and employers in addition to the society in large act as its customers.

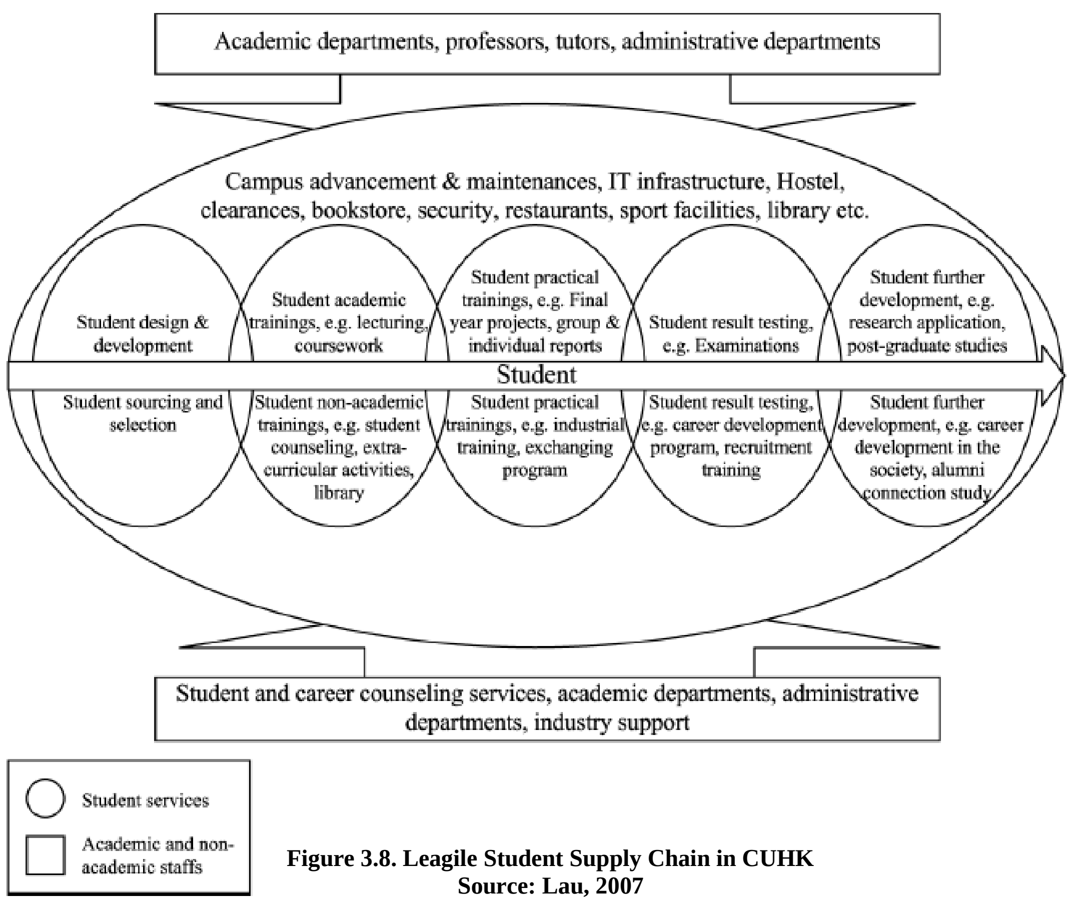


Figure 3.8. Leagile Student Supply Chain in CUHK
Source: Lau, 2007

By this means, such abovementioned SC includes primary and supporting activities to provide the required educational service and produce the demanded graduates. The primary/core activities, as elaborated by Lau (2007), comprise all the systematic steps involved throughout the higher educational process that develops the KSA of an individual (e.g., teaching, training, long-life learning, and assessment processes). On the other hand, the supporting/non-primary activities involve –as shown in Figure 3.8– ICT support, security and cleaning services, food courts, gymnasium/sports activities, and libraries/ stationeries (Lau, 2007).

In summary, one of the main objectives for a HEI (e.g., CUHK) is to provide the community in large (i.e., a stakeholder for the ESC) with qualified-graduates (i.e., educated-individuals/product/output) (Lau, 2007; Habib and Jungthirapanich, 2010; Habib, 2011; Pathik *et al.*, 2012a) while performing in terms of mass-customization (i.e., leagility SCP paradigm).

3.2.3.3. Agile Education Supply Chains

3.2.3.3.a. German Dynamic Model for sustaining Agile ESC: Using Semantic Web Technology (SWT) at International Master Program "Global Production Engineering" in Germany

From an academia-industry perspective, Teichler (2000, 2007) drew attention to the importance of the university-industry linkage/relationship through demonstrating that there is an active EMgt debate related to such indicator and was represented as one of the main tracks at the United Nations Educational Scientific and Cultural Organization (UNESCO) Conference for HE (cited in Abd-Elall *et al.*, 2011).

Building on those above-mentioned studies yet from an engineering perspective, Abd-Elall *et al.* (2011) emphasized on the significance of sustaining strategic academia-industry relationships that will help in closing the gap between job market qualifications demand (JMQD) and education market qualifications supply (EMQS); thus, adding value to all ESC stakeholders (e.g., EIs, employers' HR departments, and the workforce/individuals). They declared that HEIs are the centre of the learning hub that builds up innovative engineering specialists, who firstly attended these EIs to be supplied with the demanded KSA by the JM.

At the same time, HEIs are required to construct an updated database, of the needed KSA by the engineering industry, which comprise the existing professional practices (i.e., JMQD) together with the contemporary conceptual theories (i.e., EMQS) (Abd-Elall *et al.*, 2011). Otherwise, many graduates will face the risk of not getting the right post that demand their current KSAs as a result of this detected KSA gab between JMQD and EMQS. In other words, there are numerous job openings with required yet unavailable KSA (e.g., around 15 thousand/year engineering posts at Germany) and plenty of graduates/HR/job-applicants with un-demanded KSA (e.g., around 65 thousand structurally unemployed engineers) (Abd-Elall *et al.*, 2011).

From a larger standpoint, Teichler (2007) argued that the findings of a research paper conducted by authors and scholars of thirteen HEIs/research-centers at twelve countries indicated structural unemployment cases (cited in Abd-Elall *et al.*, 2011). Thus, different continuous improvement programs for assuring the quality of EMgt are currently incentivized by various accreditation bodies at the European union and the united states of America (e.g., ABET) (Haug and Tauch, 2001; cited in Abd-Elall *et al.*, 2011).

Consequently, from a continuous improvement perspective, HEIs are required to add to the aforesaid database a storage file including the required KSA by the potential engineering-graduates in addition to the minimum degree of expertise prerequisite to their graduation (Bankel *et al.*, 2003; cited in Abd-Elall *et al.*, 2011). For that reason, ICT is crucial to facilitate the essential collaboration between the EM and JM leaders/managers in order to achieve timely updated IS related to the KSA S&D among the interested parties (Abd-Elall *et al.*, 2011).

As for the current thesis, this synchronized SCIS sustained by the ESC up/downstream technologically-enabled integration and the university-industry partnerships represent one of the enablers for achieving agile ESCP, which is characterized by its flexibility and timely response between all the ESC stakeholders (e.g., EM, JM, HR, and the society in large).

Abd-Elall *et al.* (2011), after discussing the ESC model of Al-Turki *et al.* (2008), argued the applicability of sustaining academia-industry relationship through introducing the integrated competencies MGT (ICM) framework of Meyer (2006).

One can trace the ICM framework of Meyer (2006) in Abd-Elall *et al.* (2011) that illustrated the conducted linkage among HEIs, MFG/service organizations, and educating individuals/HR (i.e., different ESC stakeholders/nodes). According to such model, as shown in Figure 3.9, the ESC nodes interact together throughout three main common areas (i.e., research activities/centers, EM, and JM), where the KSA database can be accessed by those interdependent members according to each party's needs.

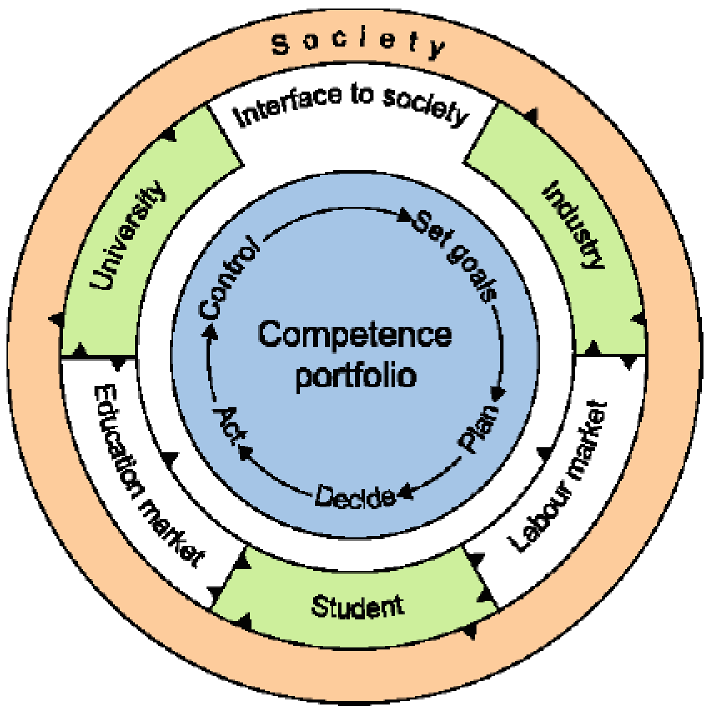


Figure 3.9. Sustaining Universities-Industries Relationship through Integrative Competence Management

Source: Meyer, 2006; cited in Abd-Elall *et al.*, 2011

In respect to that aforementioned model (Meyer, 2006; cited in Abd-Elall *et al.*, 2011), regarding the first area of interaction (i.e., JM), the KSA database will be used in satisfying the employers needs of the supplied HR, from the HEIs, through finding their potential employees in its files. From the EM perspective, the future graduates can continuously benchmark themselves according to the updated demanded KSA by the JM via that integrated/coordinated database.

From an empirical perspective, Abd-Elall *et al.* (2011) –after building on earlier works of Al-Turki *et al.* (2008) and Meyer (2006) – used an interactive approach in linking JMQD to the

EMQS via employing the semantic web technologies (SWT) that enable the development of an international KSA database. Practically speaking, applying such framework –as portrayed in Figure 3.10– will enable the different ESC parties (i.e., JM, HR/graduates/job-applicants, HEIs together with their instructors/administrators) to achieve a real-time IS via the disclosed job ads by the JM in addition to the relevant supplied academic programs syllabi by the EM in the form of supply-demand chain (Abd-Elall *et al.*, 2011).

As a result, first, the projected graduates can be updated with the JMQD; thus, becoming more qualified in choosing their majors/minors and conducting their career-path and personal-development planning. Meanwhile, at the center of the ESC, HEIs and its teaching staff can be electronically connected to its corresponding JM; thereby, customizing the intended learning outcomes (ILOs) of its academic courses –supplied to its learners– according to the changing JM needs and expectations (Abd-Elall *et al.*, 2011).

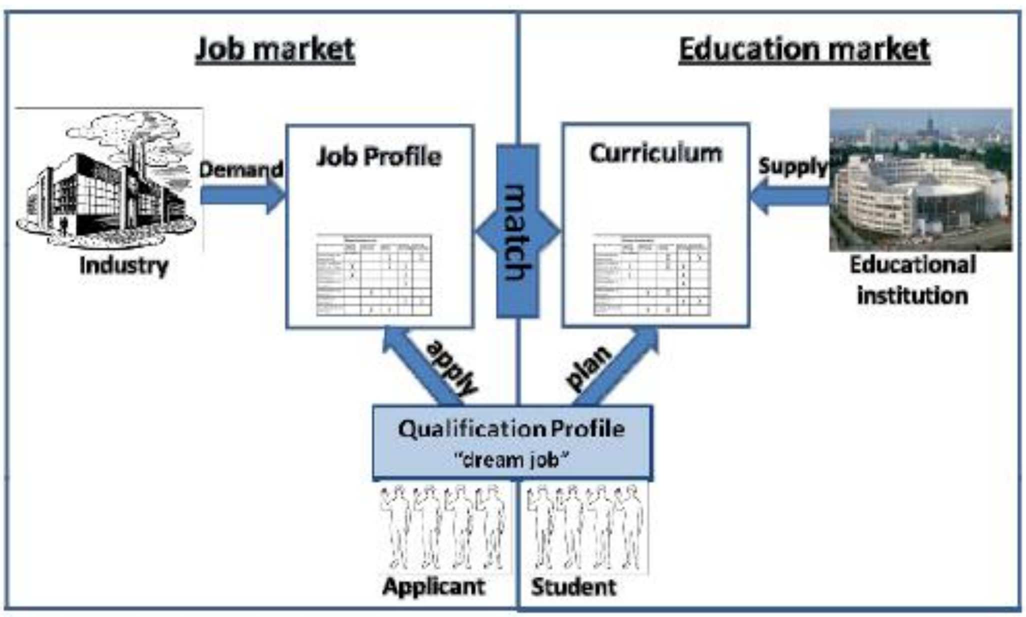


Figure 3.10. Dynamic Approach for matching Job Market Qualifications Demand & Educational Market Qualifications Supply using SW Framework

Source: Abd-Elall *et al.,* 2011

Downstream the ESC, the JM's HR specialists use standardized detailed job ads to call for their demanded KSA (i.e., representing the job-profiles); afterwards, applicants compare such ads with their prepared KSA-profiles (i.e., represented by their CVs) to choose what satisfy their supplied KSA (Abd-Elall *et al.*, 2011).

Soon after, the JM's HR specialists will have better opportunities of recruiting and hiring the most appropriate applicant. At the same time, HEIs should use an equivalent academic-profile for each supplied course to its learners electronically presented using a standardized template, which is verbally communicated using a common KSA language −for each specialization− similar to what is used professionally in the job-profiles (Abd-Elall *et al.*, 2011). More importantly, according to the suggested model of Abd-Elall *et al.* (2011), SCI and SCIS to be effectively and efficiently sustained among various ESC stakeholders require employing SWT to facilitate matching the used KSA terms at the three abovementioned profiles.

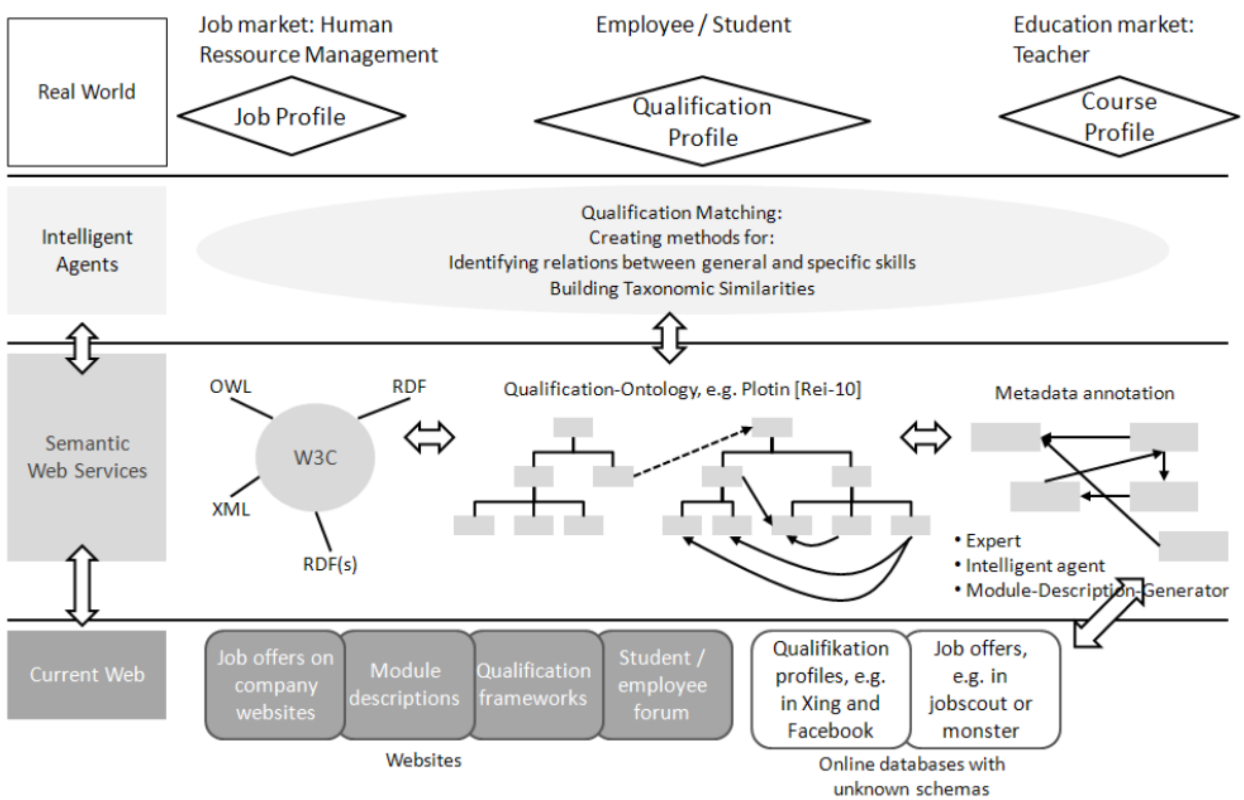


Figure 3.11. Architecture of Real-time Information Sharing between Collaborative ESC Stakeholders using SWT

Source: Abd-Elall *et al.*, 2011

In fact, after using a web ontology language (OWL), a precisely identified common conceptualization of each specialization can be exchanged between the interested ESC parties (Antoniou and Harmelen, 2008; cited in Abd-Elall *et al.*, 2011).

As illustrated in Figure 3.11, the aforesaid SW architecture comprises four distinctive levels that: (a) signify the reality with its three profiles; (b) reflect the World Wide Web; (c) employ a KSA database that is virtually operating via the internet; and (d) utilize intelligent-agents with data inputs to create demanded information by various ESC stakeholders (Abd-Elall *et al.*, 2011).

At this point, it’s important to mention that such KSA language with its common engineering terminologies has been created at the Factory MGT and Assembly Technology Department (Reise and Seliger, 2010; cited in Abd-Elall *et al.*, 2011). Afterwards, it was investigated at one example of the EM (i.e., Master’s studies of production engineering in the Technische Universität at Germany) (GPE, 2010; cited in Abd-Elall *et al.*, 2011). In this manner, such current language and more future ones at other different fields can be exchanged not only academically in the EM but also professionally in the JM and among other nodes and individuals along the entire ESC (Abd-Elall *et al.*, 2011).

In summary, ICT can be used to incentivize long-term effective and efficient ESC partnerships/integration/linkage in addition to SCIS across the ESC stakeholders (e.g., EM HR/learners, WM and JM); thus, enhancing their agile ESCP.

3.2.3.3.b. Agile Research SC in City University of Hong Kong (CUHK)

From an innovative strategic perspective, Lau (2007) proposed that a research SC should be conducted, for maintaining further sustainable development at HEIs (e.g., CUHK), through which a research proposal/project represents its main input while such research outcomes are its final output/product; additionally, different stakeholders/operators (e.g., researchers and their supervisors, research teams involving practitioners, and administrative personnel and sponsors) collaboratively aid in conducting the research process steps (e.g., research development and evaluation).

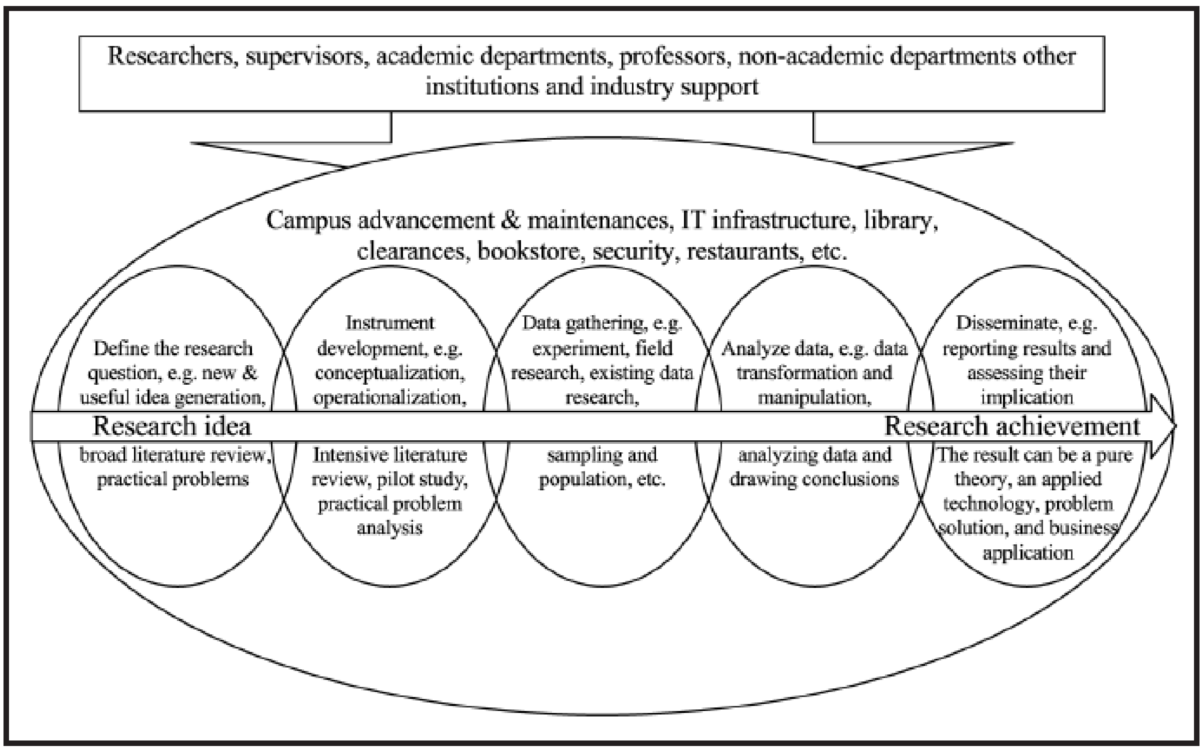


Figure 3.12. Agile Research Supply Chain in CUHK

Source: Lau, 2007

Likewise yet from a holistic SCM standpoint, Habib and Jungthirapanich (2009a, b, 2010), Habib *et al.* (2011) and Pathik *et al.* (2012b) added the research process to the HESC. By this means, HEIs can manage the detected gap between information/research supply (e.g., contemporary theories) and demand (e.g., successful practices) after sustaining the required IS with the interested parties (e.g., research-customers/business-organizations) in the form of supplier-customer relationship.

In regard to its SCP paradigm, Lau (2007) argued that the research, as a strategic and costly product, needs flexible responsive SC (e.g., agile SC) to quickly respond towards changing customers' requirements.

The research customers encompass MFG/service industries, research individual customers and the community/society (Habib and Jungthirapanich, 2009a, b; Habib *et al.*, 2011; Pathik *et al.*, 2012b).

Specially, when the conducted research is an empirical –rather than a pure conceptual– one, it needs value-adding contribution from the corresponding industry(s); thus, achieving all-win situation. Furthermore, he pointed out the importance of using ICT (i.e., a supporting activity) in maintaining the needed ESC integration; namely an intra-organizational linkage within the faculty's departments and between other related faculties as well as inter-organizational linkages among other interested universities and companies (Lau, 2007).

3.3. The Impact of Information and Communications Technology (ICT) on Education Supply Chain Performance (ESCP)

3.3.1. From IT to ICT in the Education Sector

As was discussed before in the previous chapter, Lyons (2005) elaborated on how the future trends are moving from IT to ICT, through demonstrating that the term ICT reflects the convergence or union of both IT and communications systems. Afterwards and in a similar vein, Berce *et al.* (2008) and Altun *et al.* (2011) defined ICT as a mixture of hardware (e.g., equipment), software (e.g., operating system or applications) and communication facilities (e.g., local area networks, wide area and backbone networks, and communication protocols).

While regarding the usage of ICT in the educational sector, Altun *et al.* (2011) revealed that ICT integration can be realized at different levels, as it can be studied at: (1) a state level (e.g., government); (2) an institutional level (e.g., higher education councils); (3) an organizational level (e.g., universities and schools) and this level can be studied at a university level, a faculty level, or a department level; or (4) an individual level.

In other words, ICT integration can be made at macro level as a system (i.e., national level or at both administrative and instructional levels), or meso-level (i.e., school level), or micro level (i.e., class level) or can be conducted together (Tondeur *et al.*, 2008; cited in Altun *et al.*, 2011).

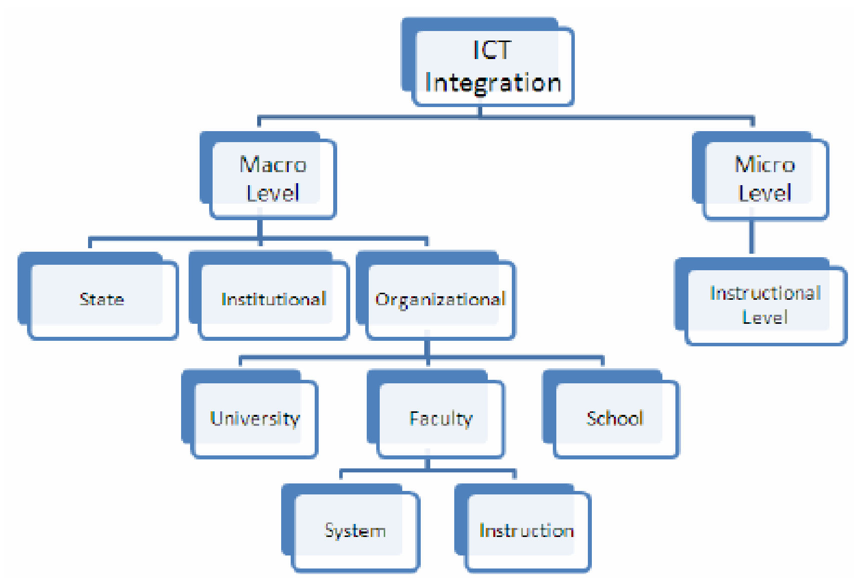


Figure 3.13. Levels of ICT Integration in the Education Sector
Source: Altun *et al.*, 2011

Additionally, Bidarian *et al.* (2011) were more concerned about the entrance of ICT into the educational field as a valuable chance for performing modifications and innovations, which resulted into increased efficiency and more value to the education system. Bidarian *et al.* (2011) defined information communication technologies (ICT) as those technologies used for collection, recording, reserving, processing, researching, transfer and receipt of information directed to teaching and learning scope. In other words, ICT is a collection of technologic tools and resources for further relations, creation, distribution, reservation and management of information (Bidarian *et al.*, 2011).

3.3.2. Using ICT in enhancing Education Supply Chain Integration (SCI), Information Sharing (IS) and Education Supply Chain Performance (ESCP)

Evoh (2010) argued the importance of the adoption and sustainability of technology-enhanced education in higher institutions of learning in Africa. Evoh (2010) pointed out the major changes that occurred in African HEIs, through indicating that the center of this change is the application of ICTs in teaching, learning and research activities. Similarly, Comm and Mathaisel (2008) indicated that the past two decades have been marked by the rapid evolution of IT into the education of students.

Specifically, Comm and Mathaisel (2008) were concerned about the effective use of IT resources and the effective delivery of IT services. Additionally, Green (2007) was concerned about how IT helps in accomplishing the institutional mission (cited in Comm and Mathaisel, 2008). Furthermore, they elaborated on how the technology has enabled HEIs stakeholders to have much faster and cheaper access to data and information (Comm and Mathaisel, 2008), as technology provides an efficient way to track information throughout the supply chain and share the information with ESC nodes.

Moreover, functions like research searches, registration, and grading are all now automated (Comm and Mathaisel, 2008). In addition to that, Comm and Mathaisel (2008) revealed that distance learning courses via the internet have led to accredited degrees and have attracted new students to universities. However, high technology implementation has a price (e.g., start-up and maintenance costs for these technology-based services) (Comm and Mathaisel, 2008), which will finally increase the tuition fees.

Subsequently, Comm and Mathaisel (2008) gave an example on ICT implementation challenges through pointing out that staff training on (a) using an "ISIS" system for course registration and grading as well as (b) teaching on-line/distance learning courses −in the state of Massachusetts− was expensive and very time consuming. However, the cost of keeping up with new developments was overwhelming in the past, but today the costs seem to have decreased.

From a different perspective for the usage of ICT in ESCs, Abd-Elall *et al.* (2011) after building on earlier works of Al-Turki *et al.* (2008) and Meyer (2006) conducted a dynamic approach for matching job market qualifications demand and educational market qualifications supply using SW technologies. The objective of this model implementation is to share a continuously updated information flow, between the job market, students, higher educational institutions and teachers, through using the Job Announcements and Course Outlines Contents (Abd-Elall *et al.*, 2011). As Abd-Elall *et al.* (2011) declared that ESC integration and real-time information sharing are hard to achieve between these ESC stakeholders (e.g., students, educational institutions and employers) because of the dynamic environment and continuous technological development; however, with the use of modern technology like SWT it will be possible.

Finally, Comm and Mathaisel (2008), after scanning the prior literature, pinpointed that recent cost-benefit analysis has shown that maintaining high technology is a worthy and justifiable investment if an educational institution is targeting sustainability in an ever changing competitive environment.

3.4. The Impact of TI on ESCP: Using TI to enhance SC Integration in Universities-Industries Partnerships

Lichtenthaler (2004c) and Savioz (2004) defined technology intelligence (TI) as a process that encompasses organizational activities related to the collection, analysis and communication of relevant information on relevant technological trends (i.e., technological factors that represent opportunities and threats to a certain field/organization) to support technological and other general decisions. These technological or strategic decisions are related to each SC node (i.e., individual organization) or to the SC as a whole.

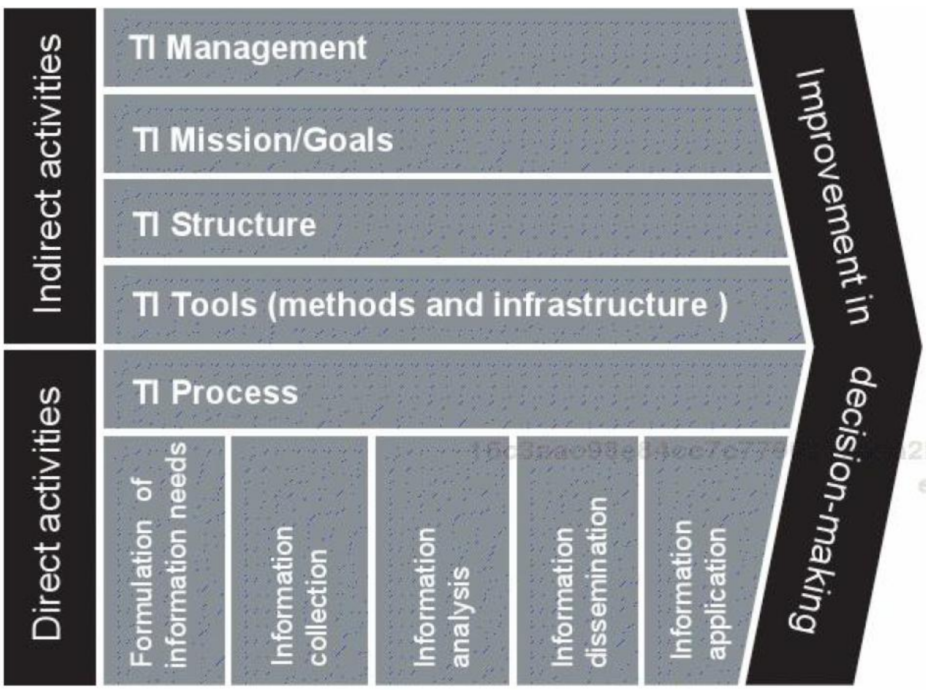


Figure 3.14. Technology Intelligence (TI) System
Source: Savioz, 2004

According to Lichtenthaler (2004c, 2005) and based on this definition, TI includes the observation and analysis of technological trends related to competitors, universities and start-up companies. Thus, the goal of TI is to exploit potential opportunities and to defend against potential threats through on time delivery of relevant information about important technological trends in the environment of an organization, which can be used later to enhance the technologies employed in that organization (Lichtenthaler 2004c, 2005; Veugelers *et al.*, 2010).

One can trace another technology intelligence (TI) definition of Kerr *et al.* (2006) in Veugelers *et al.* (2010), Dang *et al.* (2011) and Yoon and Kim (2012), who defined it as the process of collecting and disseminating technological information in order to create awareness of favorable technological opportunities in addition to possible technological threats.

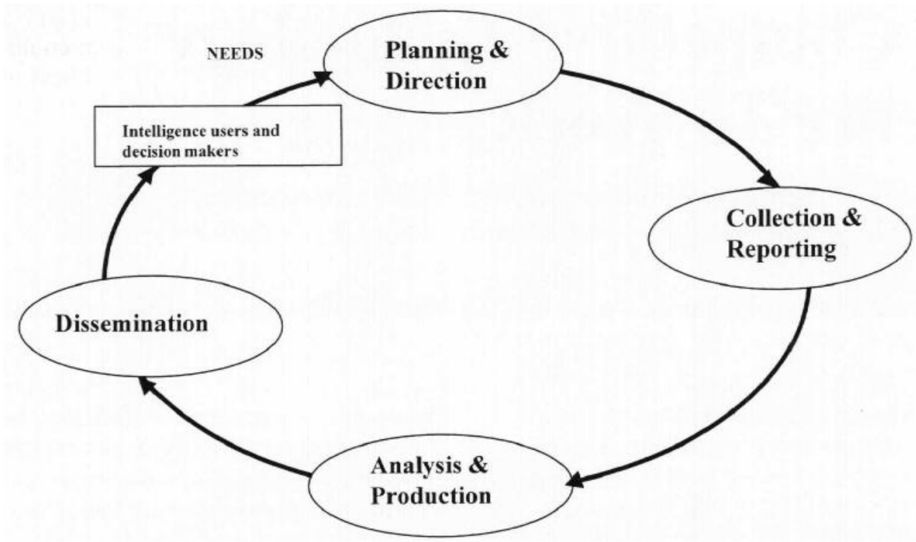


Figure 3.15. Technology Intelligence (TI) Process Steps
Source: Norling *et al.*, 2000

As elaborated by Norling *et al.* (2000) and Savioz (2004), the Technology Intelligence (TI) process in any organization involves main steps: (a) identifying the organization needs of specific technological information, (b) collecting the relevant technological information, (c) analyzing the collected information, (d) disseminating the analyzed information to its end user (e.g., department, organization, SC as a whole), and (e) take the required decisions based on the received information.

With regard to maintaining cost-benefit analysis before conducting such process, Veugelers *et al.* (2010) specified two main questions to be addressed by any organization intending to use TI: (1) which technologies are out there in our corresponding field, and (2) what technology is valuable, needed by, and fit with our organization. By this means, technology intelligence process can be conducted to facilitate a continuous, affordable and efficient updating of an organization on ICT developments and link it with innovation and continuous improvement (Veugelers *et al.*, 2010).

As for the different TI sources of obtaining the required technological information that an organization can choose from while conducting its TI process, Lichtenthaler (2004c) identified some of these sources; namely publications, patents, university contacts, start-up and product fairs, scientific and commercial conferences, consultants and external experts, national research committees, financing PhD theses, partnerships and customer interviews.

In addition to the abovementioned sources competitors can act as an important source of information, Taskov (2008) asserted that TI can highlight positive strengths and negative weaknesses of an organization's own technology/ICT infrastructure and generate insights to decision makers about the current/expected opportunities and possible threats formulated by new detected technology trends used by competitors.

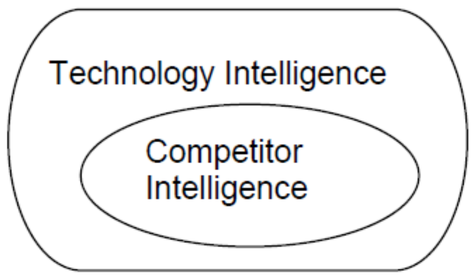


Figure 3.16. Technology Intelligence involves Competitor Intelligence
Source: adapted from Taskov, 2008

Thus, an educational institution can select the suitable TI sources for its own ICT developments and link it with innovation and continuous improvement or conduct a partnership and act as an external source of information for another MFG/service organization that also seeks reliable sources of TI. Thereby, the entire higher education SC performance will be improved after enhancing the ICT employed in each individual organization/node, which will positively affect its integration and information sharing with its stakeholders and ultimately boost the overall SCP of the related parties.

In regard to the university-industry partnerships (UIP) and TI via UIP, according to Dang *et al.* (2011), Kodak (i.e., a multinational organization that operates in more than 50 countries and employs around 20,000 individuals globally) selected the University of Cambridge at UK in order to conduct UIP with it. Dang *et al.* (2011) discussed the several played roles by the University of Cambridge; for example, exploring new technological opportunities, developing inter-company networks for Kodak and supplying it with a highly qualified workforce. The

University of Cambridge has several locations contributing to creativity and innovation and embracing incubators and science parks.

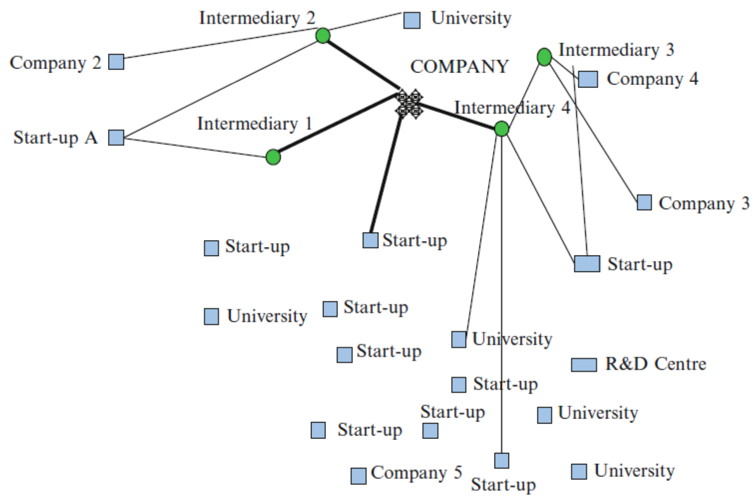


Figure 3.17. An organization's TI external networks
Source: Mortara *et al.*, 2009a; cited in Dang *et al.*, 2011

Furthermore, Dang *et al.* (2011) revealed that University of Cambridge possesses a dynamic environment that incentivized different multinational organizations operating in various MFG and service sectors (e.g., Microsoft, GlaxoSmithKline, Nokia, Hitachi, Philips, Toshiba, Rolls Royce, and Unilever) to conduct partnerships with the university, fund such university-industry research relationships, and benefit from its qualified HR output.

As it was discussed before in the previous chapter, Geiger and Sá (2005) focused on the importance of the active participation of higher education institutions to promote the required innovation. As a result, scholars have generated a growing literature on university-industry partnerships, technology transfer, systems of innovation, and the economics of university research (Geiger and Sá, 2005).

The term of universities-industries partnerships (UIP) refers to collaborative relationships between academic institutions and industry sustained by mutually beneficial information sharing between different stakeholders in order to better serve the community through improved products and processes, R&D, effective and efficient job creation, qualified graduates and fruitful research outcomes (Geiger and Sá, 2005; Worasinchai and Bechina, 2009, 2010; The Egyptian Center for the Advancement of Science, Technology and Innovation, 2014).

From a more detailed and practical perspective, Geiger and Sá (2005) discussed the relationship between collaborative/cooperative research (CR) and universities-industries partnerships (UIP) beyond the technology transfer (TT), through giving various and different examples on how American universities have long had close relations with industry, via two approaches either through linking technology creation with job creation or through collaborative research (CR) that aimed at specific technological developments.

In summary, a technology intelligence system (TIS) can be used by university-industry partnerships (UIP) in identifying the trends for research and investments and proposing new development areas (R&D). As TI was proven to be useful in technological research forecasting (TRF), UIP can use it for more effective and efficient technology creation and development. TIS can be used by UIP in identifying developments in different types of ICT that can represent new opportunities or potential threats to various industries. Thus, effective and efficient ICT employment will be able to enhance SCI and facilitate SCIS, and finally improve the entire SCP (e.g., ESCP and AISCP) as a whole.

Practically, the obtained findings from the fieldwork of the present study revealed the importance of using TI in HEIs in Egypt. The researcher assessed the moderation effect of technology intelligence (TI) on the relationship between ICT and SCI, after adding the UIP dimension to SCI. Results –as will be presented in chapter seven– revealed that TI positively and significantly affects SCI. Furthermore, the interaction between ICT and TI was also found to be significant, suggesting that the effect of ICT on SCI depends on the level of TI.

3.5. Measuring Higher Education Supply Chain Performance

Kaplan and Norton (1996, 2000, 2001a, b, c, 2004a, b, c, 2007) discussed the importance of using the balanced scorecard (BSC) approach and the strategy mapping in different manufacturing and service organizations for more balanced performance evaluation, but these strategy maps and BSC models were not widely applied to the educational sector (Adel, 2010).

According to Niven (2005), the Balanced Score-Card (BSC) was developed by Kaplan and Norton (1990) to solve a performance measurement problem by shifting from the usage of a single financial measure to the usage of a balanced set of measures in four interrelated tangible and intangible perspectives: financial, customer, internal processes, and learning and growth. Then, objectives can be developed and linked together, using arrows to draw cause and effect relationships between different key performance indicators to form Strategy Maps. In regard to the strategy map (SM), Norton (1999) defined it as a pictorial cause and effect logical reliable and consistent architecture. It represents a common model of the organization's strategy to help translate its overall quality-based vision into action and links the four-tier BSC framework with its strategic themes. Similarly, Kaplan and Norton (2000) and De Waal (2003) viewed it as a graphical comprehensive cause and effect generic framework that describes a strategy by specifying the relationships between different stakeholders, internal and external customers, business processes and core competencies.

Afterwards, some case studies used BSC and strategy maps in measuring organizational, rather than supply chain, performance of individual educational institutions (Duffy, 2005; Chen *et al.*, 2006; Cullen *et al.*, 2003; Gehlen De Leão *et al.*, 2006; Nefstead and Gillard, 2006; Papenhausen and Einstein, 2006; Asan and Tanyas, 2007; Umashankar and Dutta, 2007; Pineno, 2008; Cardoso *et al.*, 2009; Bittner and Myers, 2010; Adel, 2010; Philbin, 2011).

However, the related studies to measuring SC performance in the current literature (e.g., Brewer and Speh, 2000; Rao *et al.*, 2006) revealed that one of the obstacles for effective and efficient SCM is the inability to formulate, use and assess reliable and valid SCP measures.

At the same time, as for measuring SCP (in terms of leanness, agility and leagility), Naim and Gosling (2011) pointed out that assessing different SCP paradigms using questionnaires is more feasible to collect data on a large-scale (i.e., not case studies).

Similarly but from an organizational perspective, Yang and Liu (2012) after drawing upon their reviewed studies contended that using questionnaires with item-measures that assess managerial rather than financial performance is more feasible in case of institutions that don't disclose its financial data.

Additionally, Saad and Patel (2006), after studying the applicability of using different models and frameworks in measuring the supply chain performance in a developing country (i.e., India), concluded that some measurement models (e.g., SCOR and BSC) are infeasible in such context.

For the current study and based on the review of the prior literature, the questionnaire was found to be a more appropriate instrument –as quantitative data collection method− for collecting Hybrid lean-agile SCP data (in terms of leanness, agility and leagility) of various institutions (i.e., 41 HEIs and 84 companies) representing multiple nodes across the entire SC of the higher education sector in Egypt.

3.6. Literature Review Summary Tables

In summary and based on reviewing the prior research literature, the following LR summary tables were conducted:

3.6.1. The Research Main Concepts Summary Table

In the light of the prior studies and regarding the current research main concepts and key terms, the following conceptualization table was developed:

Table 3.1. The Research Main Concepts

Serial No.	Concept	Definition	Source/Citation
1	Supply Chain (SC)	- It is a network that starts with a supplier and ends with a customer. In other words, it is a network of organizations/individuals communicating to deliver a product to its end user and linked via different flows (e.g., raw materials supply and final product delivery). - It is a chain of exchange/reciprocity from original source to end customers moving across various nodes that are involved in different functions related to the required product (e.g., transforming raw materials, manufacturing/assembling, and distributing). - It is a system that encompasses suppliers, manufacturers, distributors and customers, which are connected together by a feed-forward flow of materials and feedback flow of information.	(Patricia *et al.*, 1996; Saunders, 1997; cited in Shukla *et al.*, 2011) (Saunders, 1997; cited in Shukla *et al.*, 2011) (Naylor *et al.*, 1999)
2	Supply Chain Management (SCM)	- It refers to the systematic integration and coordination of all the activities related to the transformation and flow of a certain product across different nodes/partners in one chain, including suppliers, manufacturers, distributors and customers, which are linked together via a seamless dynamic flow of materials, information, finance and HR that moves within and among these integrated entities. - In the light of this definition, the goal of effective and	(Bowersox and Closs, 1996; Sheffi and Klaus, 1997; Naylor *et al.*, 1999; Huang *et al.*, 2002; Kainuma and Tawara, 2006; Li *et al.*, 2006; Al-Turki *et al.*, 2008)

		efficient SCM is that the entire system is viewed as one integrated coordinated system.	(Li *et al.*, 2006; Al-Turki *et al.*, 2008)
3	SCM Practices	- A set/group of performed activities by an organization that seeks effective SCM for the purpose of improving its organizational and SC performance (e.g., strategic supplier partnership/upstream linkages with suppliers, long-term customer relationship/downstream linkages with customers, level of information sharing, quality of information sharing and postponement). - These SCM practices include supply chain integration (SCI) (e.g., upstream integration with suppliers, downstream integration with customers and intra-organizational integration) and supply chain information sharing (SCIS) (e.g., upstream IS with suppliers, downstream IS with customers and intra-organizational IS).	(Li *et al.*, 2006; Ibrahim and Ogunyemi, 2012) (Kim, 2009; Koçoglu *et al.*, 2011)
4	Service Supply Chain (SSC)	- It is a net/chain of suppliers, service providers, other parties and customers, through which different resources are used in providing services to various customers.	(Lin *et al.*, 2010)
5	Service Supply Chain Management (SSCM)	- It is the effective management of tangible and intangible resources (e.g., information) as well as different processes across different nodes/partners of the entire SSC from the suppliers till the customers.	(Lin *et al.*, 2010)
6	Lean Supply Chain	- It is the SC that applies a management philosophy which advocates the identification and removal of wastes/muda along the product's value stream flowing within the organization and across its SC network/partners. - Lean SCP is the ability of a SC to achieve more (i.e., significant outcomes/benefits) with less (i.e., waste reduction/removal); in terms of efficiency/cost-reduction, removal of wastes and continuous improvement. - Lean paradigm ―is about doing more with less: less time, inventory, space, labor, and money― is based on the best usage of input resources for the maximum output level through wastes elimination. In addition to wastes removal, two other principles should be followed, which are	(Scherrer-Rathje *et al.*, 2009) (Womack and Jones, 1996; Naylor *et al.*, 1999; Huang *et al.*, 2002; Towill and Christopher, 2002; Scherrer-Rathje *et al.*, 2009) (Womack and Jones, 1996; 2005; Towill and

		specifying the value delivered to the customer and generating/facilitating the flow of value-adding activities/processes. In summary, lean thinking involves limiting the usage of any non value-adding activity/resource.	Christopher, 2002; Melton, 2005; Kahn and Mello, 2004-05)
7	Agile Supply Chain	- It is the SC that has the ability of quickly and flexibly responding to changing customer demands; in terms of flexibility, speed and responsiveness. - It is the one that utilizes market knowledge and the benefits of virtuality in taking advantage of profitable opportunities within a stochastic/changing market.	(Naylor *et al.*, 1999; Lin *et al.*, 2006; Goldsby *et al.*, 2006; Sherehiy *et al.*, 2007) (Naylor *et al.*, 1999; Goldsby *et al.*, 2006)
8	Leagile Supply Chain	- Lean management advocates process efficiency (i.e., generating the maximum output from effective usage of input through wastes reduction); whereas, agility is about effective, rapid and flexible accommodation of changing customer/market demands. However, the leagility principle is about achieving a more robust strategy that encapsulates/incorporates the main features of both lean and agile approaches. - It is the SC that has the ability of maintaining mass-customization and postponement. It integrates leanness and agility into the entire supply chain, which are separated by a decoupling point. The leagile SC is decoupled via the customer-order/product-differentiation point (i.e., postponement strategy) so that lean attributes (e.g., efficiency and continuous improvement) are adopted up to that decoupling point (upstream) whereas the agile features/practices (e.g., speed, flexibility and responsiveness) are implemented after that point (downstream). Thus, the best of both strategies could be obtained in one SC. Postponement strategy enables the SC system to delay its final product finishing activities until the last possible SC position (or nearest to customers) in order to efficiently handle demand uncertainties.	(Goldsby *et al.*, 2006; Chan and Kumar, 2009) (Naylor *et al.*, 1999; Huang *et al.*, 2002; Turner and Williams, 2005; Chan and Kumar, 2009) (Mason-Jones *et al.*, 2000; Chan and Kumar, 2009; Naim and Gosling, 2011)
9	Hybrid Lean-Agile Supply	- It is a SC that uses a blended approach, which hybridizes the attributes of leanness (e.g., cost-minimization, waste-	This thesis conceptually adds to the active

	Chain (HSC)	reduction, continuous improvement) together with that of agility (e.g., speed, flexibility, responsiveness) and leagility (e.g., mass-customization, postponement), and the percentage of each hybridized component varies according to the organization position along the SC.	debate on the applicability of the blended lean-agile SC strategy by integrating two main streamlines of prior management research regarding this empirical issue; namely the leagility approach (Naylor *et al.*, 1999) and the hybridized lean-agile manufacturing system (e.g., Elmoselhy, 2012), into one new hybridized lean-agile approach.
10	Automotive Supply Chain (ASC)	- It is a long and hierarchical SC, and its main product (i.e., car) involves around 20,000 parts. In addition, being hierarchical means that it has many tiers of suppliers (i.e., the producer out-sources main auto-components (e.g., exhaust systems, doors and carpets) from the first tier suppliers, who out-source the sub-parts (e.g., wires and cables) from the second and third tier suppliers).	(Kim and Im, 2002)
		- It is a hybrid SC (i.e., it can be barely considered as either absolute efficient/lean or responsive/agile SC) that generates a hybrid product (e.g., vehicle) as it comprises a mixture of standard and innovative components produced via different industries. In this way, the need for a hybrid lean-agile automotive SCM is justified.	(Huang *et al.*, 2002; Turner and Williams, 2005)
		- In such a hierarchical SC, information sharing takes longer time with more defects and enhanced bull-whip effect (i.e., increased fluctuation in the inventory level) if it isn't conducted via electronic channels. Thus, the need for using SCT is justified.	(Kim and Im, 2002)
11	Education Supply Chain (ESC)	- It is a supply chain where HEIs are located at the centre of a coordinated integrated network of shared information, resources, practices, responsibilities and functions. The	(Al-Turki *et al.*, 2008; Abd-Elall *et al.*, 2011)

		interaction between ESC nodes (i.e. general and higher educational institutions, workforce market and job market) can be viewed as a chain of suppliers, customers and stakeholders. - ESCs include many stakeholders (e.g., faculty staff, students, alumni, administration, partners, product and equipment suppliers, government, third-party business, society in large, and various other intermediaries and nodes).	 (Comm and Mathaisel, 2008)
12	Supply Chain Technology (SCT)	- It is the technology used to electronically coordinate/integrate the information streams that flow across the SC network of various stakeholders; thus, conducting effective/efficient transactions, facilitating real-time access to information, improving the customer service, decreasing the paperwork, enhancing two-way communication, boosting productivity and reducing the waste of time.	(Kamaruddin and Udin, 2009)
13	Supply Chain Integration (SCI)	- The extent to which an organization is able to link and coordinate the performed activities internally within its departments and externally across its various SC participants. - It is the elevation of the linkages within each node of the SC in order to support decision making and facilitate the interaction between all SC nodes in a more efficient manner. Thus, creating a comprehensive picture of the whole SC and detecting bottlenecks. - The integration of the processes, systems and organizations, which control the flow of goods from suppliers to satisfied customers while eliminating wastes. - It is one of the SCM practices, which is an integrating philosophy of managing the total flow of a distribution chain starting from the supplier to end user/customer.	(Li *et al.*, 2009) (Putzger, 1998; cited in Power, 2005) (Ellram, 1991; cited in Shukla *et al.*, 2011) (Cooper and Ellram, 1993; Shukla *et al.*, 2011)
14	Supply Chain Information Sharing (SCIS)	- The mutual information-based exchanges between different SC players through using inter- and intra-organizational linkages for the purpose of enhancing SC performance. - It is a key driver for efficient and effective SC performance via smoothly accelerating the flow of information, reducing the response time towards satisfying customer needs,	(Koçoglu *et al.*, 2011) (Li and Lin, 2006; cited in Koçoglu *et al.*, 2011)

		improving the coordination/collaboration among SC nodes and facilitating risks/benefits sharing. - It helps in minimizing SC costs, strengthening relationships among SC partners, improving the material flow, supporting efficient delivery, sustaining customer delight through improving the order fulfillment rate, facilitating SC nodes coordination, and act as a competence for maintaining various competitive advantages.	 (Koçoglu *et al.*, 2011)
15	Information and Communications Technology (ICT)	- It is a mixture of hardware (e.g., equipment), software (e.g., operating system or applications) and communication facilities (e.g., local area networks, wide area and backbone networks, and communication protocols). - The convergence or combination of information technology (IT) and communication systems.	(Berce *et al.*, 2008; Altun *et al.*, 2011) (Lyons, 2005)
16	Technology Intelligence (TI)	- It is the process that encompasses organizational activities related to the collection, analysis and communication of relevant information on technological trends (i.e., technological factors that represent opportunities and threats) to support technological and other general decisions. The goal of TI is to exploit potential opportunities and to defend against potential threats, through on time delivery of relevant information about technological trends in the environment of an organization. - It is the process of collecting and disseminating the technological information in order to create awareness of the technological opportunities in addition to its threats.	(Lichtenthaler, 2004c; Savioz, 2004) (Kerr *et al.*, 2006; cited in Veugelers *et al.*, 2010; Dang *et al.*, 2011; Yoon and Kim, 2012)
17	Technology Forecasting (TF)	- It is the process of identifying and predicting important research and technology trends. TI is the key to estimating technological opportunities and threats.	(Behkami and Daim, 2012)
18	Universities-Industries Partnerships (UIP)	- Collaborative relationships between academic institutions and industry sustained by mutually beneficial information sharing between different stakeholders in order to better serve the community through improved products and processes, R&D, effective and efficient job creation, qualified graduates and fruitful research outcomes.	(Geiger and Sá, 2005; Worasinchai and Bechina, 2009, 2010; The Egyptian Center for the Advancement of Science, Technology and Innovation, 2014)

3.6.2. ESC Literature Review Summary Table

The researcher's thematic critical analysis was facilitated by recording and summarizing key details of the prior ESCs relevant studies as follows:

Table 3.2. ESCM LR summary table: Main prior studies that pioneered the investigation of applying SCM practices to the education sector

Citation/ Source	Research Title	ESCP Paradigm	Location/ Country	Objectives	Research Methodology	Conclusions and Recommendations	Limitations
(Lau, 2007)	Educational supply chain management	Lean commodity supply chain, lean special requested supply chain, lean outsourcing supply chain; leagile student SC; agile research SC	Non-profit tertiary higher education institution (HEI): City University of Hong Kong (CUHK)	To study the implementation of the philosophy of supply chain management in the higher education environment of Hong Kong and suggest innovative management ideas in higher education management.	(Qualitative approach) An in-depth case study approach was conducted through interviewing the personnel of the supply chain department and analyzing the collected university documents.	This study identified three supply chains of the university: Commodity, Special requested and Outsourcing supply chains in addition to two strategic supply chains: student and research SCs to further improve the efficiency and effectiveness of higher education. Since, the case study is weak to generalize through a single case approach. Further studies via multiple cases were recommended to validate the study findings. It recommended further researches to be conducted in order to study some	A case study approach was used to study the City University's performance, which affected the research generalization. His research, which qualitatively reviewed the supply chain management in the City University of

						unanswered problems in managing supply chain in the academic world; for example the information synchronization and visibility are key but difficult to achieve in the academic world, because the invisibility of the information harms the educational supply chain performance.	Hong Kong, failed to obtain objective instruments to assess the supply chain performance in the university.
(Al-Turki *et al.*, 2008)	Stakeholders integration in higher education: supply chain approach	Leagile ESC	Saudi Arabian leagile ESC (Saudi Aramco, a large oil company, conducted collaborative educational program with different universities including the King Fahd University)	To study the implications of supply-chain management principles on higher education, describe and analyze a supply-chain view/model of higher education and its environment for the possibility of adopting supply chain principles, and finally, to pinpoint features that might be catalysts or	(Qualitative approach) A case study approach was used to describe and summarize an experience representing a partial implementation of the ESC concepts and practices in Saudi Arabia.	They conducted a framework and developed a model for supply-chain coordination and integration in higher education that takes into consideration successful SCM practices. Moreover, they determined the existing practices that address supply-chain in higher education and suggested some new practices representing a natural extension of supply-chain management practices. They concluded that SCM practices can help the HEIs in closing the existing gap between its outcomes and job market needs. These SCM practices emerged to bridge the gap between the KSAs offered by the education market, and the required KSAs by the job market.	Only one case study was analyzed and summarized which affected the research generalization ability.

				hurdles towards these principles.			
(Comm and Mathaisel, 2008)	Sustaining higher education using Wal-Mart's best supply chain management practices	Lean ESCs	Public and private higher educational institutions in U.S.A	To identify lessons higher education could learn from Wal-Mart’s reasons for its financial success with its focus on efficient and effective supply chain management (SCM) best practices.	(Secondary data literature review) Wal-Mart’s best practices in SCM were investigated through a secondary data literature review, which revealed that Wal-Mart’s best practices in SCM can be categorized into four main segments: strategic concepts, logistics and distribution, information technology, and supplier collaboration.	They explored the problems facing public educational institutions in U.S.A. and found out that applying SCM principles to the higher education can lead to more effective and efficient ESCP in U.S.A. They concluded that technology, outsourcing, and collaboration practices are particularly useful in higher education to help control its costs.	The adoption of Wal-Mart’s best practices was investigated for only one service industry (higher education). They recommended that future research could apply these practices to other service industries, such as hotels and transportation.
(Kargaev,	Cooperation among	Leagile	Public and private higher	To analyze the current operating	(Quantitative	He concluded that universities in Kyrgyzstan are failing to match with	This study is preliminary and

2008)	educational institutions and industry: Supply chain perspective	"Pull" ESC	educational institutions in Kyrgyzstan	system of the educational institutions in Kyrgyzstan in terms of a supply chain view.	approach) He hypothesized that as the current educational system in Kyrgyzstan lacks cooperation with the industry, it is turning out to be ineffective in meeting the needs of the labor market. Data gathered from a survey based on a constructed questionnaire that was used to test the above hypothesis.	labor market requirements because of the low level of cooperation with the industry. He proposed a "Pull" operating system as a feasible solution to the failure of the educational institutions in Kyrgyzstan in matching the market demands for the labor force because of the insufficient level of cooperation with the industry. It was recommended that the educational institutions in Kyrgyzstan should adopt a "Pull System".	the results reported are based on limited observations. It was suggested that more work should be done in the future toward undertaking a study of the ESC in a more comprehensive manner both in terms of data collection as well as use of more in-depth methodology and analytical approaches.
(Ang and Griffin, 2008)	Supply chain management for higher education	Lean ESC	Public higher educational systems in U.S.A	To explore the appropriateness of applying supply chain management	(Secondary data literature review) They discussed the use of supply chain management	They concluded that the learning outcome is justified if student's terminal learning goals can align with the job skills and knowledge requirements to perform at workplace.	The study only argued the strategies and tactics and lacked the detailed

				(SCM) as an innovative management strategy to achieve learning outcome in public higher educational systems.	(SCM) principles as an innovative management strategy to implement in higher learning educational systems in order to achieve learning outcome and attain operational effectiveness and efficiencies. They introduced a framework of using SCM principles to apply in HE systems.	Additionally, they found out that the service sector supply chain is definable and business benefits and competitiveness can be effectively achieved through the implementation of SCM. They recommended that higher educational system should act as a pull-production system, a system of collaboration, a system of supplier and customer relationship, and a system of logistics.	operational practices. More in-depth methodology and analytical approaches are needed.
(Ang *et al.*, 2010)	Enterprise systems education through supply chain management	Agile ESC	Higher educational institutions in U.S.A.	To provide a framework in order to describe the use of SCM principles as an effective strategy to attain competitiveness for "Enterprise	(Secondary data literature review) They explained the use of SCM principles as an effective strategy to attain competitiveness for these so-called	They concluded that relationship management systems must be developed to oversight the collaboration and integration activities based on the given level of demand and supply along the ESC and to coordinate the information and material flows among the supply chain members in the supply chain. They	Again, the paper only argued the strategies and tactics and lacked the detailed operational practices.

				systems education" institutions.	"Enterprise systems education" institutions (i.e., sharing a set of common goals).	suggested that this educational supply chain management system should be implemented, so that qualified graduates with exemplary education and career pathways can be achieved. Moreover, they conducted steps in creating effective higher learning SCM.	This study is not empirical but only conceptual.
(Abd-Elall *et al.*, 2011)	A dynamic model for matching job market qualifications demand and educational market qualifications supply	Agile ESC	International Master Program "Global Production Engineering" in Berlin, Germany	To introduce a dynamic approach for matching job market qualifications demand and educational market qualifications supply using semantic web technology (SWT). The objective of this model implementation is to share a continuously updated	Causal (Experimental) Qualification representation language for the field of engineering was developed at Factory Management and Assembly Technology department and was tested in the education market by the International Master Program of Global	They concluded that the effectiveness and efficiency of the ESC integration and real-time information sharing are possible to be achieved between ESC stakeholders (e.g., students, educational institutions and employers), through the use of modern technologies as SWT. However, they recommended further research in the creation of relations and algorithms in order to visualize dependencies and taxonomic similarities of qualification profiles for engineers.	Since, they noted that the annotation of qualification statements in web documents is not broadly accomplished. Therefore, further studies via multiple cases should be conducted to overcome this weakness and to validate the study findings.

				information flow, between the job market, students, HEIs and teachers, through using the job announcements and course outlines contents. To view the interaction between these nodes as a chain of suppliers and customers.	Production Engineering at TU (i.e., a University in Germany).		
(O'Brien and Deans, 1996)	Educational supply chain: A tool for strategic planning in tertiary education	Leagile ESC	University of Strathclyde Department of Marketing in U.K.	To examine the concept of adapting industry models to higher education with specific reference to the idea of an educational supply chain, in which employers, students, university staff,	(Qualitative approach) The empirical research was undertaken as part of the University of Strathclyde's Department of Marketing's review of the undergraduate program. It	They found out that both student and employer markets are welcoming the idea of further integration and collaboration and that there are some valuable lessons to be learned from industry in the arena of strategic planning. The results of the employers' interviews showed that they favored this close cooperation because it provides a higher caliber of student, reduces recruitment costs and	A quantitative approach will be needed using large sample to enhance the research generalization ability.

				schools and colleges work in collaboration to ensure that the needs of all are satisfied.	involved both students and employers in the decision making process and tested the reaction of both sectors to the idea of becoming more integrated into the university planning structure. In-depth interviews with the employers and focus groups with the students were conducted.	facilitates the establishment of a long-term working relationship with a chosen university. Moreover, several employers were later integrated into the degree program making it a more balanced combination of theory and practice. Additionally, students felt that their learning experience at the University of Strathclyde had prepared them well for the challenges of employment and that the practical, interactive approach between industry and academe was a unique competitive advantage.	

3.7. Conclusion

Despite the abundance of studies which have discussed the importance of ICT in the field of production and operations management, there is a little empirical research that investigated the effect of ICT on SCP directly and indirectly through SCM. Additionally, there is a disharmony in the reported empirical findings (i.e., mixed results) of these few studies that directly/indirectly assessed the ICT-SCM-SCP relationship (Zhang *et al.*, 2011). Furthermore, as far as the literature has been investigated, there is a lack of studies that assessed its effect on hybrid SCP in terms of leanness, agility and leagility; especially in the automotive and education sectors.

Therefore, this research empirically investigates the direct effect of ICT and the mediation effect of SCM (i.e., SCI and SCIS) on hybrid lean-agile SCP of the automotive and higher education sectors (i.e., serving as two important examples of the manufacturing and service industries).

Moreover, despite the abundance of studies which have focused on applying SCM practices to different manufacturing industries, few studies were concerned about the application of successful SCM practices to the service sector; particularly the education sector in spite of the fact that its SC affects either positively or negatively many other different sectors/industries. Furthermore, as far as the literature has been investigated, there is a lack of studies that empirically assessed the ICT/TI-SCM-HSCP relationship in terms of leanness, agility and leagility in the context of higher education; especially in Egypt.

Thus, the researcher was motivated to add via this study to the few detected attempts in the contemporary SCM research literature, which considers education management (EMgt), technology management (TM) and SCM as interdependent fields of research.

For the above-mentioned reasons, in regard to applying SCM practices to the service industries especially the higher educational sector, this chapter presented different attempts in the prior research literature that focused on how HEIs can sustain an active participation in promoting the required innovation in the society through effectively and efficiently applying SC approach to their operations. Additionally, this chapter introduced various examples of profit and nonprofit HEIs in different countries, which pioneered the investigation of applying SCM practices to the education sector and successfully applied some of these practices to their educational institutions. However, most of these education

SCM researches conducted the “case study” approach −which affects the research generalization ability− in either profit or non-profit institutions, and at the same time, recommended further studies via multiple cases. Thus, this research will study the impact of ICT and TI on different SC performance paradigms (e.g., lean, agile, and leagile SCP) of public and private HESCs operating in Egypt. In addition, the difference between manufacturing supply chain and service supply chain; especially education service supply chain was comparatively revealed in this chapter. Further, the impact of ICT, TI, SCI and SCIS on the performance of lean, agile and leagile education SCs were critically and thematically reviewed in the prior research literature throughout this chapter.

As a fruitful output after reviewing the related prior research literature, which was discussed within chapters two and three, the research constructs and measurements were developed based on what has been used in the prior studies. ICT employment –the independent variable– is considered in two levels in this research following the study of Zhang *et al.* (2011); inter-organizational level (INTEROL) (Byrd and Davidson, 2003; Rao *et al.*, 2006; Paulraj and Chen, 2007; Paulraj *et al.*, 2008; Li *et al.*, 2009; Azevedo *et al.*, 2011; Azevedo *et al.*, 2012; Prajogo and Olhager, 2012) and intra-organizational level (INTRAOL) (Rai *et al.*, 2006; Lee *et al.*, 2007; Swafford *et al.*, 2008; Kim, 2009; Li *et al.*, 2009). Whereas, based on the studies of Boon-itt and Paul (2006), Kim (2009) and Koçoglu *et al.* (2011), the researcher measured SCI –the first mediating variable– in three dimensions: upstream integration with suppliers (UI) (Boon-itt and Paul, 2006; Li *et al.*, 2006; Kim, 2009; Ibrahim and Ogunyemi, 2012), downstream integration with customers (DI) (Boon-itt and Paul, 2006; Li *et al.*, 2006; Ibrahim and Ogunyemi, 2012) and intra-organizational integration (II) (Boon-itt and Paul, 2006; Lee *et al.*, 2007; Kim, 2009; Koçoglu *et al.*, 2011). In addition, the researcher used the university-industry partnership (UIP) as a fourth dimension in measuring the SCI of the HEIs following the studies of Geiger and Sá (2005), Ponis and Koronis (2005), Om *et al.* (2007), Shultz (2007), Worasinchai and Bechina (2009, 2010), Habib and Jungthirapanich (2010), Habib (2011), Van Hoek *et al.* (2011), Pathik *et al.* (2012a, b), Varma (2012), Bak and Boulocher-Passet (2013) and Sohal (2013). Concerning the measurement of SCIS, the second mediating variable, the researcher relied on the research of Koçoglu *et al.* (2011) and used three main aspects: upstream information sharing with suppliers (UIS) (Li *et al.*, 2006; Sezen, 2008; Koçoglu *et al.*, 2011; Ibrahim and Ogunyemi, 2012), downstream information sharing with customers (DIS) (Boon-itt and Paul, 2006; Li *et al.*, 2006; Paulraj *et al.*, 2008; Sezen, 2008; Kim, 2009; Koçoglu *et al.*, 2011; Ibrahim and Ogunyemi, 2012; Prajogo and Olhager, 2012) and intra-organizational information sharing (IIS) (Boon-itt and Paul, 2006; Eng, 2006; Koçoglu *et al.*, 2011). As for the assessment of the technology intelligence (TI), the moderator, the researcher relied on the studies of Lichtenthaler (2003, 2004a, 2004b, 2004c, 2005, 2007), López-Ortega *et al.* (2004), Savioz (2004), Boon-itt and Paul (2006), Taskov (2008), Yoon (2008), Veugelers *et al.* (2010), Dang *et al.* (2011), Behkami and Daim (2012) and Yoon and Kim (2012). Finally, based on the studies of Naylor *et al.* (1999), Huang *et al.* (2002) and Elmoselhy (2012), the researcher assessed HSCP –the dependent variable– in terms of leanness (LSCP) (Womack and Jones, 1996; 2005; Kahn and Mello, 2004-05; Melton, 2005; Lee *et al.*, 2007; Koçoglu *et al.*, 2011; Mohaghar and Ghasemi, 2011a; 2011b), agility (ASCP) (Li *et al.*, 2006; Swafford *et al.*, 2008; Koçoglu *et al.*, 2011; Mohaghar and Ghasemi, 2011a; 2011b; Azevedo *et al.*, 2012; Ibrahim and Ogunyemi, 2012) and leagility (LEAGSCP) (Huang *et al.*, 2002; Turner and Williams, 2005; Li *et al.*, 2006).

Figure 3.18 presents the proposed framework of the current research, which shows the direct effect of ICT on hybrid lean-agile SCP –in terms of leanness, agility and leagility– and its indirect effect on HSCP, through SCI and SCIS (i.e., mediation effect of SCM) and TI (i.e., moderation effect).

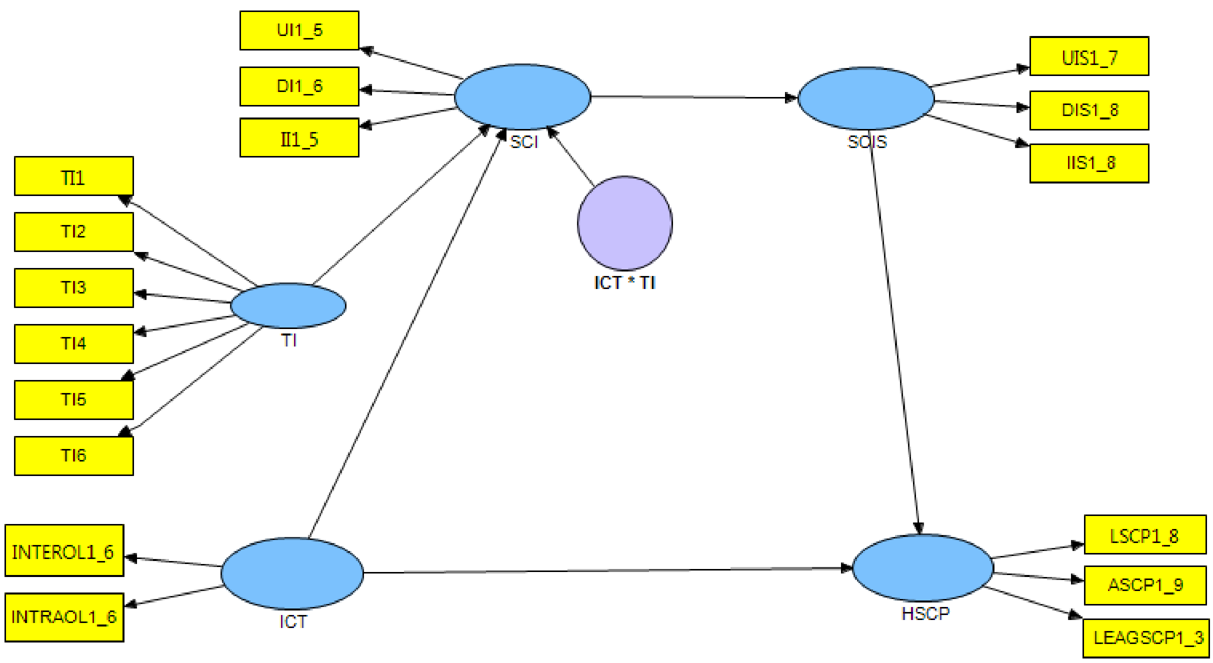


Figure 3.18. The Research Model drawn via SmartPLS software and its variables were developed based on what has been used in the prior research literature

CHAPTER FOUR

Research Methodology

4.1. Introduction

This chapter introduces the used methodology. It pinpoints how the research questions were addressed via both qualitative and quantitative approaches (i.e., mixed methods approach). In the light of the prior research literature that was thematically scanned throughout chapter two and three, the boundary of this research was properly addressed to prevent irrelevant data collection and that is thoroughly discussed in this chapter. Accordingly, this chapter specifies the types and sources of the collected data in the area of SCM; especially ASCM, ESCM, ICT, TI and HSCP. In addition, this chapter indicates the research population and the sampling technique and data collection methods used throughout the research process. Furthermore, it presents summary tables of the collected data from 129 organizations located in 15 Governorates in Egypt operating in the automotive and higher education sectors; whereas, other detailed data collection tables are shown throughout the appendices of this thesis.

4.2. Research Design and Approach

The purpose of this research was to investigate the direct and indirect effect of ICT on hybrid SCP in terms of leanness, agility and leagility of the automotive/auto-parts companies and higher education institutions in Egypt. A mixed methods approach (i.e., Triangulation design) was used in the data-collection phase, to obtain greater insights and better understanding of (a) the research proposed relationships between the main constructs: ICT, TI, SCM and HSCP –due to their breadth and complexity– and (b) the nature of the automotive industry and the higher education sector in Egypt, which represent two important examples of the manufacturing and service industries. Another purpose of using a triangulation mixed methods approach and combining several research methods in studying the hybrid performance (i.e., leanness, agility and leagility) carried out by multiple nodes across the AISC and ESC in Egypt is to provide management researchers with a comprehensive view of attractive yet unexplored contexts of contemporary SCM research.

In order to test the research specific hypotheses and examine the proposed relationships among the variables of the suggested research model, the research design was chosen to be a conclusive descriptive research of single cross sectional design.

This research can be characterized as a qualitative and quantitative research (i.e., Abductive; combining research approaches). First, the researcher started with conducting a qualitative research approach in the form of an exploratory research (i.e., ten in-depth personal interviews with SMEs from the two sectors before data collection). At this point it is important to mention that the qualitative part of this research (i.e., mainly through a total of 160 in-depth interviews) provided an in-depth qualitative understanding and description of the underlying causes of the research problem and discover the hybridized nature of both automotive and educational SCP. Further, it was developed to ensure an accurate formulation of the research operationalization, which was used, later on, in the quantitative analysis. Through abduction, the collected data were used to explore and study the new features of their hybridized SCP and generate the new modified hybridized lean-agile SC theory (Inductive), which was subsequently tested through additional data collection (qualitative and quantitative). With regard to the quantitative part, the researcher carried out a quantitative research approach (Deductive) to quantify the collected data, through questionnaires, and then a quantitative statistical analysis was used in order to be able to analyze and interpret the quantitative data, and recommend final courses of actions.

4.3. Research Sampling

<u>The target population of this research was</u>:

I. All organizations in the automotive industry –throughout its three main sub-sectors– in Egypt (i.e., an example of a manufacturing industry); namely manufacturers/assemblers of the auto-feeding and automotive industries and CBU importers and distributors. A total of 101 automotive firms were contacted –through email and/or phone– of which 84 accepted to participate, resulting in a response rate of 83.16%.

These organizations were registered on different databases and key references. As for the first sub-sector (i.e., EAFI), local auto-component manufacturers were listed/registered as follows: (1) 39 companies on the Egyptian Auto-feeders Association (EAFA) –an Egyptian not-for-profit association that provides its members with technical, financial, legal and marketing services– website (http://www.eafa-egypt.com/en/companylist.aspx); (2) 22 companies in the study of American Chamber of Commerce in Egypt (AmCham) (Business

Studies and Analysis Center, 2011); and (3) 54 companies on the EAFA database and via interviewees' nominations (referrals obtained throughout the conducted interviews).

With regard to the vehicle manufacturers/assemblers (i.e., the second sub-sector EAM), 17 firms were retrieved from the AmCham study (Business Studies and Analysis Center, 2011), 20 companies were obtained from EAFA report (Egyptian Auto-feeders Association, 2010), and 6 more companies were nominated throughout the conducted interviews and their names are not registered in any of the aforementioned databases.

In respect to the last sub-sector (i.e., CBUM), 25 CBU importers/distributors were identified based on the Egyptian Automobile Manufacturers Association (EAMA) reports (Automotive Marketing Information Council, 2006; 2007; 2008; 2009a; 2009b; 2010a; 2010b; 2011; 2012a; 2012b; 2013), AmCham study (Business Studies and Analysis Center, 2011) and the provided referrals by other respondents.

Finally, after combining the contents of these above-mentioned references/databases together and removing any repetition, shutdowns and discontinued operations, the researcher developed a new up-dated list of 56 auto-parts manufacturers (of which 45 responded, 80.35% response rate), 20 vehicle manufacturing/assembling companies (of which 18 responded, 90% response rate), and 25 CBU agents/distributors (of which 21 responded, 84% response rate). Additionally, any missing contact information for these companies was further obtained from the National Information Center (NIC) at the Central Agency for Public Mobilization and Statistics (CAPMAS) –the official statistical agency of Egypt– (CAPMAS, 2007; NIC, 2012a) and the Chamber of Engineering Industries (CEI) (2012), which is one of the sixteen industrial governmental chambers of the Federation of Egyptian Industries.

II. All the higher education institutions (HEIs) operating in Egypt (i.e., an example of a service sector); namely universities and academies (i.e. 63 HEIs: 25 public universities, 23 private universities and 15 academies) (National Information Center (NIC) at the Central Agency for Public Mobilization and Statistics (CAPMAS), 2011a; 2011b; 2011c; 2012b; 2012c; 2014; Ministry of Higher Education (MHE), 2008; 2012; 2014; Egyptian Supreme Council of Universities (ESCU), 2012; Statistics Department at the Research Center of University

Education Development at the ESCU, 2014). A total of 63 HEIs were contacted –through email and/or phone– of which 41 accepted to participate, resulting in a response rate of 65.08%. After combining the contents of these aforementioned references together and removing any repetition, shutdowns and discontinued operations, the researcher developed a new up-dated list of 25 public universities (of which 15 responded, 60% response rate), 23 private universities (of which 17 responded, 73.91% response rate), and 15 academies (of which 9 responded, 60% response rate).

While, the sampling unit was:

a. All the auto-feeding and automotive companies –that are operating in Egypt and implementing or partially implementing SCM practices– represented by individuals (e.g., leaders, managers and specialists) that are empowered/responsible in the area of study (e.g., SCM, ICT, and research and development (R&D) activities in these companies).
b. All the HEIs; namely universities and academies –that are operating in Egypt and implementing or partially implementing SCM practices– represented by individuals (e.g., leaders, managers and specialists) that are responsible in the area of study (e.g., SCM, ICT and research activities in these HEIs and its research centers/TICO/GICO offices).

With respect to the first sector (i.e., automotive industry), probability simple random sampling technique was used as this study targeted the entire population (i.e., 101 automotive firms were contacted through email and/or phone) of which 84 accepted to participate through face-to-face depth interviews, resulting in a response rate of 83.16%. Despite being characterized by a small population size, the companies of this industry are physically dispersed at various governorates in Egypt and virtually located at different positions (i.e., multiple nodes/heterogeneous) across the same SC, which made the data collection process an extremely difficult yet value-adding one.

Similarly, probability simple random sampling technique was used in case of the higher education sector (i.e., second sector; universities and academies in Egypt). The researcher targeted the entire population (i.e., 63 HEIs were contacted through email and/or phone) of which 41 accepted to participate, resulting in a response rate of 65.08%. These public/private universities and academies, which are geographically dispersed at 15 different governorates all over the country act as example of a service SC and strategic suppliers for the first manufacturing sector.

4.4. Data Collection

Primary data collected (using triangulation design) was mainly based in part on direct/personal semi-structured in-depth interviews (qualitative data) and in part on questionnaires (quantitative data). A mixed methods approach (i.e., Triangulation design) was used in the data-collection phase to understand, map out and investigate from different standpoints (a) the research problem and proposed relationships, (b) the nature of the Egyptian automotive industry and higher education sector, (c) the hybrid performance (i.e., leanness, agility and leagility) carried out by multiple nodes across both SCs. With triangulation approach, this thesis generated and tested the new modified hybridized lean-agile SC strategy through integrating and analyzing the collected quantitative and qualitative data. Specifically, questionnaires (quantitative) were used to study the research proposed relationships and the hybrid SCP. At the same time, the hybrid AISCP/ESCP in terms of leanness, agility and leagility was also explored using (qualitative) data collected through depth interviews, forums, conferences, documents/visual materials, observations and field notes.

In order to test the research hypotheses, two types of data were required:

4.4.1. Primary Data

The research primary data were collected from:

a) Questionnaires: Regarding the quantitative part of this research, 94.4% of the questionnaires were filled through face-to-face in-depth interviews (i.e., total of 125 surveys/questionnaires within different automotive companies and HEIs) and a five-point Likert scale (between 1 = strongly disagree and 5 = strongly agree) was used for responses. The questionnaire item-measures –as shown in Appendix A and B– were developed based on a combination of support from the review of prior research literature (several aforementioned key references as shown in chapter one) and a conducted exploratory study (i.e., ten in-depth personal interviews with SMEs from both sectors for the purpose of verifying content/face validity) before data-collection for measurement purification, through which these adopted and adapted measures were pre-tested then modified.

b) Depth Interviews: Direct semi-structured in-depth interviews were conducted by the researcher with 160 subject-matter-experts (SMEs) working in different organizations from both sectors (i.e., 89 interviews within 86 auto-parts/automotive companies + 71 interviews within 43 educational institutions). These 129 organizations are physically/geographically dispersed at 15 governorates in Egypt and virtually located at different positions (i.e., multiple SC nodes; tier 1/2 supplier, manufacturer/service provider, distributor and customer) across the AISC and ESC. The interview questions lists –as shown in Appendix A and B– were adopted/adapted from several references (Azevedo *et al.*, 2011; Azevedo *et al.*, 2012; Boon-itt and Paul, 2006; Lau, 2007; Swafford *et al.*, 2008; Li *et al.*, 2006; Ibrahim and Ogunyemi, 2012; Lee *et al.*, 2007; Kim, 2009). Based on the qualitative analysis of the collected data throughout these conducted in-depth interviews, different fruitful outcomes were extracted. First, as far as the researcher knows, this is the first study that maps the Egyptian automotive industry SC in order to depict a holistic view of the nature of this important industry in an emerging market, which serves as an example of an interesting yet uninvestigated context of contemporary SCM research. In an interdependent manner, this thesis draws the Egyptian automotive industry's main players and sub-sectors. In addition, regarding the higher education sector, this study presents a new education SCM model –as shown in chapter six– and recommends its usage for improving the SCP of HEIs operating in Egypt.

c) Forums: The researcher continued the qualitative research through attending and participating in conducting three collaborative semi-structured forums in The American University in Cairo (AUC) School of Business, Management Center (MC) with different SC academics and industry specialists from 15 different organizations in Egypt, including automotive manufacturers (AMs) and HEIs. The main problem/challenge that faced the AUC three institutes (Management Development, Banking and Finance, and Quality Management), after their students graduate through different professional programs (e.g., CSCP, CPIM), is the lack of linkage that bridges academic education (Theory) and industry (Practice) to maintain the required agility with the job market. With these forums, they provided their students during their study with real cases about the application of SCM practices to different companies operating in the Egyptian market (e.g., automobile, pharmaceuticals, dairy and juice, cosmetic, telecommunications, and food supply chains operating in Egypt). After participating in these forums, the researcher was able to collect qualitative data on how HEIs can bridge the detected gap between: (a) HR supply (i.e., supplied qualifications) and demand (i.e., needed qualifications), and (b) information/research supply (e.g., contemporary theories) and demand (e.g., successful practices).

d) Conferences: Qualitative data collected throughout conferences helped the researcher to obtain greater insights and better understanding of the research problem. Two ways were used for this purpose; the research attended related conferences to the research problem and presented/communicated some of the research outputs and received valuable feedback from SMEs attending these conferences. First, the researcher attended the British Egyptian Education conference on “Education: The best investment” held by the British Egyptian Society (BES), and conducted in collaboration between University of London and Cairo University via video conferencing. The conference covered the ways in which HEIs can respond to the requirements of business and industry and the best kind of relationships that can be created between universities and industry. Different education experts, industry professionals and specialists pointed out the required skills for employability and how relations can be developed more effectively and efficiently between companies/employers on one side and schools/institutes/universities on the other side. The researcher drew upon different presented projects and real case studies in Egypt, in which educational institutions and industry worked together in closing the gap between qualifications supply and demand. Furthermore, the researcher presented different research outputs associated with this thesis at other conferences: (a) the 4th conference of the International Network of Business and Management Journals (INBAM) at Barcelona, Spain; (b) the 3rd ASU conference on interdisciplinary and multidisciplinary studies and labor market needs at Ain Shams University; (c) the 1st FCBD conference on contemporary business research: prospects for theory and practice at Faculty of Commerce, Business Administration Department, Cairo University. By this means, the researcher received valuable feedback from SMEs attending these conferences through presentations questions, discussions and participating in its workshops.

e) Researcher observation and reflexivity, through using field notes and metaphors that reflected everything observed at these automotive companies and HEIs.

4.4.2. Secondary Data

a) Internal data available within the automotive companies (e.g., Bavarian Auto Group (BAG)-BMW; Egyptian German Automotive Co. S.A.E (EGA)-Mercedes Benz Industrial Joint Venture in Egypt) and HEIs databases either ready to be used or required further processing.

b) External data: Different published materials (e.g., academic articles, and industry reports), data collected from computerized databases (e.g., EAFA, AmCham, EAMA, CAPMAS, CEI), and other data collected from the internet websites.

4.4.3. Research data collection/fieldwork summary tables

Table 4.1. The research data collection/fieldwork summary table-Part I (Automotive sector/ASC)

Organization	Position in ASC	Primary Product	Respondent/ Interviewee	Research Approach	Data Collection Method
1) Nissan Motor Egypt S.A.E 2) General Motors (GM) Egypt 3) Suzuki Egypt S.A.E 4) Aboul Fotouh (AF) Automotive S.A.E (Daewoo Motor Egypt) 5) Al-AMAL Co. for Vehicles Manufacturing and Assembly (AVM) (Lada Egypt) 6) MOBICA (Advanced Industries) 7) Bavarian Auto Manufacturing Co. (Bavarian Auto Group (BAG)) 8) Peugeot Egypt (Cairo for Development and Cars Manufacturing) S.A.E 9) Ghabbour Auto (GB Auto) 10) Egyptian German Automotive Co. S.A.E (EGA) [Mercedes-Benz] 11) Abouel Yazeed (AY) Group Engineering Co. for Exhaust Systems 12) Arab American Vehicles Co. (AAV) Arab Organization for Industrialization (AOI) 13) Industrial Development of Automotive Components S.A.E (IDACO) 14) LEONI Wiring Systems Egypt S.A.E 15) Chrysler Group Egypt Limited 16) El Zaharna Company 17) ARTOC Auto- Skoda 18) Egyptian International for Trading and Agencies Co. (EIT)- KIA Motors 19) Ezz Elarab Automotive Group 20) Melco Metal Working Co. (MELCO Filter) 21) Al-Mansour Automotive 22) Debes Company for Plastic Products 23) EL TERIAK Industrial Group 24) ELTAREK Automotive 25) Egyptian German Electric Systems S.A.E (EGES)	Manufacturer/ Assembler (Main Activities: Manufacturing /Assembling from Local Components and CKDs) or 1st tier and 2nd tier Supplier or Distributor (Agent, i.e., 3S: Sales, After Sales and Spare Parts) (Main Activities: Importing CBUs and Spare Parts – Distributing)	Passenger Cars (PCs) and Commercial Vehicles (CVs) or Main auto-components (e.g. exhaust systems, doors and carpets) from the first tier suppliers or Sub-parts (e.g., wires and cables) from the second and third tier suppliers	Subject Matter Experts (SMEs) working in these organizations	Mixed methods approach - Qualitative approach - Quantitative approach	- Direct in-depth semi-structured interview, observation (Fieldwork notes), and text and image analysis (Documents, reports and media data) - Personal survey method

26) FUTURE Industry & Trade (FIT) (MISRIAT) 27) ELSEWEDY CABLES- Wires and Cables Sector- United Industries Company (UIC) 28) Dr. Greiche for Glass 29) Abou Ghaly Motors 30) Giza National Automotive (GNA) 31) Promise Insurance Brokerage (PIB) 32) Aboul Fotouh Service Center 33) Modern Motors 34) Autocool- Auto A/Cs 35) Egyptian International Motors (EIM)- Renault 36) Gorica Egypt Group (GEG) for Industry S.A.E- Trucks 37) Almohandes Automotive 38) Feeding Industries Manufacturing Company (FIMCO) 39) Mitsubishi Motors (Diamond Motors Company) 40) El Kady- Hoses and Pipes 41) Egyptian Axles 42) GB-Polo Bus Manufacturing Company S.A.E. 43) Chloride- Batteries 44) Al-Masoud Automotive 45) General Techniques International (GTI) Group-Automotive Interiors 46) Stop Automotive 47) AKL- Lamps, mirrors, wheel covers and cooling fans 48) Egypt for Engineering Industries (EEI)- Auto parts 49) EEI- Chevrolet Express Bus 50) International Supplementary Industries (ISI) 51) Nile Trading and Engineering (NTE)-Honda (Al-Futtaim Group Co.) 52) Toyota Misr for Trading S.A.E 53) Aman and Safety Group (ASG)- Auto Glass 54) Egyptian Automotive and Trading Company (EATC)- VolksWagen 55) GEG- MAN 56) Bahgat Group- Audio speakers and cassettes 57) Manufacturing Commercial Vehicles (MCV)- Mercedes Benz	Manufacturer/ Assembler (Main Activities: Manufacturing /Assembling from Local Components and CKDs) or 1st Tier and 2nd Supplier or Distributor (Agent, i.e., 3S: Sales, After Sales and Spare Parts) (Main Activities: Importing CBUs and Spare Parts – Distributing)	Passenger Cars (PCs) and Commercial Vehicles (CVs) or Main auto-components (e.g. Lamps, mirrors, wheel covers and cooling fans) from the first tier suppliers or Sub-parts (e.g., wires and cables) from the second and third tier suppliers	Subject Matter Experts (SMEs) working in these organizations	Mixed methods approach - Qualitative approach - Quantitative approach	- Direct in-depth semi-structured interview, observation (Fieldwork notes), and text and image analysis (Documents, reports and media data) - Personal survey method

58) Tredco Engineering Industries 59) Taki Vita Company S.A.E 60) El-Wahab Group- Chevrolet Minibus 61) Al-Shehab Auto- Chevrolet Minibus 62) Trust for Engineering Industries- Automotive seats 63) Egyptian Aluminum Products Co. (ALUMISR) 64) Ghabbour Egypt (GB) Trucks and Buses 65) El-Gammal Company for Paints and Chemical Industries 66) ALIAA- Car interiors 67) Automotive Filters Industrial Co. (AFICO) 68) Egypt Springs and Transport Needs Company 69) El Magmoua Company For Design and Printing- Vehicles Stickers 70) Engineering for Industries Co. (ENGIN)- Sheet metal plant 71) Industrial Engineering Group (INDE)- Auto components 72) INDE Plast- Plastic injection factory 73) INDE Moulds 74) INDE Motorcycle- Egyptian Motorbikes and Bicycles Co. (EMB) 75) INDE Fire Truck 76) Star for Auto Feeding Industries- Rubber products 77) FAC Filter S.A.E (The Arab Co. Manufacturing of Filters) 78) Tawplast- Plastic 79) Auto Plast- Lamps 80) El Sobky Industrial- Metal parts 81) El Dahshan for Auto Spare-parts 82) FAIK Manufacturing Co. 83) AOI Aircraft Factory 84) International Trade Agency and Marketing Co. (ITAMCO) 85) Industrial Control Group- Industrial Control for Engineering Industries (ICEI)- Chassis 86) Egyptian Auto-feeders Association (EAFA) (Stakeholder)	Manufacturer/ Assembler (Main Activities: Manufacturing /Assembling from Local Components and CKDs) or 1st Tier and 2nd Supplier or Distributor (Agent, i.e., 3S: Sales, After Sales and Spare Parts) (Main Activities: Importing CBUs and Spare Parts – Distributing)	Passenger Cars (PCs) and Commercial Vehicles (CVs) or Main auto-components (e.g. Cooling Modules, A/C Condensers and Radiators) from the first tier suppliers or Sub-parts (e.g., wires and cables) from the second and third tier suppliers	Subject Matter Experts (SMEs) working in these organizations	Mixed methods approach - Qualitative approach - Quantitative approach	- Direct in-depth semi-structured interview, observation (Fieldwork notes), and text and image analysis (Documents, reports and media data) - Personal survey method

Table 4.2. The research data collection/fieldwork summary table-Part II (Higher education sector/HESC)

Organization	Position in ESC	Primary Product	Respondent/ Interviewee	Research Approach	Data Collection Method
1) Cairo University (CU) 2) Ain Shams University (ASU) 3) Suez Canal University (SCU)- Ismailia branch 4) Benha University (BU) 5) Kafrelsheikh University 6) Beni-Suef University (BSU) 7) Alexandria University 8) Zagazig University (ZU) 9) Tanta University 10) Suez University 11) Damietta University (DU) 12) Mansoura University 13) Helwan University 14) Al-Azhar University 15) Fayoum University 16) The American University in Cairo (AUC) 17) The British University in Egypt (BUE) 18) Pharos University in Alexandria (PUA) 19) October University for Modern Sciences and Arts (MSA) 20) Ahram Canadian University (ACU) 21) Misr University for Science and Technology (MUST) 22) Future University (FU) 23) October 6 University (O6U) 24) Heliopolis University (HU) for Sustainable Development 25) Nahda University (NUB) 26) Delta University for Science and Technology 27) Egyptian E-Learning University (EELU) 28) The Arab Open University (AOU)	Higher education service provider (Under-graduate and/or post-graduate studies, and/or research services)	Graduates and/or research outcomes (Intellectual)	Subject Matter Experts (SMEs) working at these institutions in addition to other interviewees including various stakeholders representing multiple nodes of the HESC - University President - Vice President for Community Service - Vice President for post-graduate studies and research - Dean of Faculty - Vice Dean for Student Affairs - Vice Dean for Community Service and Environ-mental Development - Director of international collaboration, technology transfer and innovation office (TICO) - Director of grants and international collaboration office (GICO) - Head Of	Mixed methods approach - Qualitative approach - Quantitative approach	- Direct/face-to-face in-depth semi-structured interview - Attended a meeting for signing a Collaboration Protocol Agree -ment between Helwan University and the Ministry of Trade, Industry and Investment-Industrial Development Authority (IDA) - Attended/ participated in Collaborative Semi-structured Forums in The American University in Cairo (AUC) about strengthening Universities-Industries Relationships - Personal survey method

29) Nile University (NU) 30) French University in Egypt (Université Français d'egypte) 31) Sinai University (SU) 32) Zewail City of Science and Technology 33) Sadat Academy for Management Sciences (SAMS) 34) The Arab Academy for Science, Technology and Maritime Transport (AASTMT) 35) International Academy for Engineering and Media Science (IAEMS) 36) Akhbar El-Yom Academy 37) Arab Academy for Banking and Financial Sciences (AABFS) 38) Thebes Academy 39) Canadian International College (CIC) 40) ESLSCA Business School 41) Ain Shams Academy 42) National Research Center (NRC) 43) Mubarak Cool (Al-Amal technical school)	Higher education service provider (Under-graduate and/or post-graduate studies, and/or research services)	Graduates and/or research outcomes (Intellectual)	Department - Marketing Manager - Public and External Relations Manager - Training Manager - Accounting manager - Professors, associate professors, lecturers, and LAs and TAs	Mixed methods approach - Qualitative approach - Quantitative approach	- Direct/face-to-face in-depth semi-structured interview - Personal survey method

4.5. Measurement and Scaling

Table 4.3. The research hypotheses, constructs and its operational variables and measures

Hypotheses	Latent construct	Independent/ Dependent	Factors/ Dimensions	Required data and measures	No. of measured items	Source and scale
H1. Inter- and intra-organizational levels of ICT employment will significantly and positively affect hybrid supply chain performance in terms of leanness, agility and leagility	ICT	Independent	INTEROL	The inter-organizational level of ICT (e.g., web-based, e-business, e-mail, EDI, fax) employment to collect, process and communicate information externally across different SC players (Swafford *et al*., 2008; Zhang *et al*., 2011).	6	Personal Survey Method (Interval)
			INTRAOL	The intra-organizational level of ICT (e.g., ERP) employment to collect, process and communicate information internally within each individual SC node (Swafford *et al.*, 2008; Zhang *et al.*, 2011).	6	
	HSCP	Dependent	LSCP	The ability of a SC to achieve more (i.e., significant outcomes/benefits) with less (i.e., waste reduction/removal) (Naylor *et al.*, 1999; Towill and Christopher, 2002; Scherrer-Rathje *et al.*, 2009); in terms of efficiency/cost-reduction, removal of wastes and continuous improvement (Womack and Jones, 1996; Huang *et al.*, 2002).	8	
			ASCP	The ability of a SC to quickly and flexibly respond to changing customer demands; in terms of flexibility, speed and responsiveness (Naylor *et al.*, 1999; Lin *et al.*, 2006; Goldsby *et al.*, 2006; Sherehiy *et al.*, 2007).	9	
			LEAGSCP	The ability of a SC to maintain mass-customization and postponement (Naylor *et al.*, 1999; Huang *et al.*, 2002; Turner and Williams, 2005).	3	
H2. Inter- and intra-organizational levels of ICT employment will significantly and positively affect supply chain integration in terms of upstream, downstream and intra-organizational integration	ICT	Independent	INTEROL	The inter-organizational level of ICT (e.g., web-based, e-business, e-mail, EDI, fax) employment to collect, process and communicate information externally across different SC players (Swafford *et al*., 2008; Zhang *et al*., 2011).	6	Personal Survey Method (Interval)
			INTRAOL	The intra-organizational level of ICT (e.g., ERP) employment to collect, process and communicate information internally within each individual SC node (Swafford *et al.*, 2008; Zhang *et al.*, 2011).	6	
	SCI	Dependent	UI	The extent to which an organization is able to link and coordinate the performed activities externally (Li *et al.*, 2009) along with its various SC suppliers (Koçoglu *et al.*, 2011).	5	
			DI	The extent to which an organization is able to link and coordinate the performed activities externally (Li *et al.*, 2009) along with its different SC customers (Koçoglu *et al.*, 2011).	6	
			II	The extent to which an organization is able to link and coordinate the performed activities internally within/across its departments (Li *et al.*, 2009; Koçoglu *et al.*, 2011).	5	
H3. Upstream, downstream and intra-organizational			UI	The extent to which an organization is able to link and coordinate the performed activities externally (Li *et al.*, 2009) along with its various SC suppliers (Koçoglu *et al.*, 2011).	5	

integration will significantly and positively affect supply chain information sharing in terms of upstream, downstream and intra-organizational IS.	SCI	Independent	DI	The extent to which an organization is able to link and coordinate the performed activities externally (Li *et al.*, 2009) along with its different SC customers (Koçoglu *et al.*, 2011).	6	Personal Survey Method (Interval)
			II	The extent to which an organization is able to link and coordinate the performed activities internally within/across its departments (Li *et al.*, 2009; Koçoglu *et al.*, 2011).	5	
	SCIS	Dependent	UIS	The mutual information-based exchanges between the organization and its suppliers through using inter-organizational linkages (Koçoglu *et al.*, 2011).	7	
			DIS	The mutual information-based exchanges between the organization and its customers through using inter-organizational linkages (Koçoglu *et al.*, 2011).	8	
			IIS	The mutual information-based exchanges internally within/across its departments through using intra-organizational linkages (Koçoglu *et al.*, 2011).	8	
H4. Upstream, downstream and intra-organizational IS will significantly and positively affect hybrid SCP in terms of leanness, agility and leagility.	SCIS	Independent	UIS	The mutual information-based exchanges between the organization and its suppliers through using inter-organizational linkages (Koçoglu *et al.*, 2011).	7	Personal Survey Method (Interval)
			DIS	The mutual information-based exchanges between the organization and its customers through using inter-organizational linkages (Koçoglu *et al.*, 2011).	8	
			IIS	The mutual information-based exchanges internally within/across its departments through using intra-organizational linkages (Koçoglu *et al.*, 2011).	8	
	HSCP	Dependent	LSCP	The ability of a SC to achieve more (i.e., significant outcomes/benefits) with less (i.e., waste reduction/removal) (Naylor *et al.*, 1999; Towill and Christopher, 2002; Scherrer-Rathje *et al.*, 2009); in terms of efficiency/cost-reduction, removal of wastes and continuous improvement (Womack and Jones, 1996; Huang *et al.*, 2002).	8	
			ASCP	The ability of a SC to quickly and flexibly respond to changing customer demands; in terms of flexibility, speed and responsiveness (Naylor *et al.*, 1999; Lin *et al.*, 2006; Goldsby *et al.*, 2006; Sherehiy *et al.*, 2007).	9	
			LEAGSCP	The ability of a SC to maintain mass-customization and postponement (Naylor *et al.*, 1999; Huang *et al.*, 2002; Turner and Williams, 2005).	3	
H2a. Higher significant and positive effect of ICT employment on SCI depends on higher level of TI (i.e., TI moderates the relationship between ICT and SCI).	ICT	Independent	Interaction term (ICT * TI)	The inter- and intra-organizational levels of ICT employment to collect, process and communicate information externally across different SC players and internally within each individual SC node (Swafford *et al.*, 2008; Zhang *et al.*, 2011).	12	Personal Survey Method (Interval)
	TI	Moderator		The extent to which an organization is able to collect, analyze and communicate relevant information on recent technological trends to support technological and other general decisions of an organization (Lichtenthaler, 2004c).	6	
	SCI	Dependent	UI DI II	The extent to which an organization is able to link and coordinate the performed activities internally within its departments and externally across its various SC participants (Li *et al.*, 2009).	16	

4.6. Data Analysis

Since, structural equation modeling (SEM), which is one of the most powerful methods of multivariate data analysis, was proven to obtain more accurate results than other traditional methods (e.g., regression) (Saghaei and Ghasemi, 2009). Therefore, SEM was used in testing the research hypotheses and examining the relationships between the specified variables. Practically speaking and according to Dow *et al.* (2008), SEM has a major advantage, which is the ability to identify and test joint relationships between latent and observed/measured variables. Specifically, path analysis, which is the original structural equation modeling technique (Dow *et al.*, 2008) was used to examine and test the causal relationships between the research different variables. In other words, path analysis, as an extension of the regression model, was conducted with a regression performed for each research model variable as an endogenous causal variable on others (Dow *et al.*, 2008). Regarding the research quantitative analysis, AMOS software, SmartPLS software, LISREL software, and SPSS software were used in conducting the required validity and reliability tests and examining the proposed relationships between the specified variables of the suggested model; whereas, critical description and text interpretation, in addition to thematic analysis, creative synthesis and reflexivity were all used for the research qualitative analysis.

4.7. Conclusion

The purpose of this study was to investigate the direct and indirect effect of information and communication technology (ICT) (i.e., via the mediation effect of SCM) on hybrid supply chain performance (HSCP) in terms of leanness, agility and leagility of the automotive companies (ACs) and higher education institutions (HEIs) in Egypt. Furthermore, the moderation effect of TI on the ICT-SCI relationship was assessed.

A conceptual framework developed based on the prior literature –as shown in chapter one and three– was proposed and tested using questionnaires, which were filled through face-to-face in-depth interviews. A mixed methods approach was used to obtain greater insights and better understanding of the research relationships. The focus of this research is the hybridized performance, in terms of leanness, agility and leagility of the automotive and higher education supply chains (HESC) in Egypt as two examples of the manufacturing and service industries in

Egypt. A triangulation mixed methods approach was used to obtain a realistic and comprehensive picture of the type and structure of the hybrid performance (i.e., leanness, agility and leagility) carried out by multiple nodes across the AISC (i.e., different sub-sectors of an emerging automotive market) and HESC in Egypt.

The target population of the automotive sector was 101 organizations in the Egyptian automotive industry throughout its three main sub-sectors; namely manufacturers of auto-feeding and automotive industries and CBU distributors (i.e., multiple nodes). A sample of 84 was obtained using probability random sampling technique (i.e., 83.16% response rate). Regarding the higher education sector, a total of 63 HEIs (i.e., universities and academies) were contacted, of which 41 accepted to participate (i.e., 65.08% response rate) also through using probability random sampling technique. Structural Equation Modeling was used to examine the proposed relationships. In addition to the 125 questionnaires (quantitative), 160 direct depth interviews (qualitative) were conducted with subject-matter-experts (SMEs) working in 129 organizations from both sectors at 15 different governorates in Egypt.

CHAPTER FIVE

Mapping the Automotive Industry and its Supply Chain in Egypt as an Emerging Market: Qualitative Analysis (Comparative Approach- Global vs. Local SC)

5.1. Introduction

This chapter presents a background on the nature of the global automotive industry supply chain and maps out the Egyptian automotive emerging market. As this research can be characterized as a qualitative and quantitative research (i.e., using abductive approach), the researcher in this chapter provides an in-depth qualitative understanding of the nature of this important industry, which motivated the researcher to choose this context. More importantly, it ensures an accurate formulation of the research operationalization, which was used later on in the quantitative analysis. The qualitative analysis was performed by the researcher through conducting a comparative study between global automotive supply chain and Egyptian automotive supply chain. Thus, an in-depth qualitative understanding of the proposed relationships and description of the underlying causes of the research problem can be achieved.

5.2. A Comparative Study between Global Automotive Supply Chain and Egyptian Automotive Supply Chain

5.2.1. The Global Automotive Industry and its Supply Chain

The automotive industry supply chain (AISC) is long and hierarchical, and its main product (i.e., car) involves around 20,000 parts (Kim and Im, 2002). Kim and Im (2002) defined the hierarchical supply chain as the one that has many tiers of suppliers (i.e., the producer out-sources main auto-components (e.g., exhaust systems, doors and carpets) from the first tier suppliers, who out-source the sub-parts (e.g., wires and cables) from the second and third tier suppliers).

In a similar vein, a conducted study by the Industrial Modernisation Centre (IMC) (Industrial Modernisation Programme, 2005) elaborated on the lengthy global automotive supply chain (ASC) nodes by discussing how the vehicle/original equipment manufacturers (OEMs) own many factories all over the world, and each of these factories sources auto-components from other international suppliers, who in turn buy from their own overseas suppliers.

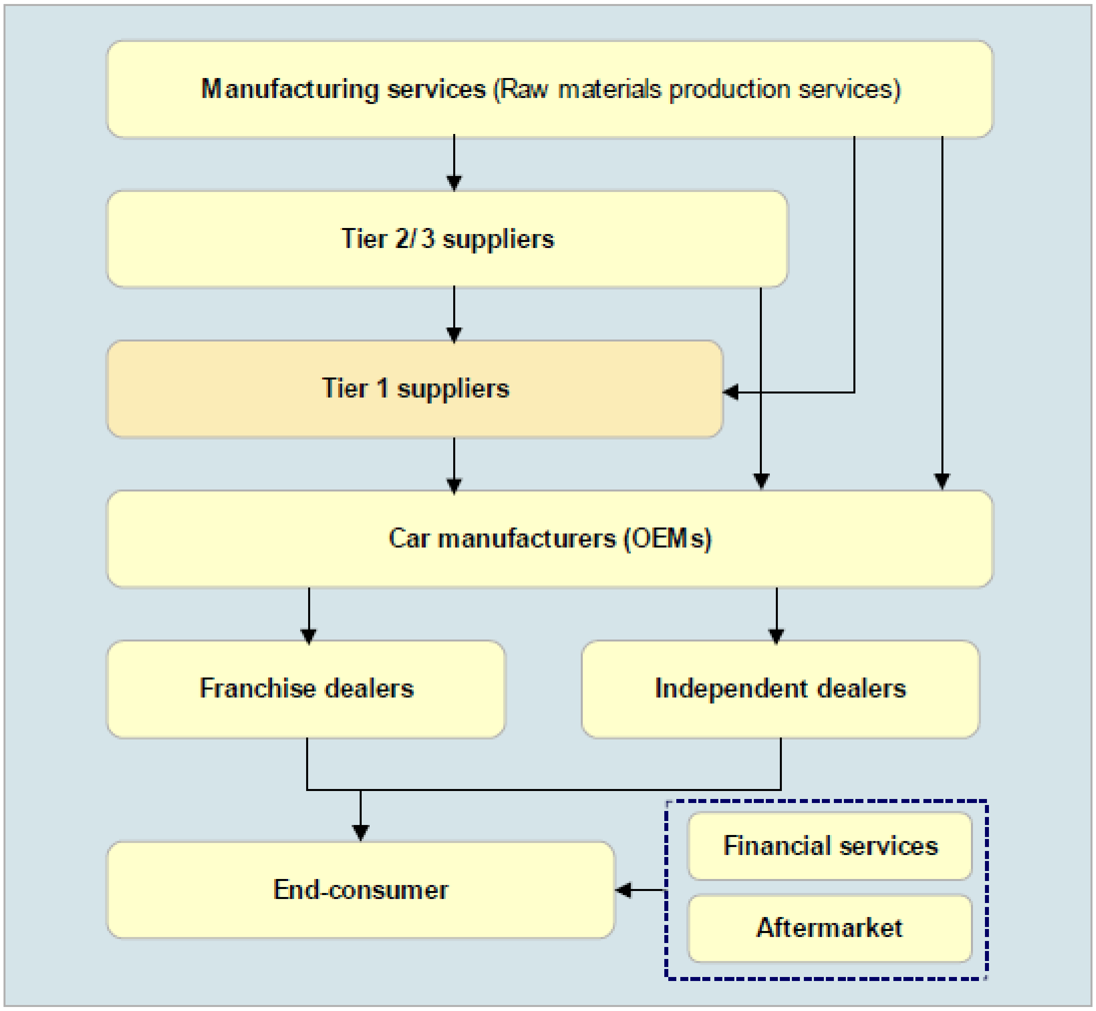


Figure 5.1. Global Automotive Supply Chain

Source: Industrial Modernisation Programme IMC, 2005

In addition to being hierarchical, Huang *et al.* (2002) and Turner and Williams (2005) pointed out that the AISC is a hybrid SC (i.e., it can be barely considered as either absolute efficient or responsive SC) that generates a hybrid product (e.g., vehicle) as it comprises a mixture of standard and innovative parts/components produced via different industries.

In general, the automotive industry includes different types of vehicles, mainly passenger cars (PC) and commercial vehicles (CV) that encompass buses and trucks, in addition to the auto-feeding industries (i.e., up-stream the ASC) (Central Agency for Public Mobilization and Statistics, 2009a; 2009b; National Information Center, 2009; Business Studies and Analysis Center, 2011). In fact, automotive manufacturers collaborate with many other different auto-feeding industries (e.g., glass, aluminum, textiles, rubber, plastics, and paints and coating) (Business Studies and Analysis Center, 2011).

According to a study carried out by the American Chamber of Commerce in Egypt (AmCham) (Business Studies and Analysis Center, 2011), the automotive industry is regarded as one of the most profitable sectors of various countries and its average annual growth rate is 30 percent throughout the past decade. For instance, in 2009, the global automotive production exceeded 61,000,000 vehicles (Business Studies and Analysis Center, 2011). As declared by the International Organization of Motor Vehicle Manufacturers (OICA), if auto manufacturing is considered as a country, it will be ranked as the sixth largest economy worldwide (cited in Business Studies and Analysis Center, 2011).

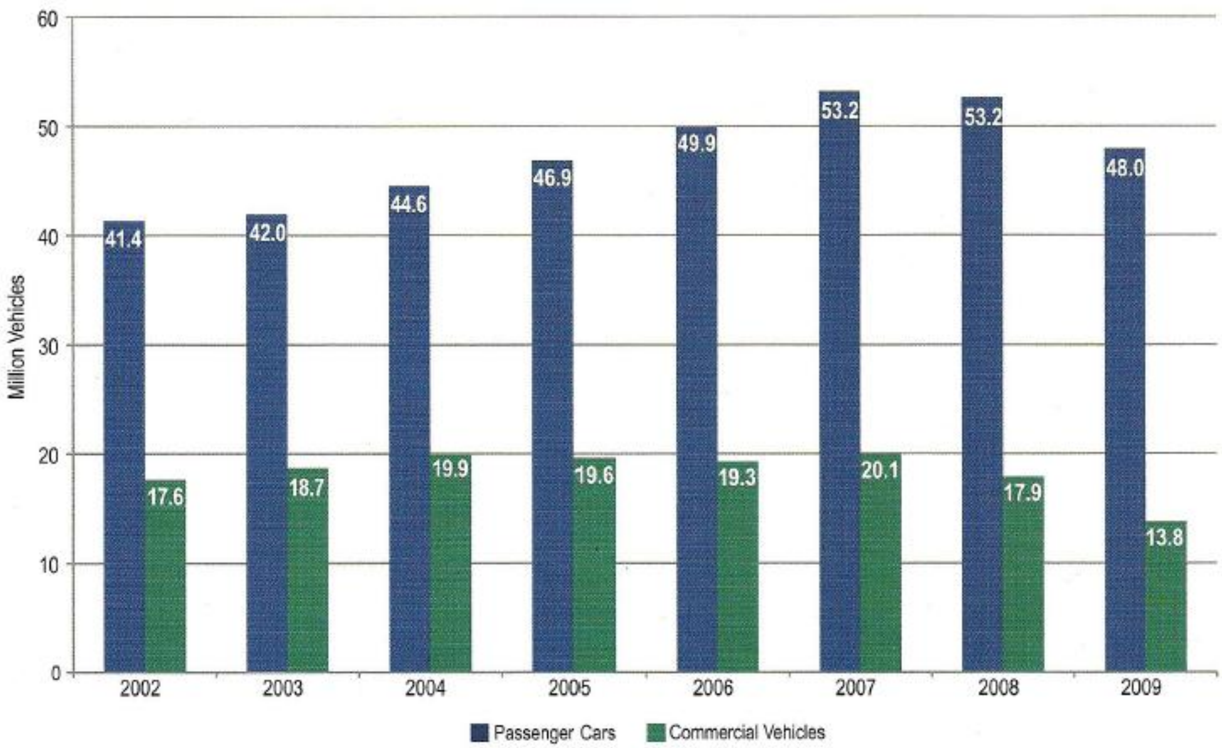


Figure 5.2. The Global Automotive Production by Type

Source: The International Organization of Motor Vehicle Manufacturers (OICA), 2010; cited in Business Studies and Analysis Center AmCham, 2011

At this point, it is important to mention that such an industry is considered as one of the giant providers of direct and indirect job opportunities all over the world as it provides around 8 million direct jobs, which is over 5% of the world's total manufacturing employment (Business Studies and Analysis Center, 2011). According to OICA, each direct job in the automotive industry supports at least another five indirect jobs, including employment in related manufacturing and service industries (cited in Business Studies and Analysis Center, 2011). In addition, it is dominated by the top automotive producing countries (e.g., USA, China, Japan, and Europe) that account for 90% of the total automotive output (Business Studies and Analysis Center, 2011).

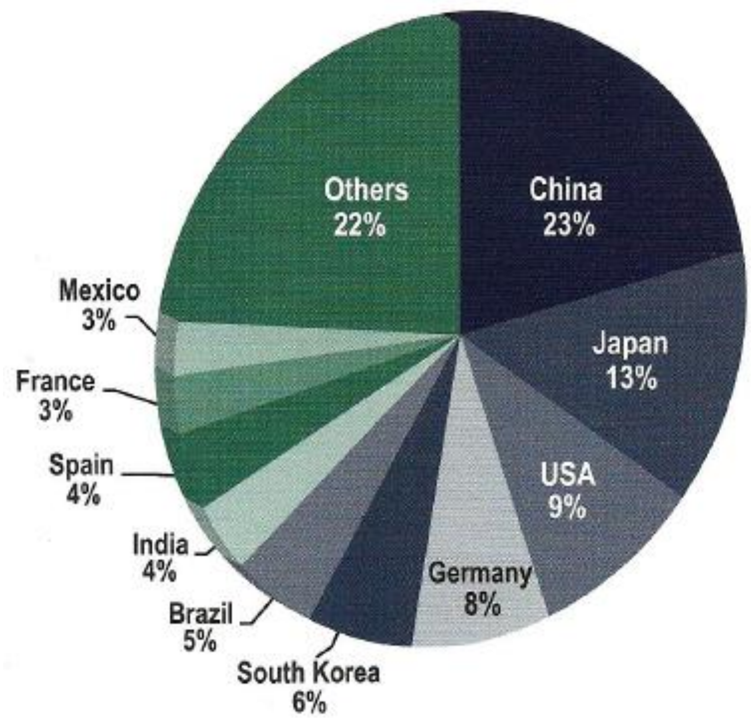


Figure 5.3. Top 10 Automotive Producing Countries

Source: The International Organization of Motor Vehicle Manufacturers (OICA), 2010; cited in Business Studies and Analysis Center AmCham, 2011

The United States, in 2007, was the world's 2nd largest manufacturing country after Japan. However, in 2008, China displaced the United States by being the 2nd largest automotive producing nation with a total of 9.3 million vehicles (Business Studies and Analysis Center, 2011). Later on, in 2009, China managed to surpass Japan and become the top automotive producing country worldwide, with a total of 13.7 million vehicles, which is equivalent to a share of 22.6% of global automotive production (Business Studies and Analysis Center, 2011). Then, Japan came in the 2nd position with a share of 13%, followed by the US with a share of 9% and a total of 5.7 million vehicles. China succeeded to become the world's biggest automotive producer because of the successful policy incentives of China's government, which positively stimulated automobile sales in China and led to rapid growth levels that the Chinese auto industry has been witnessing over the past 10 years (Business Studies and Analysis Center, 2011).

While regarding the top 10 automotive manufacturers by brand, Business Studies and Analysis Center (2011) discussed how Toyota, in 2008, managed to displace GM for the first time to become the leading global automobile manufacturer with a total production of 7.2 million vehicles, followed by GM with 6.5 million, then Volkswagen, Europe's first automotive manufacturer, as being ranked the 3rd with 6 million vehicles. Whereas regarding the light commercial vehicle production, Ford came first, with 1.6 million, then, GM with 1.4 million light commercial vehicles in 2009 (Business Studies and Analysis Center, 2011).

Figure 5.4. Top 10 Global Automotive Manufacturers

Source: The International Organization of Motor Vehicle Manufacturers (OICA), 2010; cited in Business Studies and Analysis Center AmCham, 2011

Table 5.1. Top 10 Global Automotive Manufacturers and their Total Production in units

Rank	Group	Total (million units)
1	Toyota	7.234
2	GM	6.459
3	Volkswagen	6.067
4	Ford	4.685
5	Hyundai	4.645
6	PSA Peugeot Citroen	3.042
7	Honda	3.012
8	Nissan	2.744
9	Fiat	2.460
10	Suzuki	2.387

Source: The International Organization of Motor Vehicle Manufacturers (OICA), 2010; cited in Business Studies and Analysis Center AmCham, 2011

5.2.2. The Automotive Industry in Egypt and its Supply Chain

5.2.2.1. Mapping the Automotive Industry SC in Egypt as an emerging market

Moving to the Egyptian automotive industry, the Business Studies and Analysis Center (BSAC) (2011) indicated that increasing competition in the global automotive industry has forced many producers to maintain various manufacturing facilities in emerging markets (e.g., Egypt). Thereby, they can minimize their labor costs and facilitate their international distribution (Business Studies and Analysis Center, 2011).

As published by Oxford Business Group (OBG) (2011), Egypt possesses one of the largest automotive markets in the MENA region. There are 20 operating ASCs in Egypt (Egyptian Auto-feeders Association, 2010) that produce/assemble different international brands (e.g., Chevrolet, BMW, Mercedes Benz, Nissan, Toyota and Hyundai) (Egyptian Auto-feeders Association, 2010; Business Studies and Analysis Center, 2011; Oxford Business Group, 2011). In fact, Egypt's automotive market is mainly based on the vehicle assembly. According to the Egyptian law, assembled vehicles in Egypt must include at least 45% Egyptian auto-components (Business Studies and Analysis Center, 2011; Oxford Business Group, 2011).

Practically, the obtained findings from the fieldwork of the present study revealed that many automotive companies in Egypt are assembling CVs that contain not less than 70-80% locally manufactured components and each PC/CV manufacturer has its own supply-base, which makes it an attractive emerging market. In regard to the automotive market volume in Egypt, a recently published report by the Egyptian Automobile Manufacturers Association (EAMA) (Automotive

Marketing Information Council, 2012b) showed that the total automotive market volume for 2012 was 200,252 units and increased by 14% in comparison with 2011 sales (i.e., not large enough yet increasing).

The Egyptian automotive industry's competitive advantage arises from the availability of skilled labor with affordable cost compared to its competitors, in addition to the country's unique geographic location that is close to other emerging and developed markets (Business Studies and Analysis Center, 2011). With respect to its contribution to employment in Egypt, it provides job opportunities to 75,000 people (i.e., 35% in the automobile assembly and 65% in the auto-feeding industries), and 150,000 employees and workers are working down-stream the AISC (e.g., distribution, sales, and spare parts) (Business Studies and Analysis Center, 2011; Oxford Business Group, 2011).

Despite the abundance of research on different Egyptian manufacturing sectors, the Egyptian automotive emerging market remains an unexplored context of contemporary management research, especially the area of SCM. Hence, it was found to be an attractive context for the researcher of this study.

Based on the qualitative analysis of the collected data for the present thesis throughout 94 conducted in-depth interviews (i.e., 89 interviews within 86 auto-parts/automotive companies + 5 more interviews within five HEIs and research centers supplying these ACs with information/HR) in Egypt, the researcher mapped the AISC in order to depict an overall view of the nature of this important industry in a country that serves as an example of an emerging market.

Such an industry in Egypt is a heterogeneous industry that comprises three main sub-sectors, each one has its own SC with its suppliers and customers; however, the three SCs/sub-sectors integrate together at certain points across the whole SC. Figure 5.5 illustrates the Egyptian automotive industry SC, including its main players and three sub-sectors; namely (a) Egyptian auto-feeding industry (EAFI), (b) Egyptian automotive manufacturing (EAM), and (c) Completely built units (CBU) market.

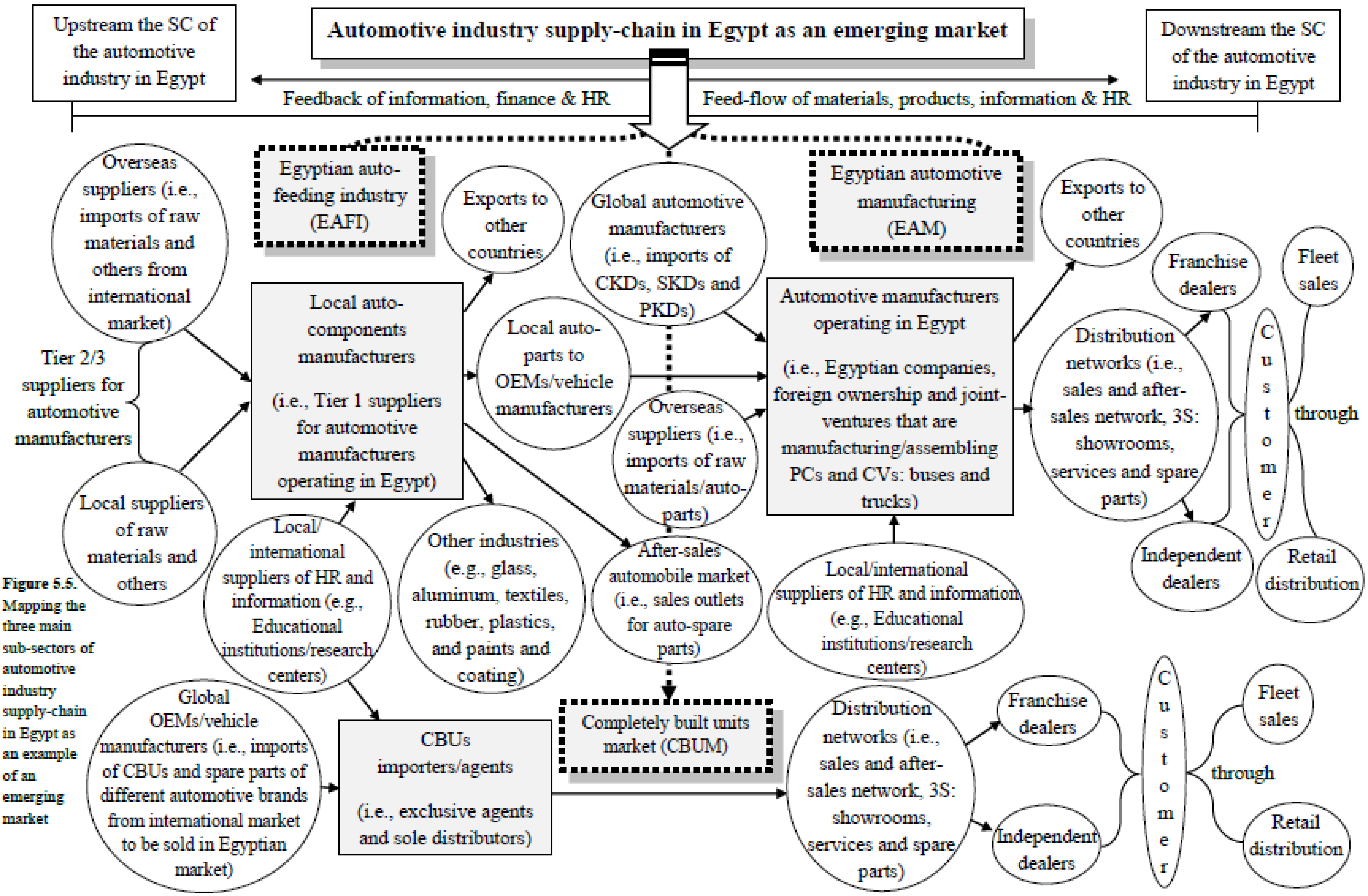


Figure 5.5. Mapping the three main sub-sectors of automotive industry supply-chain in Egypt as an example of an emerging market

Since, any vehicle is made up of around 10,000 main components, which represent about 60% of its production cost (Business Studies and Analysis Center, 2011). Therefore, the auto-feeding sub-sector, which includes overseas and local suppliers, was considered by Business Studies and Analysis Center (2011) as the backbone of the automotive industry. However, this thesis views – as presented in Figure 5.5– the Egyptian auto-feeding industry as a spinal cord (i.e., a strategic supplier of different tangible and intangible SC flows: information, HR, materials and product) that runs up along the backbone (i.e., supply chain) of the automotive industry in Egypt. Additionally, following the studies of Lau (2007), Al-Turki *et al.* (2008), Kargaev (2008), Ang *et al.* (2010) and Abd-Elall *et al.* (2011) that discussed the importance of conducting education SCM (i.e., managing SC flow of HR) and collaborative research (i.e., managing SC flow of information) through universities-industries partnerships, the researcher considers the education market (i.e., educational institutions and its research centers) as one of the strategic suppliers of information and HR to the automotive industry.

In this interdependent manner, the automotive industry can bridge the gap between: (a) HR supply (i.e., supplied qualifications) and demand (i.e., needed qualifications) (Al-Turki *et al.*, 2008; Abd-Elall *et al.*, 2011); and (b) information/research supply (e.g., contemporary SCM theories) and demand (e.g., successful SCM practices). Whereas down-stream the AISC, as shown in Figure 5.5, there is an entire automotive distribution network, including agents, distributors and traders, which operate in the market of both the completely built units (CBU) (i.e., imported from the international market) and the completely knocked down units (CKD) (i.e., assembled together with the local auto-parts by local automotive manufacturers) (Business Studies and Analysis Center, 2011).

Regarding its evolution, Business Studies and Analysis Center (2011) stated that such an industry in Egypt started to assemble vehicles in 1949; then, it expanded its operations in l974 and enjoyed different agreements with international companies as a result of the “open door policy” and the economic liberalization that was initiated in the country in the l990s (Business Studies and Analysis Center, 2011). Later, different OEMs found the Egyptian automotive emerging market an attractive pool for their investments, which incentivized them to enhance their operations in Egypt (Business Studies and Analysis Center, 2011).

5.2.2.2. The Evolution of Automotive Industry in Egypt

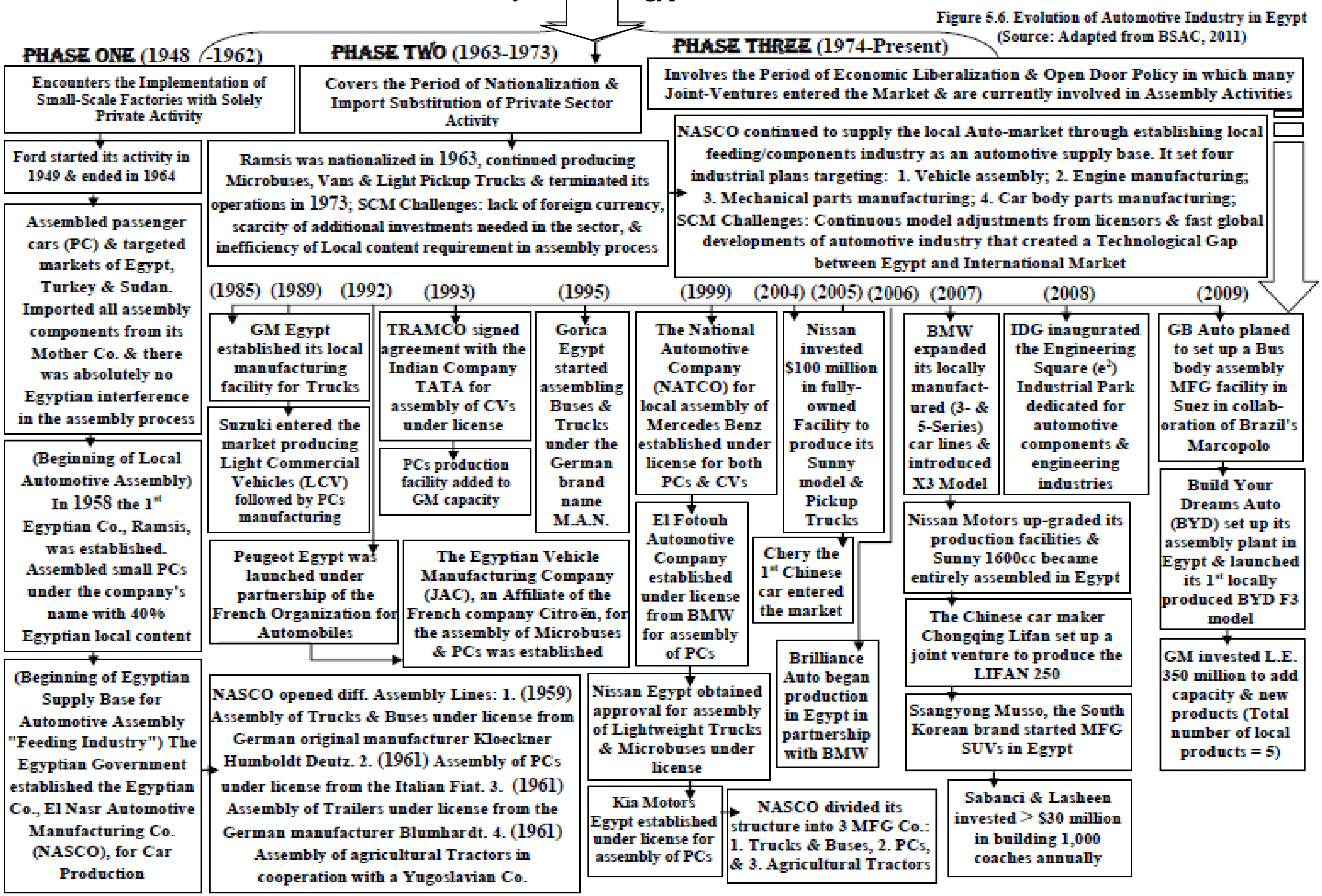


Figure 5.6. Evolution of Automotive Industry in Egypt
(Source: Adapted from BSAC, 2011)

5.2.2.3. Up-stream and Down-stream ASC Nodes operating in Egypt

5.2.2.3.1. Egyptian Automotive Market Overview

As published by Oxford Business Group (OBG) (2011), Egypt's automotive manufacturing sector is one of the strongest in the MENA region, and its domestic market among the largest. There are 17 Automotive Supply Chains (ASC) operating in Egypt, including international brands such as BMW, Mercedes Benz, General Motors (GM), Nissan, Hyundai and Suzuki (Oxford Business Group, 2011).

Table 5.2. The Automotive Manufacturers operating in Egypt

Egyptian Companies	100% Foreign Ownership	Joint Ventures (Egyptian/Foreign)
1- Automotive Eng. Co	Nissan	1- Arab American Vehicles
2- Automotive Gate Egypt		2- Daewoo Motor Egypt
3- Bavarian Auto Group (BAG)		3- Egypt German Automotives
4- Ghabbour Auto (GB Auto)		4- GB-Polo
5- Gorica Egypt		5- General Motors Egypt
6- JAC		6- Peugeot Egypt
7- Lada Egypt		7- Suzuki Egypt
8- MCV		8- Temsa Egypt

Source: Industrial Development Authority (IDA), 2010; cited in Business Studies and Analysis Center AmCham, 2011

However, after combining the contents of the aforementioned references in chapter four (Egyptian Auto-feeders Association, 2010; Business Studies and Analysis Center, 2011) together and removing any repetition, shutdowns and discontinued operations, the researcher in the current study developed a new up-dated list of 20 vehicle manufacturing/assembling companies, of which 18 responded with 90% response rate (as shown in Appendix C/1- Table AIII.1).

Similarly, in the light of a study conducted by the American Chamber of Commerce in Egypt (AmCham) (Business Studies and Analysis Center, 2011) about the Egyptian automotive industry, it was pointed out that Egypt is the largest automotive market in North Africa and possesses one of the few automotive production capacities in the Middle East and North Africa (MENA) region. However, the vehicles market in Egypt is mainly downstream in nature as it is mainly based on the vehicle assembly rather than manufacturing (Business Studies and Analysis Center, 2011).

Regarding its contribution to employment, the broader sector (i.e., vehicle assembly, service and components segments) employs 75,000 people, 65% of them in the automotive component/feeding and service industries (i.e., Up-stream ASC) (Business Studies and Analysis Center, 2011; Oxford Business Group, 2011). Additionally, there are a total of 150,000 workers employed in backward integration activities (i.e., Down-stream ASC) (e.g., logistics, distribution, sales, service and spare parts) (Business Studies and Analysis Center, 2011).

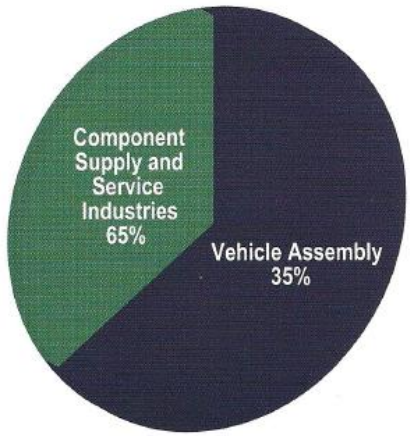


Figure 5.7. Employment Distribution along the ASC operating in Egypt

Source: Industrial Development Authority (IDA), 2009; cited in Business Studies and Analysis Center AmCham, 2011

One of the main strengths of the automotive industry in Egypt is that it enjoys a comparative advantage in both the supply and cost of labor, as Egypt has a large pool of skilled labor working at competitive wage rates, giving the country an advantage over its competitors (Business Studies and Analysis Center, 2011).

As was discussed and elaborated before in the previous section, Motor vehicles assembly in Egypt was initiated in 1949, then, gained momentum with the l974 Open Door Policy and accelerated with the economic liberalization of the l990s (Business Studies and Analysis Center, 2011). Later on, Egypt attracted investment from many of the word's Original Equipment Manufacturers (OEMs). As articulated by the Business Studies and Analysis Center AmCham (2011), Investments in the Egyptian automotive industry including Cars, Transportation Vehicles and Components can be classified as follows: 74% Egyptian, 2% Arab and 24% Foreign Investment.

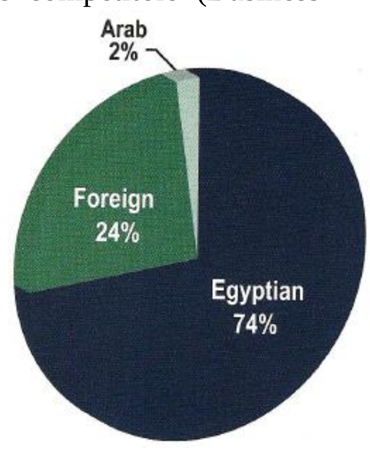


Figure 5.8. Investments in the Egyptian Automotive Industry

Source: Business Studies and Analysis Center AmCham, 2011

Whereas regarding the automotive market volume in Egypt, as published by the Automotive Marketing Information Council (AMIC) (2012a) at the Egyptian Automobile Manufacturers Association (EAMA), the total automotive market volume for the YTD 2012 was 159,947 units and specifically for Oct 2012 was 18,492 units, which was analyzed by brand according to Automotive Marketing Information Council (AMIC) (2012a) as follows:

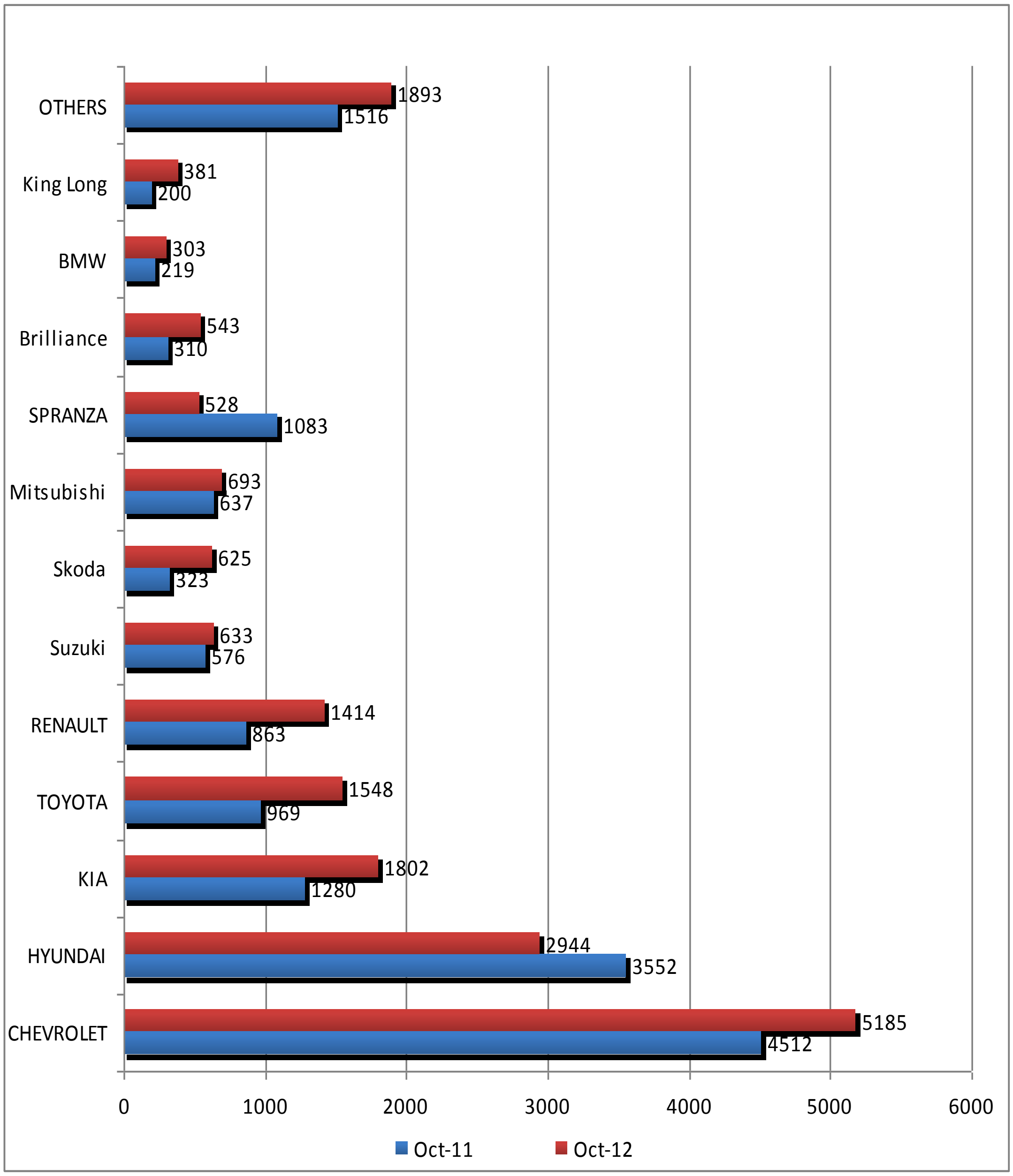


Figure 5.9. Total Automotive Market Volume by Brand (Top 12) (Oct. 2011 – Oct. 2012)
Source: Automotive Marketing Information Council (AMIC), 2012a

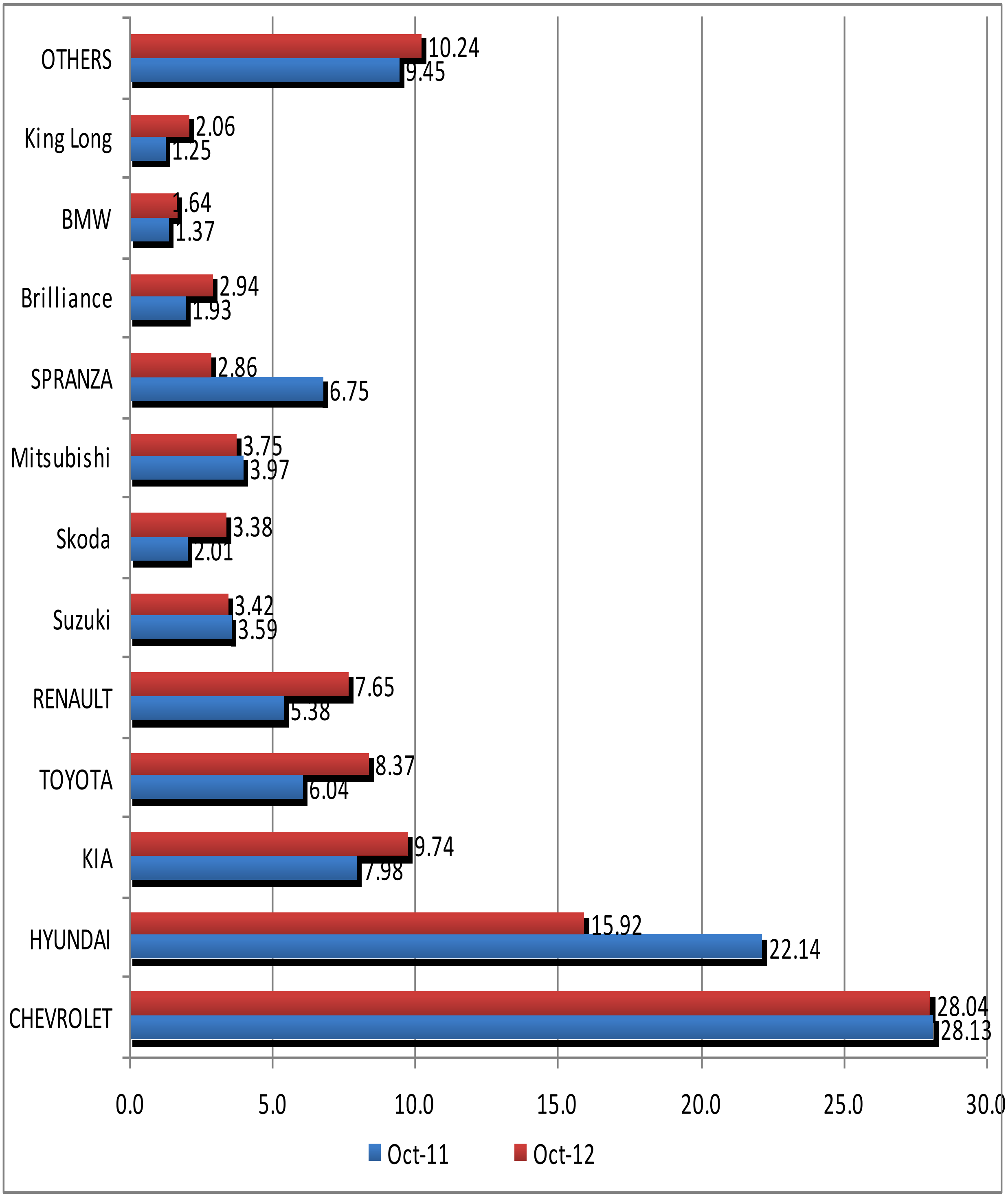


Figure 5.10. Total Automotive Market Share by Brand (Top 12) (Oct. 2011 – Oct. 2012)

Source: Automotive Marketing Information Council (AMIC), 2012a

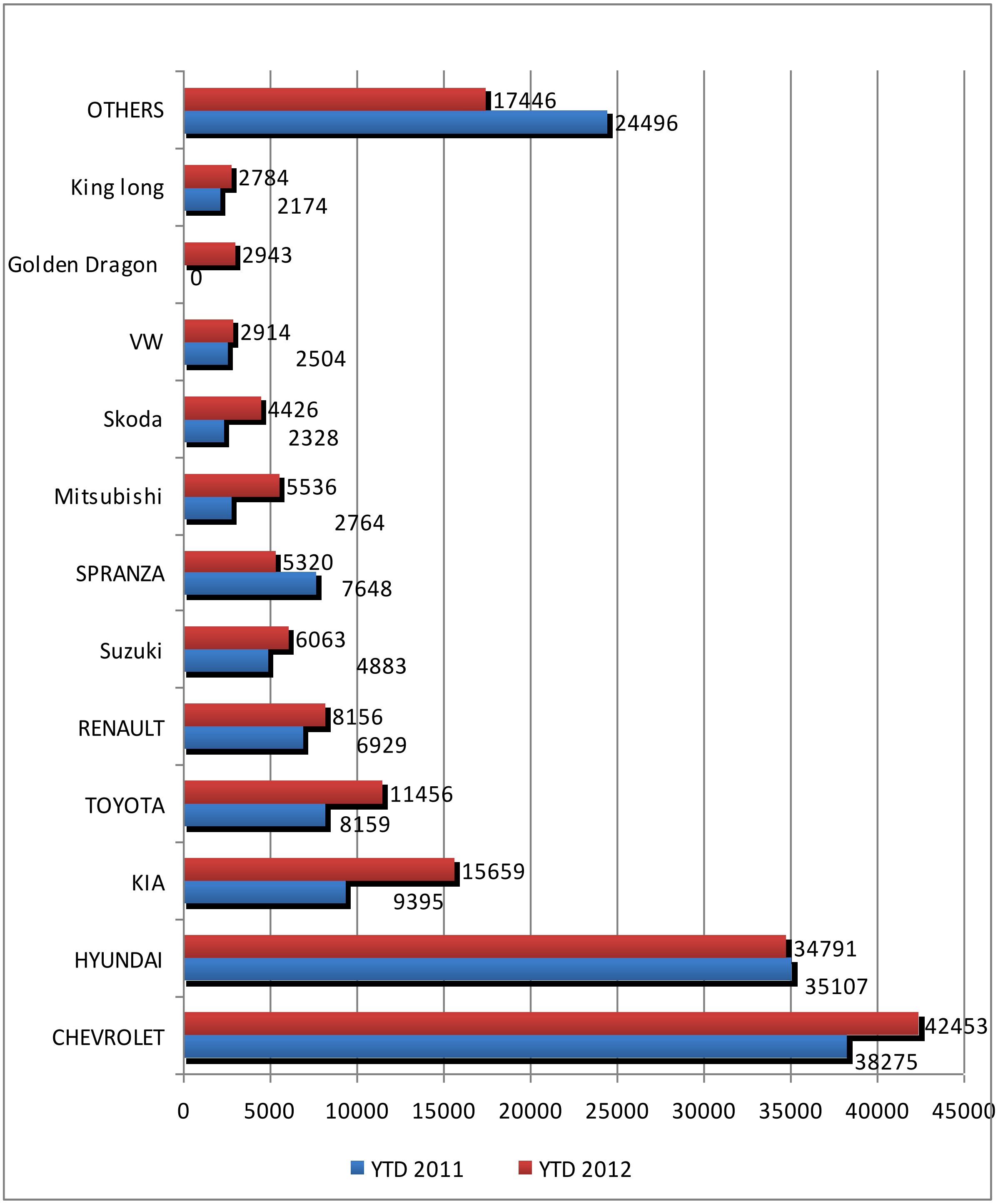


Figure 5.11. Total Automotive Market Volume by Brand (Top 12) (YTD 2011 – YTD 2012)
Source: Automotive Marketing Information Council (AMIC), 2012a

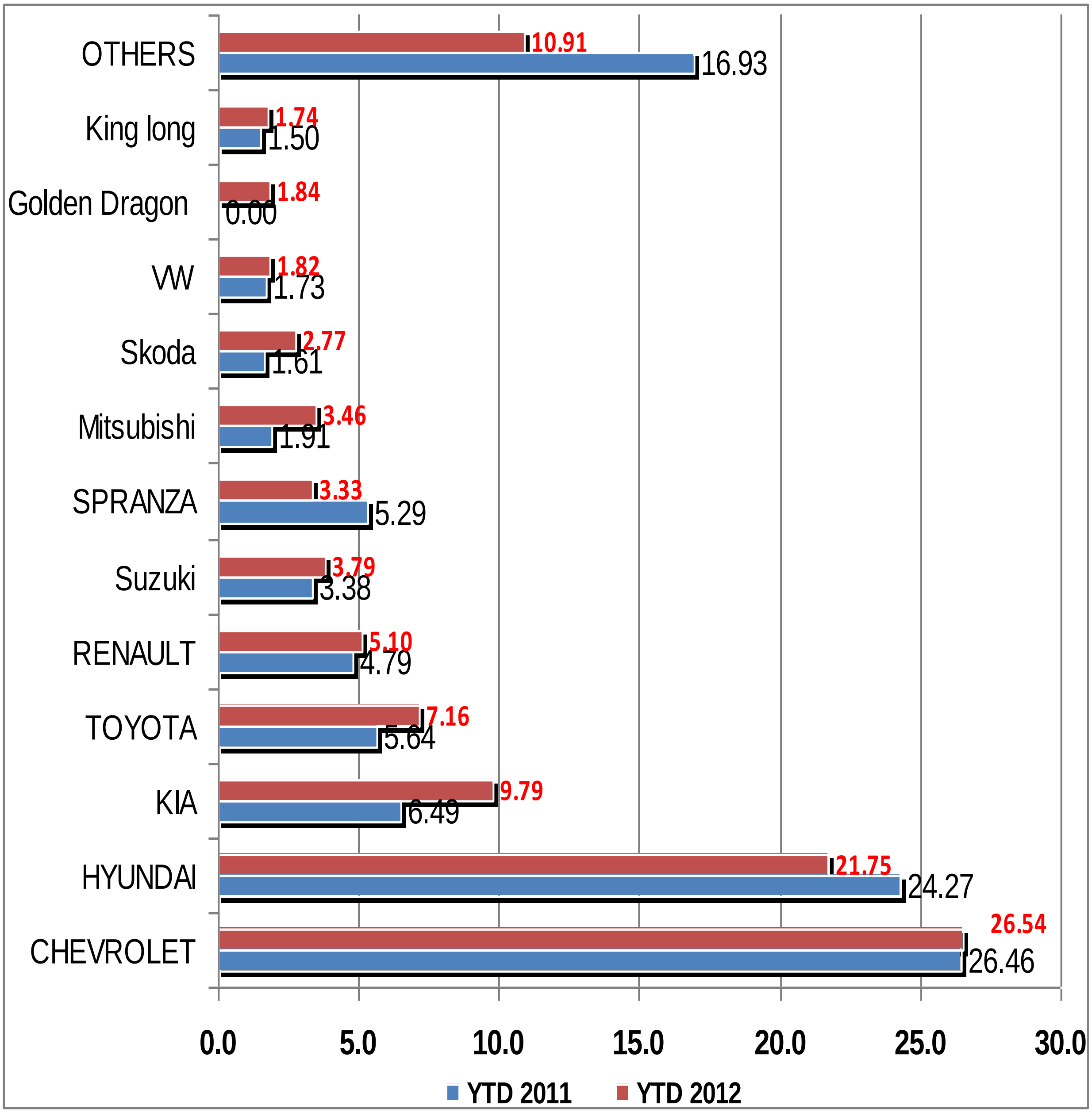


Figure 5.12. Total Automotive Market Share by Brand (Top 12) (YTD 2011 – YTD 2012)

Source: Automotive Marketing Information Council (AMIC), 2012a

5.2.2.3.2. Egyptian Automotive Industry Analysis: Down-stream ASC (Manufacturing/Assembly – Distribution)

According to the Business Studies and Analysis Center AmCham (2011), the automotive industry in Egypt holds 17 Automotive Manufacturers (i.e., 17 ASCs operating in Egypt) running 27 assembly lines, which encompasses 11 Passenger Cars (PC), and 16 Commercial Vehicles (CV) of which 7 are for Buses and 9 are for other CV (Industrial Development Authority, 2010; cited in Business Studies and Analysis Center AmCham, 2011). However, after combining the contents of the aforementioned references in chapter four (Egyptian Auto-feeders Association, 2010; Business Studies and Analysis Center, 2011) together and removing any repetition, shutdowns and discontinued operations, the researcher in the current study developed a new up-dated list of 20 vehicle manufacturing/assembling company.

Down-stream the supply chain, there is an automotive distribution system including: (1) agents (i.e., authorized dealers of foreign vehicle brands), (2) distributors (i.e., mainly appointed by the authorized dealers to sell the cars and in few cases provide after sales service and spare parts), and (3) traders (i.e., not associated with any brand and do not provide aftermarket services of any kind) (Industrial Development Authority, 2010; cited in Business Studies and Analysis Center, 2011).

Regarding the most important automotive manufacturers/assemblers in Egypt, General Motors (GM Egypt) has the largest automotive production facility in Egypt and Ghabbour Auto (GB Auto) is the leading automotive player in terms of market value (Business Studies and Analysis Center, 2011).

First, GB Auto is Egypt's largest listed automaker (Oxford Business Group, 2011). As revealed by Oxford Business Group (OBG) (2011) and Economist Intelligence Unit (EIU) (2012), GB manufactures, assembles, imports and distributes vehicles for international firms (e.g., Hyundai-South Korea, Mitsubishi-Japan, Volvo-Sweden and Mazda-Japan).

Moreover, Business Studies and Analysis Center AmCham (2011) pointed out that Ghabbour Auto (GB Auto) is the leading automotive player in terms of market value and dominates the various vehicle segments (i.e., passenger cars, commercial vehicles, and three wheelers).

Furthermore, GB Auto is Hyundai's sole distributor, since 1992, and assembler, since 1995, in addition to that, GB operates Egypt's biggest network of service centers. Additionally, it produces Volvo and Mitsubishi trucks and buses, Bajaj motorcycles and three wheelers (Business Studies and Analysis Center AmCham, 2011).

However, GB Auto not only operates in the Egyptian local market, but also targets the international market. The company started to integrate its ASC into the global ASC through: (a) penetrating the Algerian market in February 2009 via conducting a joint venture (JV) with SENTRAX to distribute semi-trailers in Algeria (Business Studies and Analysis Center, 2011); then (b) entering the Iraqi market in February 2010 through establishing a 50-50 JV with Al-Kasid Group, which mainly imports Hyundai vehicles and spare parts into the Iraqi market in a deal that worth $80 million (Business Studies and Analysis Center, 2011; Business Monitor International, 2012a); and (c) conducting in 2008 another JV with a Brazilian company named Marcopolo in order to open an assembly plant with a capacity to produce 1,500 buses a year that could be enhanced to 8,000 a year by 2014 (Economist Intelligence Unit, 2012). Thereby, a portion of these vehicles will be allocated for export (Economist Intelligence Unit, 2012).

With regard to General Motors (GM Egypt) as being considered an important Automotive Manufacturer, Business Studies and Analysis Center AmCham (2011) revealed that it has the largest automotive production facility in Egypt with a capacity of 6,000 units annually. GM, through this huge production facility, assembles and manufactures light/medium-duty trucks, buses, PCs and sport utility vehicles (SUVs).

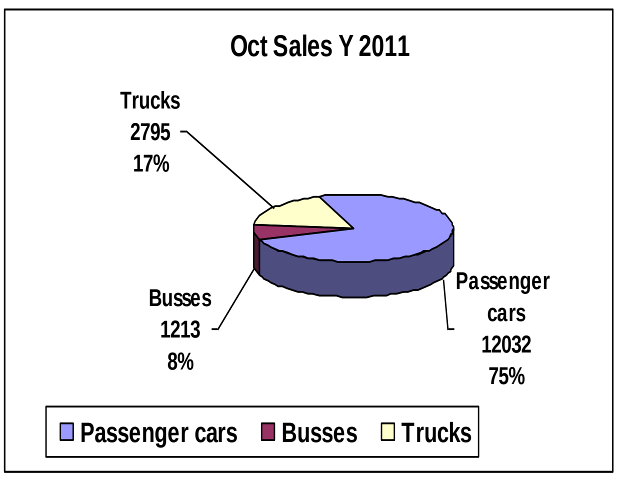
Moving along GM SC −especially its down-stream distribution nodes− you can find Al-Mansour Company, which is GM Egypt exclusive distributor. Through Al-Mansour Company, GM Egypt sells the following brands: Opel (e.g., Vectra, Astra and Corsa); and Chevrolet (e.g., Aveo, Cruze, Lanos, Optra and Spark). Additionally, GM offers, with regard to CV, a wide range of Tough Trucks (N-series) and Pickup Trucks (T-Series) and Minibus chassis (Business Studies and Analysis Center, 2011).

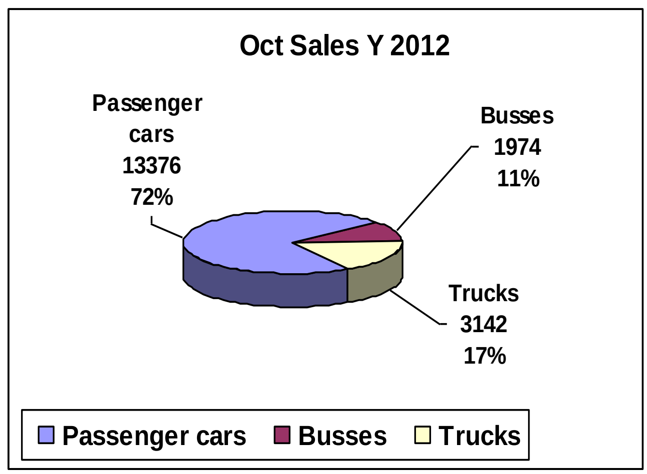
In Egypt, according to Automotive Marketing Information Council (AMIC) (2012a) and Business Studies and Analysis Center (2011), the vehicles market is dominated by the PC segment in terms of sales volume, with a share of 71% of total sales in YTD 2012 (i.e., from

January 2012 till October 2012), followed by the trucks segment that comes in the 2nd place with a market share of 19%, and finally, the bus sales with a share of 10%.

In regard to the total Egyptian automotive market volume by origin (YTD 2012), results have shown that 55.16% of vehicles sales were completely built units (CBU) imported from the international market, whereas, 44.84% were completely knocked down units (CKD) assembled by local automotive manufacturers (Automotive Marketing Information Council, 2012a; Business Studies and Analysis Center, 2011).

According to the Automotive Marketing Information Council (AMIC), Egyptian Automobile Manufacturers Association (EAMA) (2012a), the total automotive market volume for Oct 2012 was higher than Oct 2011 sales by 15%, as it increased from 16,040 units to 18,492 units. In fact, the passenger cars segment had a volume increase of 11% in units, when comparing Oct 12 to Oct 11; while, the buses segment had a volume increase of 63%, whereas, the trucks segment had a volume increase of 12% (AMIC, 2012a).





Monthly Sales Oct 2011

Type	No.	%
Passenger cars	12,032	75.0
Busses	1,213	7.6
Trucks	2,795	17.4
Total Market Volume	16,040	100.0

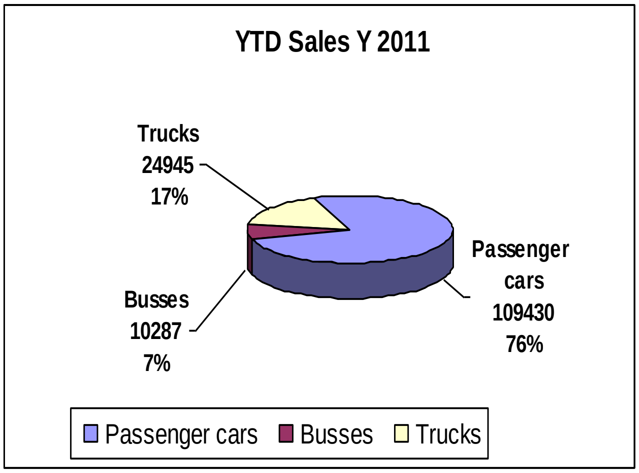
Monthly Sales Oct 2012

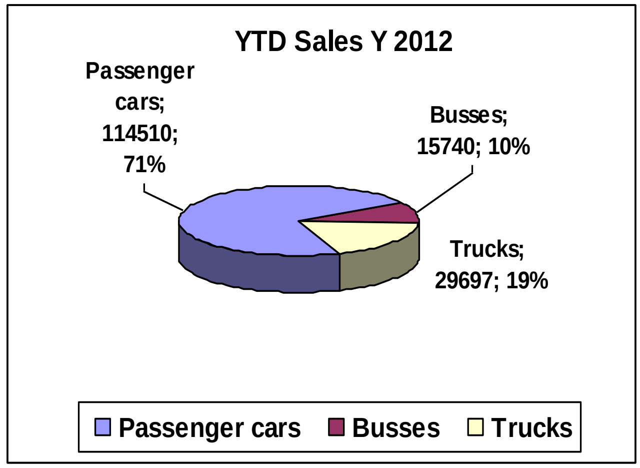
Type	No.	%	Var. %
Passenger cars	13,376	72.3	11.2
Busses	1,974	10.7	62.7
Trucks	3,142	17.0	12.4
Total Market Volume	18,492	100.0	15.3

Figure 5.13. Total Automotive Market Split in Volume (Oct 2011– Oct 2012)

Source: Automotive Marketing Information Council (AMIC), 2012a

While the total automotive market volume for the YTD 2012 was higher than YTD sales by 11%, as it increased from 144,662 to 159,947 units. In fact, the passenger cars segment had a volume increase of 5% in units, when comparing YTD 2012 to YTD 2011; whereas, the buses segment had a volume increase of 53%, and finally, the trucks segment had a volume increase of 19% (Automotive Marketing Information Council, 2012a).





YTD Sales

Type	No.	%
Passenger cars	109,430	75.6
Busses	10,287	7.1
Trucks	24,945	17.2
Total Market Volume	144,662	100.0

YTD Sales

Type	No.	%	Dev %
Passenger cars	114,510	71.6	4.64
Busses	15,740	9.8	53.01
Trucks	29,697	18.6	19.05
Total Market Volume	159,947	100.0	10.57

Figure 5.14. Total Automotive Market Split in Volume (YTD 2011 – YTD 2012)

Source: Automotive Marketing Information Council (AMIC), 2012a

From a larger perspective, after comparing Oct. 2012 automotive sales to other periods, Automotive Marketing Information Council (AMIC) (2012a) indicated that there is a favorable increase in the automotive market volume in Egypt. This chart has been developed by AMIC (2012a) for the three automotive sectors (i.e., passenger cars, and commercial vehicles; namely buses and trucks), which reveals that:

- Oct 2012 sales are higher than 2012 YTD average sales by 15.6%.
- Oct 2012 sales are higher than 2011 YTD average sales by 27.8%.
- Oct 2012 sales are higher than 2011 average sales by 26%.
- Oct 2012 sales are higher than Oct 2011 sales by 15.3%.
- Oct 2012 sales are higher than Sep 2012 sales by 0.39%.

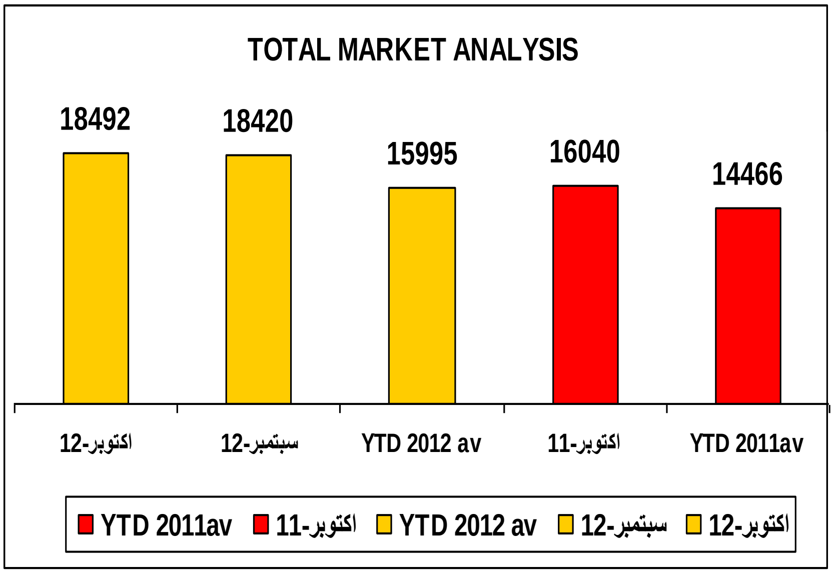


Figure 5.15. Total Automotive Market Analysis in volume (Oct. 2012)

Source: Automotive Marketing Information Council (AMIC), 2012a

5.2.2.3.2.a. Passenger Cars (PC) Market

In fact, PC in Egypt suffered from a severe decrease in its sales volume, during the first half of the decade, falling from a peak of 72,000 cars per year in 1998 to about 46,700 in 2002. Later, in 2005, sales increased by an average annual rate of 27.3% to reach a total of 158,926 cars in 2009 (Automotive Marketing Information Council, 2009b; Business Studies and Analysis Center, 2011). At this point, it's important to mention that PC local production doubled its volume from 32,600 cars, in 2003, to 72,500 cars in 2009 at an average annual growth rate of 15% (Automotive Marketing Information Council, 2009b; Business Studies and Analysis Center, 2011).

As declared by Business Studies and Analysis Center AmCham (2011), the main factors behind the aforementioned favorable increase in PC sales were: (a) strong macroeconomic growth; (b) enhanced PC private consumption; in addition to (c) significant tariff reduction in late 2004 on finished vehicles, inputs and spare parts; and combined with (d) the strengthening of the Egyptian Pound that began late 2004 and scored a positive currency appreciation.

However, in 2009 PC sales suffered from a significant reduction that was amounted by 20%, due to the global financial crisis that negatively affected car purchases. Conversely, in July 2009, PC sales reached its peak again, as a result of the implementation of the Taxi Scrappage/Replacement program, which was officially launched in April 2009. Thus, this program implementation –between the Ministry of Finance and five PC manufacturers: GB Auto, GM, Wagih Abaza, Aboul Fotouh and El Amal Group- incentivized the demand for local assembly industry, and helped in overcoming the negative effects of the global financial crisis (Business Studies and Analysis Center, 2011).

While in regard to the current situation, as being announced by Automotive Marketing Information Council (2012a), the total PC market volume for YTD 2012 was higher than YTD 2011 sales by 5%, as it increased from 109,430 units to 114,510 units.

Table 5.3. Total PC Market Split in Volume (YTD 2011 – YTD 2012)

YTD 2011 Sales

Type	No.	%
<=1000 cc	2252	2.1
1.0 - 1.3 cc	5900	5.4
1.3 - 1.5 cc	17695	16.2
1.5 - 1.6 cc	72145	65.9
1.6 - 2.0 cc	1980	1.8
>2.0 cc	712	0.7
SUV <= 2.0 cc	5806	5.3
SUV > 2.0 cc	2940	2.7
PC Volume	109430	100.0

YTD 2012 Sales

Type	No.	%	Var. %
<=1000 cc	2116	1.8	-6.0
1.0 - 1.3 cc	7387	6.5	25.2
1.3 - 1.5 cc	22055	19.3	24.6
1.5 - 1.6 cc	69238	60.5	-4.0
1.6 - 2.0 cc	885	0.8	-55.3
>2.0 cc	636	0.6	-10.7
SUV <= 2.0 cc	8196	7.2	41.2
SUV > 2.0 cc	3997	3.5	36.0
PC Volume	114510	100.0	4.6

Source: Automotive Marketing Information Council (AMIC), 2012a

According to Automotive Marketing Information Council (2012a), the total PC market volume of YTD 2012, if compared to 2011, continued its ups and downs starting from January till September, until it surpassed 2011 sales in October, as finally, the overall PC market volume of October 2012 was higher than October 2011 sales by 11 %, because PC sales increased from 12,032 to 13,376 units.

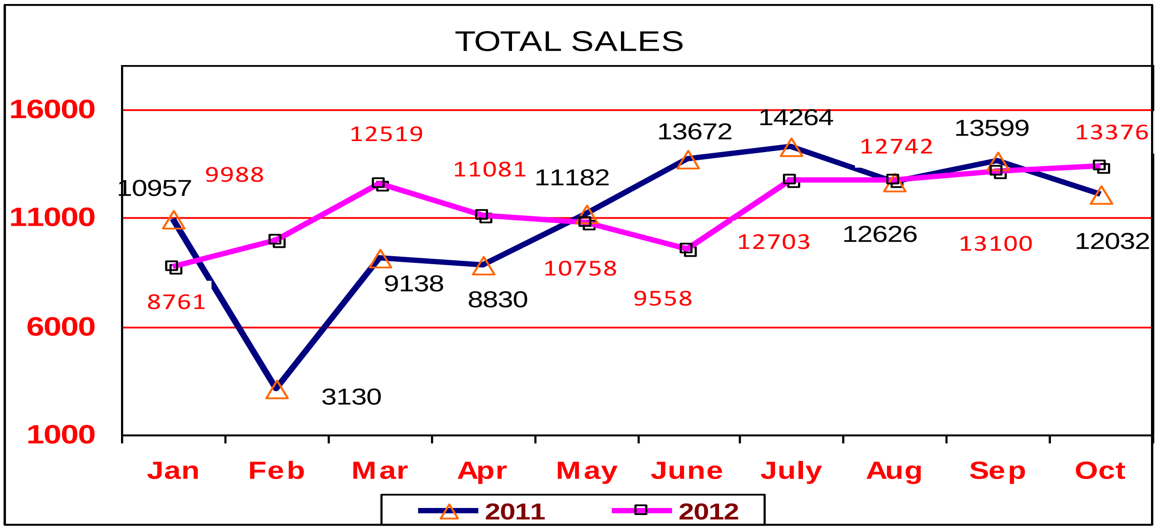


Figure 5.16. Total PC Market Seasonality in Volume (YTD 2011 – YTD 2012)

Source: Automotive Marketing Information Council (AMIC), 2012a

From a different analytical perspective and according to Automotive Marketing Information Council (AMIC) (2012a), comparing PC sales of October 2012 to that of other periods indicates a favorable increase in the PC market volume in Egypt. This chart has been developed by AMIC (2012a) for the three automotive segments (i.e., PC, and CV; namely buses and trucks), which reveals that:

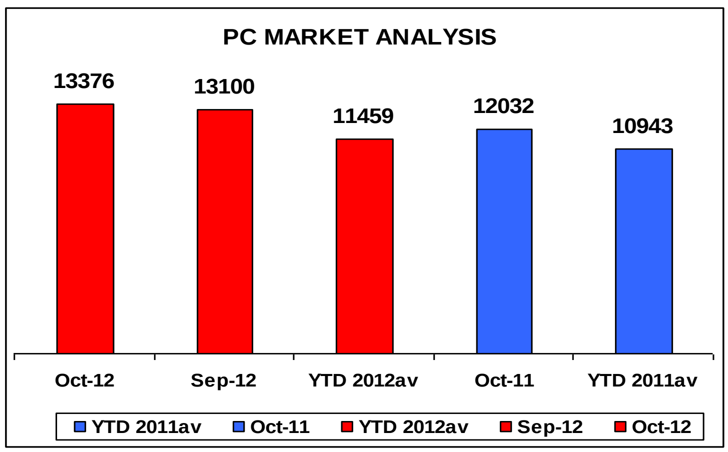


Figure 5.17. Total PC Market Analysis in volume (Oct. 2012)

Source: Automotive Marketing Information Council (AMIC), 2012a

- Oct 2012 sales are higher than 2012 YTD average sales by 22%.
- Oct 2012 sales are higher than 2011 YTD average sales by 16.8%.
- Oct 2012 sales are higher than 2011 average sales by 20.5%.
- Oct 2012 sales are higher than Oct 2011 sales by 11%.
- Oct 2012 sales are higher than Sep 2012 sales by 2.1%.

The majority of passenger cars sold in YTD 2012 were completely built units (CBU) units with a share of 61.7% and the remaining 38.3%, were completely knocked down units (CKD) supplied by local assemblers (Automotive Marketing Information Council, 2012a). However, CKD of YTD 2012 decreased in volume by 0.5% compared to that of YTD 2011, whereas, CBU of YTD 2012 increased by 8.1 % than that of YTD 2011 (AMIC, 2012a).

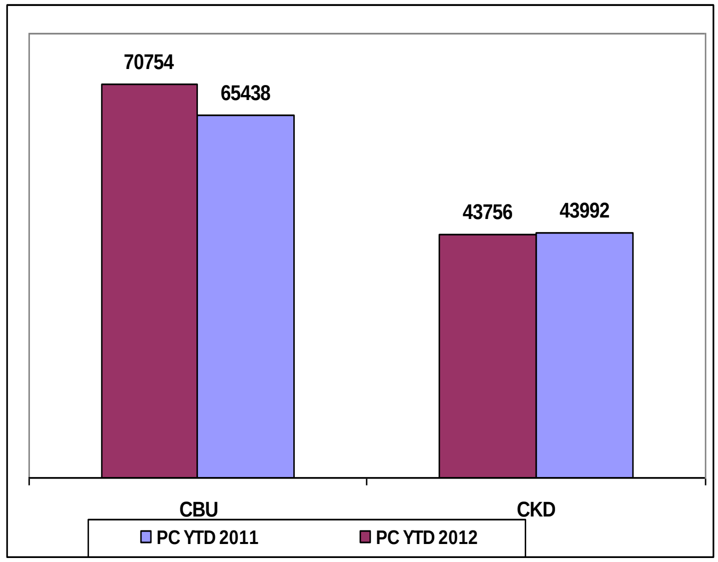


Figure 5.18. Total PC Market Volume by Origin (YTD 2011 – YTD 2012)

Source: Automotive Marketing Information Council (AMIC), 2012a

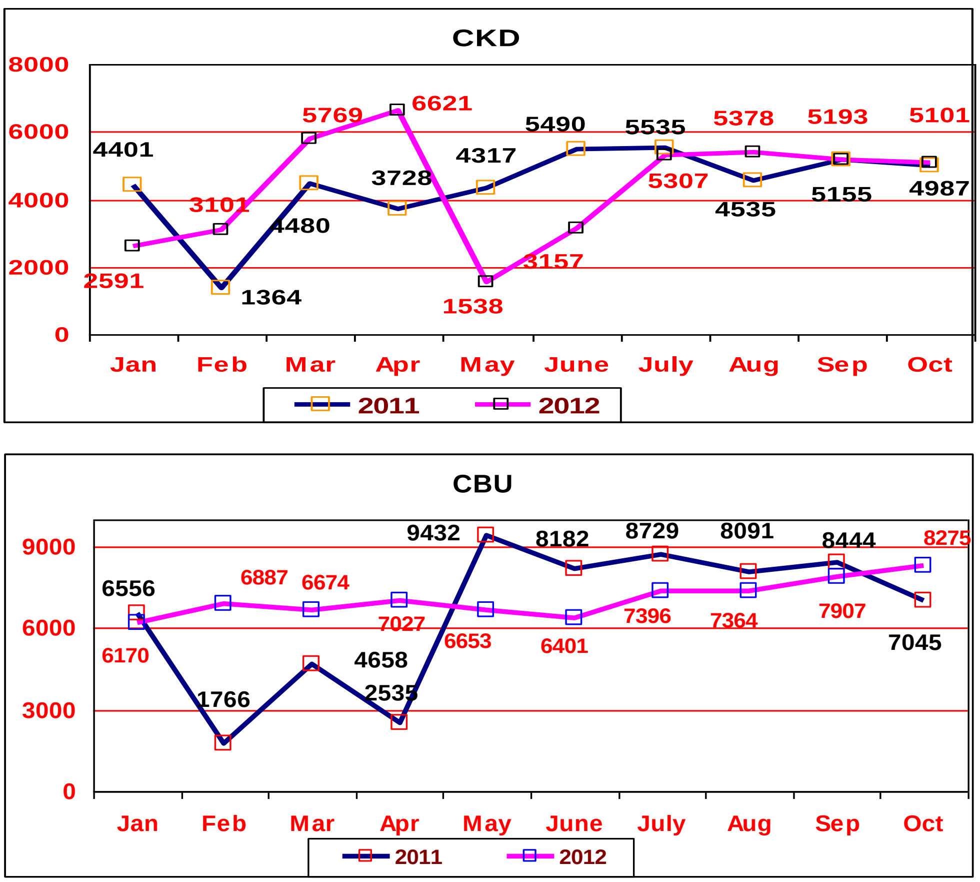


Figure 5.19. Total PC Market Seasonality in Volume by Origin (YTD 2011 – YTD 2012)

Source: Automotive Marketing Information Council (AMIC), 2012a

As pointed out by Business Studies and Analysis Center (BSAC AmCham) (2011), in general since, the local automotive market is characterized by being very price sensitive. Therefore, many South Asian brands and car components that were introduced into the market earned a significant market share in a short period of time. Thus, most PC brands sold are from Asia and the US, as European brands are generally characterized by being more expensive. However, high quality European brands are valued by high-end customers, who seek quality, innovation, technology and value-added product (BSAC AmCham, 2011).

According to the AMIC (2012a) rankings of the top 13 PC brands in 2012, Hyundai-South Korea was leading the market in 2012 with a share of 29.9%; followed by Chevrolet (US), which recorded a considerable increase of market share to 17.2% in the same year (BSAC AmCham, 2011). Then, Kia came in the third position, with a share of 13.7%, through earning a significant increase in its market share (BSAC, 2011). Conversely, Toyota lost its position in the PC market recently as its share decreased to 4.5% (BSAC AmCham, 2011).

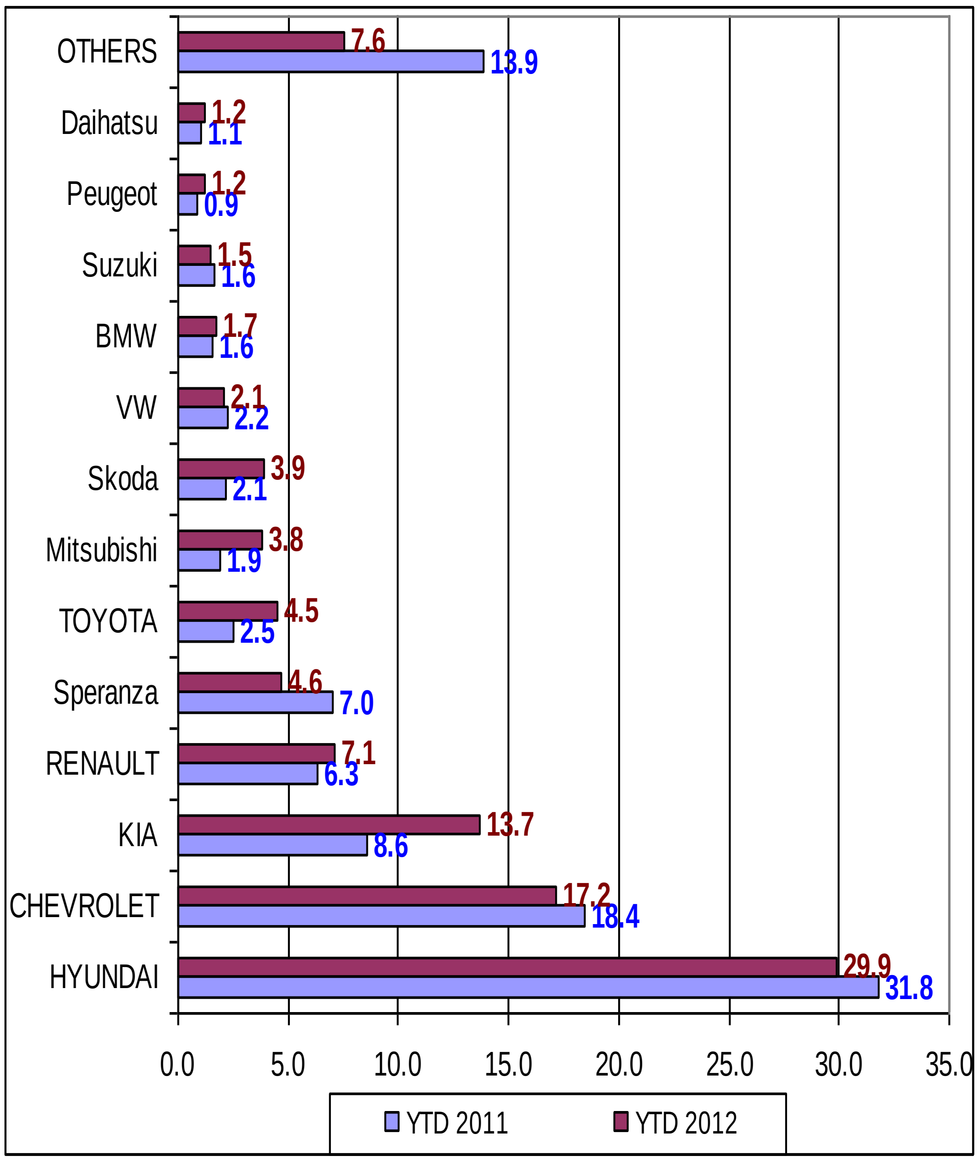


Figure 5.20. Total PC Market Share by Brand (Top 13) (YTD 2011 – YTD 2012)

Source: Automotive Marketing Information Council (AMIC), 2012a

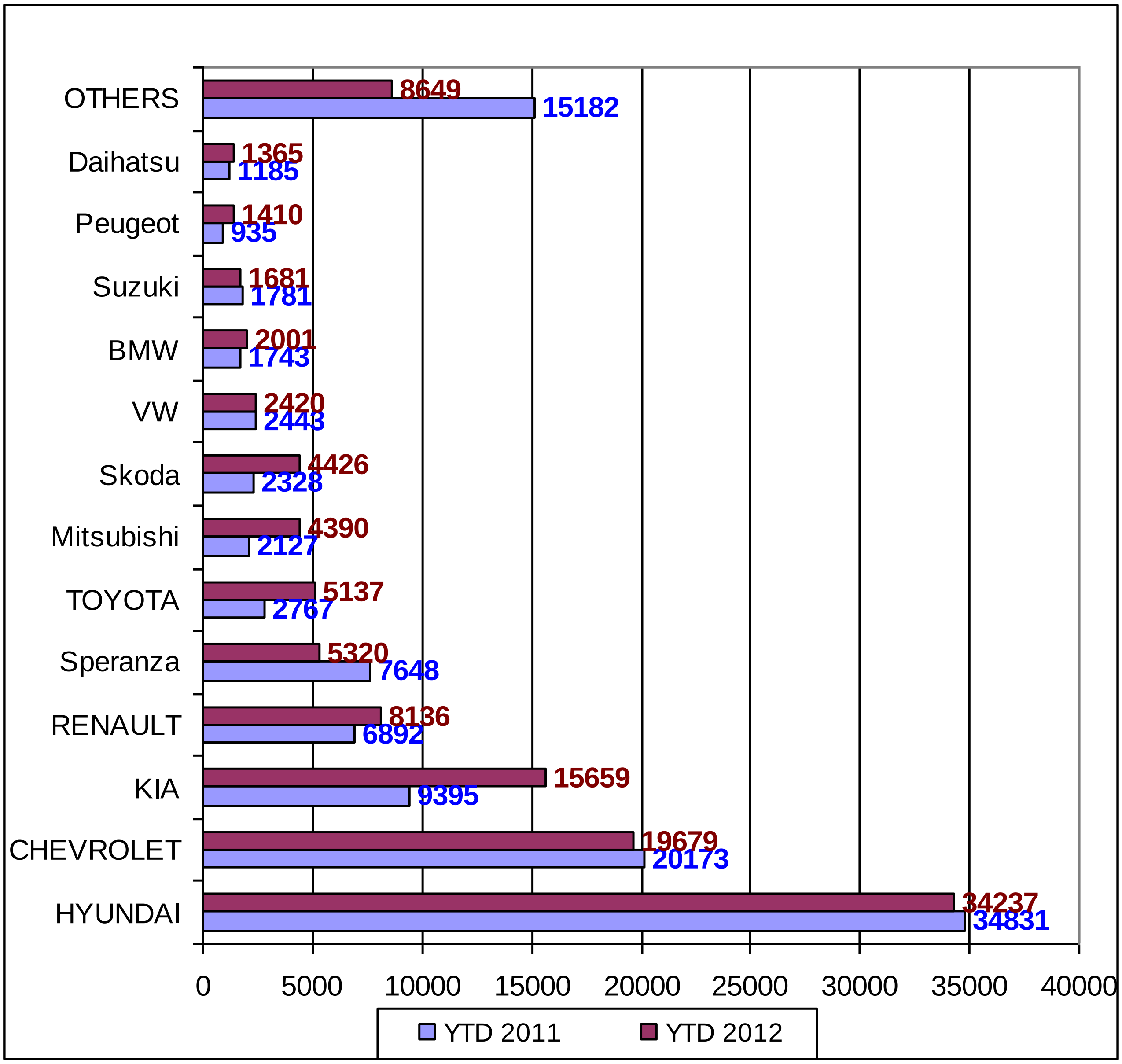


Figure 5.21. Total PC Market Volume by Brand (Top 13) (YTD 2011 – YTD 2012)

Source: Automotive Marketing Information Council (AMIC), 2012a

In Egypt, the majority of PC purchasers prefer the medium-sized and cheaper models (i.e., in the category of 1.5 liters-1.6 liters) (Business Studies and Analysis Center, 2011), which accounted for 61% of sales in 2012, 5% less than the previous year. At the same time, the share of SUVs in sales less than 2 liters increased in 2012 reaching 7%. However, sales of SUVs greater than 2 liters remained the same without any increase from 2011 till 2012, as a result of the tight financial conditions and the increase in SUV licensing fees (i.e., 2% of the vehicle price), which is relatively expensive even for high-end PC customers (Business Studies and Analysis Center, 2011; AMIC, 2012a). Accordingly, after analyzing PC sales by price segment, since, most purchased PC in 2012 lie in the more than 50,000 - 70,000 L.E. and more than 70,000 - 100,000 L.E. price segments (i.e., are in the average car price segment (L.E. 50,000-100,000) (Business Studies and Analysis Center, 2011)). Therefore, this reflects growing demand from the middle-class that is willing to buy new PCs (Business Studies and Analysis Center, 2011; AMIC, 2012a).

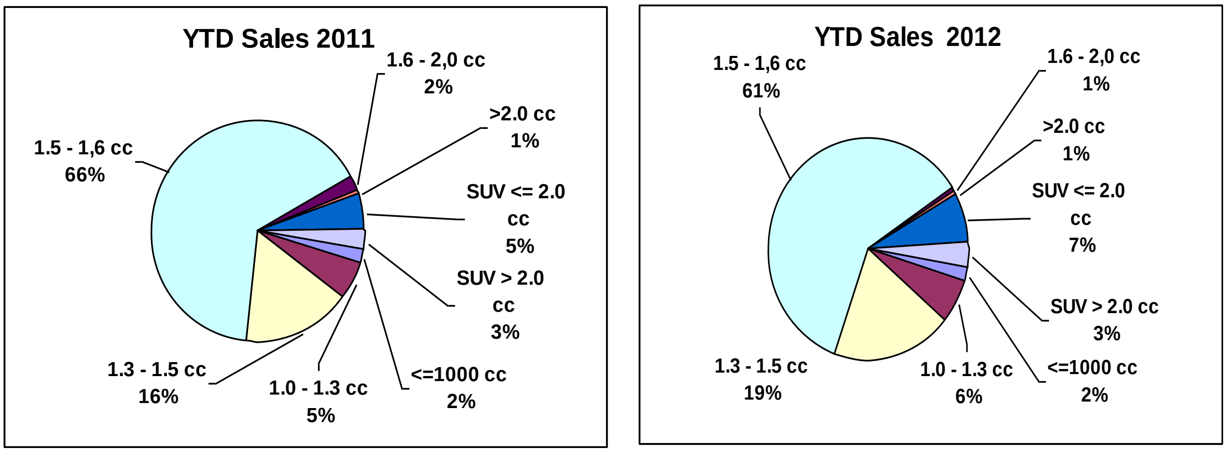


Figure 5.22. Total PC Market Split in Share by Segment (YTD 2011 – YTD 2012)

Source: Automotive Marketing Information Council (AMIC), 2012a

5.2.2.3.2.b. Commercial Vehicles (CV) Market

As revealed by Automotive Marketing Information Council (2012a), CV in 2012 represented almost 29% of Egypt's automotive sales volume, from which buses scored a share of 10%; whereas trucks accounted for the bulk of CV sales volume with a share of 19% of total automotive market in Egypt.

A. Busses Market

In Egypt, buses are the most popular means of mass transport due to many reasons: (1) buses are widely used by private tourism companies; (2) demand for new buses is incentivized by the considerable growth in the Egyptian tourism industry; (c) significant population growth; along with the (d) spread of new residential compounds outside Greater Cairo (e.g., 6th of October and New Cairo); in addition to the (e) growing pressure on public transportation (Business Studies and Analysis Center, 2011).

Regarding bus production strategy, Business Studies and Analysis Center (2011) tackled a very important difference between bus manufacturing and PC manufacturing through pointing out that the first is considered labor-intensive; thus, giving Egypt a competitive advantage in this segment. More importantly, the percentage of bus sales that are locally assembled (CKD) units is higher than that of PC sales (Business Studies and Analysis Center, 2011).

Results have shown that the total sales of buses in YTD 2012 if compared to 2011, it shows an increase of 53% as it scored 15,740 units instead of 10,287 units (Automotive Marketing Information Council, 2012a).

Table 5.4. Total Buses Market Split in Volume by Segment (YTD 2011 – YTD 2012)

Buses Sales YTD 2011

Type	No.	%
Transport Micro Micro	3053	29.7
Tourism Micro	715	7.0
Transport Micro	4484	43.6
Tourism Mini	149	1.4
Transport Mini	1154	11.2
Transport Midi	392	3.8
Tourism Maxi	63	0.6
Transport Maxi	68	0.7
Transport Maxi-city	209	2.0
Bus Volume	10,287	100.0

Buses Sales YTD 2012

Type	No.	%	Dev. %
Transport Micro Micro	4678	29.7	53.23
Tourism Micro	710	4.5	-0.70
Transport Micro	8159	51.8	81.96
Tourism Mini	410	2.6	175.17
Transport Mini	1213	7.7	5.11
Transport Midi	361	2.3	-7.91
Tourism Maxi	38	0.2	-39.68
Transport Maxi	164	1.0	141.18
Transport Maxi-city	7	0.0	-96.65
Bus Volume	15,740	100.0	53.01

Source: Automotive Marketing Information Council (AMIC), 2012a

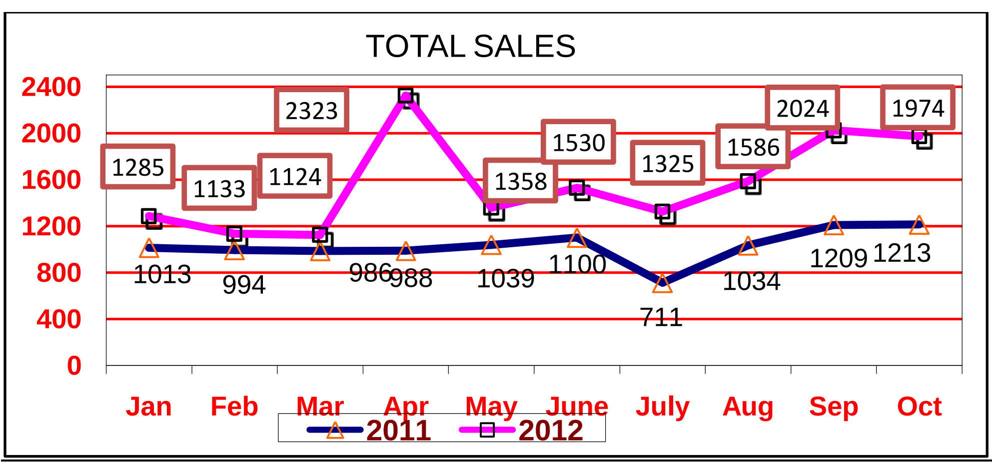


Figure 5.23. Total Buses Market Seasonality in Volume (YTD 2011 – YTD 2012)
Source: Automotive Marketing Information Council (AMIC), 2012a

Toyota used to dominate the market for buses with a share of 43% in 2008 and almost a similar share of 40% in 2007 (Business Studies and Analysis Center, 2011). However, according to the Automotive Marketing Information Council (2012a) rankings of the top bus brands, Suzuki succeeded in surpassing Toyota through scoring a share of 24.2% of the bus market; while Toyota maintained only a market share of 22.6% in the same year.

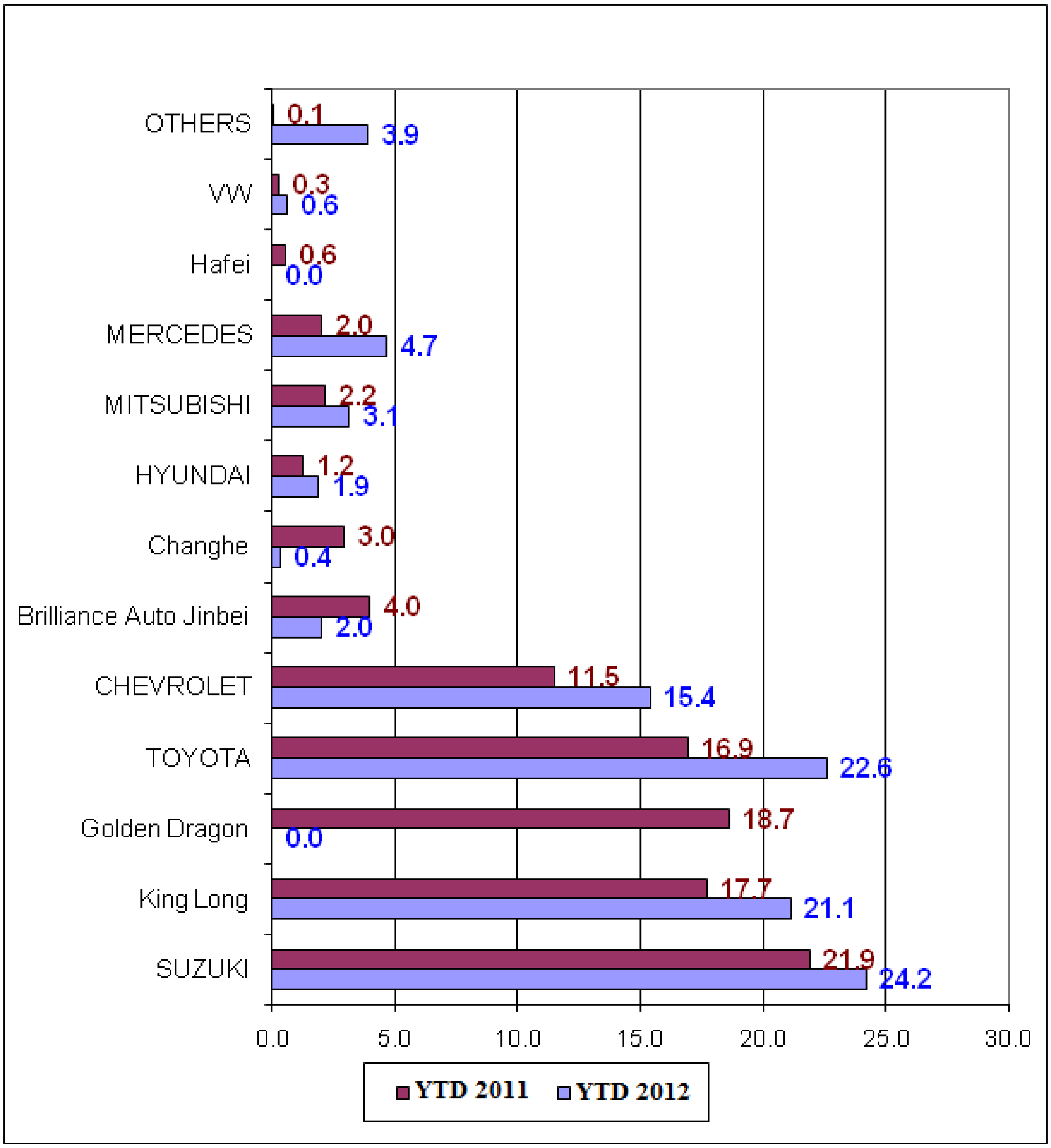


Figure 5.24. Total Bus Market Share by Top Brands (YTD 2011 – YTD 2012)

Source: Automotive Marketing Information Council (AMIC), 2012a

B. Trucks Market

Since, road transportation in Egypt captures more than 95% of the volume of total inland freight; therefore, demand on trucks will maintain its strength in the Egyptian vehicle market (Business Studies and Analysis Center, 2011).

In 2012, trucks accounted for 19% of total automotive market in Egypt (i.e., trucks sales volume represents a bulk of total CV sales volume in Egypt) (Automotive Marketing Information Council, 2012a). Furthermore, trucks segment sales volume in YTD 2012 increased by 19.05% than that of YTD 2011 as a result of the Pickup segment’s market share increase by 9.8%; in addition to the light trucks segment's share increase of 89.4 % (Automotive Marketing Information Council, 2012a). With regard to Pickup trucks, it's considered by far as the most popular truck type (Business Studies and Analysis Center, 2011) representing 65.4% of total truck sales in 2012, followed by light-medium trucks, which captured 15% of Trucks sales volume in the same year in Egypt (Automotive Marketing Information Council, 2012a).

Table 5.5. Total Trucks Market Split in Volume by Segment (YTD 2011 – YTD 2012)

Sales YTD 2011

Type	No.
Mini Pickup/Van	1133
Pickup	17696
Light Truck	960
Light Medium Truck	4509
Medium Truck	228
Heavy Truck	419
Truck Volume	24,945

Sales YTD 2012

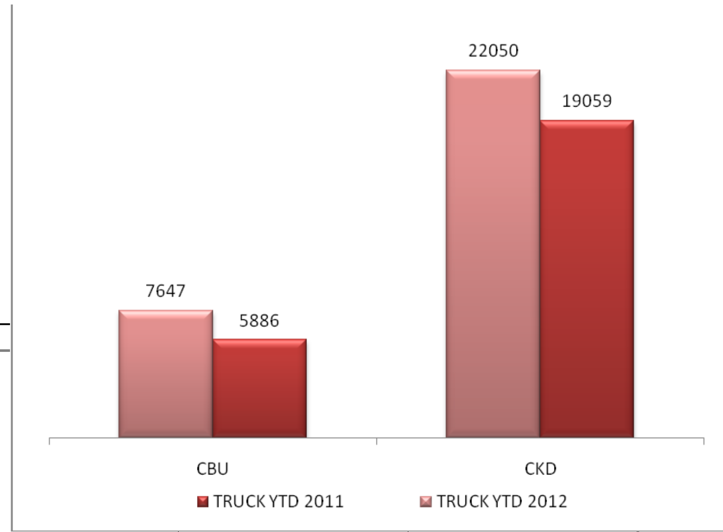
Type	No.	%	Dev. %
Mini Pickup/Van	2046	6.9	80.58
Pickup	19428	65.4	9.79
Light Truck	1818	6.1	89.38
Light Medium Truck	5497	18.5	21.91
Medium Truck	291	1.0	27.63
Heavy Truck	617	2.1	47.26
Truck Volume	29,697	100.0	19.05

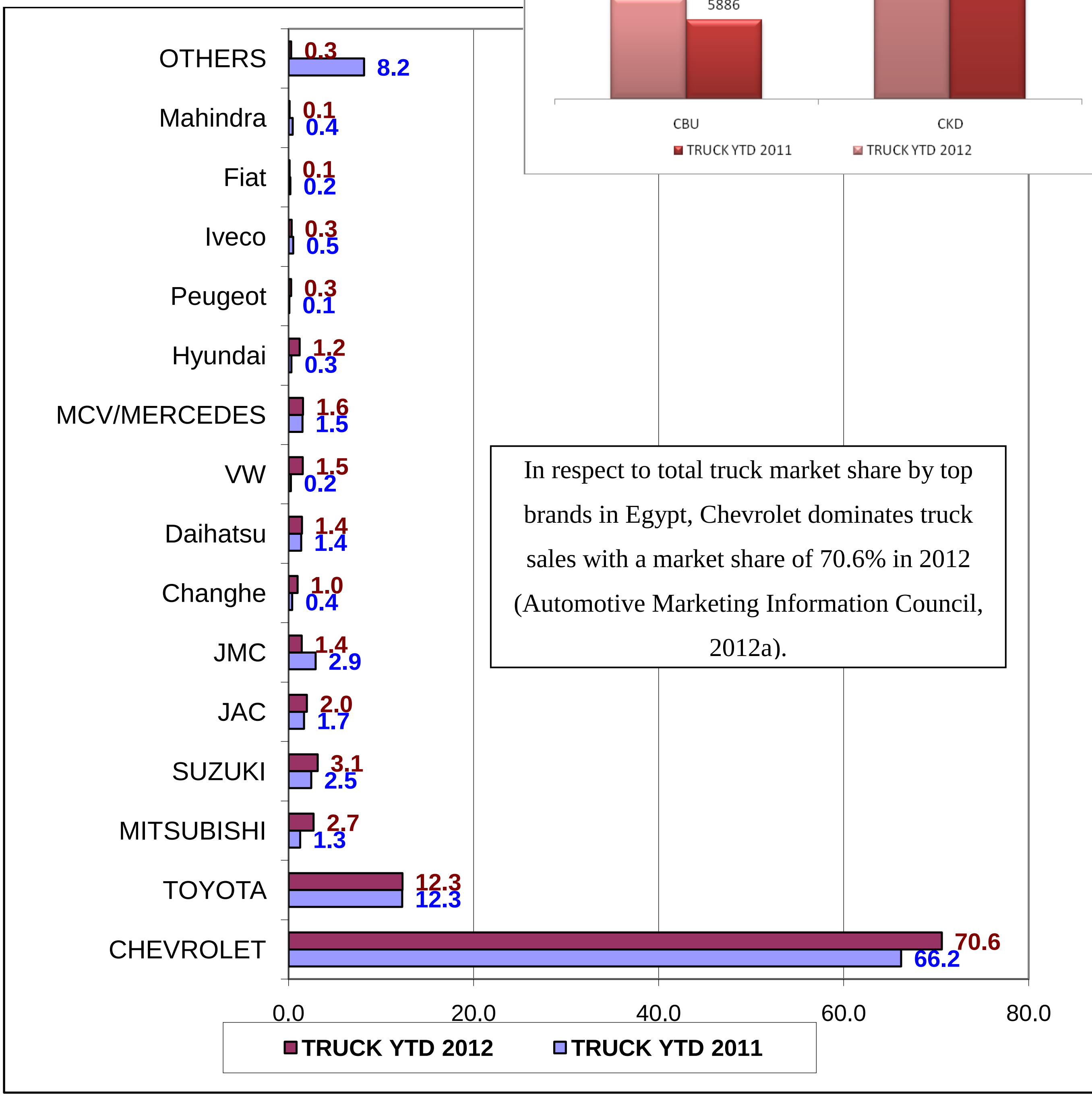
Source: Automotive Marketing Information Council (AMIC), 2012a

However, the majority of Trucks units are imported (CBU) rather than locally assembled (CKD). As for 2012, about 25.8% of total truck sales, which represents 7,647 trucks were locally assembled (CKD); whereas, CBU trucks sales accounted for 74.2% of total truck sales in Egypt (i.e., CBU volume has much more influence on YTD 2012 total trucks volume than CKD) (Automotive Marketing Information Council, 2012a). While from a different analytical perspective, CKD of YTD 2012 increased by 15.7% than that of YTD 2011 and CBU also increased by 29.9% (Automotive Marketing Information Council, 2012a).

Figure 5.25. Total Trucks Market Volume by Origin (YTD 2011 – YTD 2012)

Source: Automotive Marketing Information Council (AMIC), 2012a





In respect to total truck market share by top brands in Egypt, Chevrolet dominates truck sales with a market share of 70.6% in 2012 (Automotive Marketing Information Council, 2012a).

Figure 5.26. Total Truck Market Share by Top Brands (YTD 2011 – YTD 2012)

Source: Automotive Marketing Information Council (AMIC), 2012a

5.2.2.3.3. Egyptian Automotive Feeding Industry: Up-stream ASC (Overseas and Local Supply)

The automotive components manufacturing/feeding industry that lie up-stream the ASC −including the overseas and local suppliers− represent crucial value-added nodes in that ASC. Components manufacturing is the backbone of a well established automotive industry (Business Studies and Analysis Center, 2011).

However, the researcher in this thesis views the automotive feeding industry as a spinal cord (i.e., a cord of nerve cells) that runs up along the backbone of the automotive industry, which is the ASC.

Since, there are up to 10,000 components (or 20,000 parts on average (Kim and Im, 2002)) in every vehicle that represents about 60% of its manufacturing cost (Business Studies and Analysis Center, 2011). Therefore, fulfilling vehicle assembly plants' requirements through local components enables them to work at their full capacity and accordingly reduces automotive production costs (Business Studies and Analysis Center, 2011).

5.2.2.3.3.a. Local Components

The Egyptian automotive feeding industry started its operation with the assembly of the first vehicle in Egypt; however, it began on a very small scale to supply simple components to the automotive local assemblers (Business Studies and Analysis Center, 2011).

By law, vehicles assembled in Egypt must contain at least 45% Egyptian parts (Oxford Business Group, 2011). This minimum local content requirement of the automotive manufacturing process incentivized many public and private auto feeding companies operating in Egypt to develop their manufacturing capability in order to be able to locally supply more than 300 different automotive components (e.g., metal and engineering products) (Business Studies and Analysis Center, 2011).

One of the most important strengths of ASC in Egypt is developing programs that facilitate the involvement of many producers with multinationals, which improved their automotive production process through installing new machinery, in addition to transfer of know-how and technology (Business Studies and Analysis Center, 2011).

The production of automotive components in Egypt is feeding two main segments (Business Studies and Analysis Center, 2011):

a. The original equipment manufacturers (OEMs), and
b. The after-sales market (i.e., sales outlets for automotive spare parts and on which there is a demand of about three-quarters of total automotive components production).

This elevated after-sales demand on automotive components/parts is mainly related to the relatively long vehicle lifetime, combined with generally rough road conditions that results in a deteriorating vehicle condition; thus, leading to an increase in the need for that after-sales market goods and services (Business Studies and Analysis Center, 2011).

Table 5.6. Major Automotive Components Manufactures/Auto Suppliers in Egypt (Up-stream ASC)

Company	Products	Representative Customers in Egypt
Abou El Yazeed	Mufflers and exhaust systems	GM, Egyptian Automotive, MCV, NASCO, Kia, Ghabbour, AAV
AKL	Lamps, wheel covers, mirrors, cooling fans	Egyptian assemblers and aftermarket
Autocool	Air conditioning and radiators	BMW, Citroën, Daewoo, Jeep Cherokee, Kia Pride, Mercedes, Opel, Peugeot, Suzuki
Chloride	Batteries	NASCO, domestic assemblers and aftermarket
Dr Greiche	Glass	Egyptian assemblers and aftermarket
El Teriak	Cooling systems and radiators	Ghabbour other local assemblers
IDACO	Wire harnesses, instrument clusters, sun visors	GM, Hyundai, AAV, Kia, Ghabbour, NASCO, Lada
Leoni	Cable harnesses and complete wiring systems for cars and commercial vehicles, ready-to-fit battery cables	–
Traxx	Brake linings and brake pads	Aftermarket

Source: Industrial Modernisation Programme IMC, 2005; cited in
Business Studies and Analysis Center AmCham, 2011;
Chamber of Engineering Industries (CEI), 2012

At this point, it's important to mention that –as stated by Business Studies and Analysis Center (2011) – many local component producers obtained licensing agreements with multinationals to achieve technical know-how and technology transfer. Furthermore, assemblers provide technical and engineering support for the purpose of ensuring an acceptable level of quality of the supplied components. Additionally, international PC manufacturers operating in Egypt deal with local components' suppliers to satisfy the local content requirements imposed by the Egyptian Law (Business Studies and Analysis Center, 2011).

Moreover, regarding the integration of ASC in Egypt into the global ASC, locally produced auto-components (e.g., tires, oil filters, glass products, electrical and aluminum parts) that meet international standards are exported to European markets (Business Studies and Analysis Center, 2011).

In order to strengthen the automotive industry and its supply chain without violating GATT, the Egyptian government is formulating measures to encourage the purchases of PC made from at least 50% local components and buses with at least 60% local parts (Oxford Business Group, 2011).

Thus, this will lead to many positive outcomes: (1) stimulate demand on the Egyptian automotive components/parts; (2) encourage the manufacturing of locally produced PCs at least those at the low cost end of the market; and (3) motivate manufacturers to use local parts and fully construct vehicles in Egypt rather than relying totally on imported full kits (Oxford Business Group, 2011).

In a similar vein, Business Studies and Analysis Center (2011) pointed out the importance of the minimum local content requirement in Egypt as a major force behind the flourishing of local components industry, as it incentivize vehicle assemblers in Egypt to use local components in order to take advantage of duty reductions when importing other components.

However, the local suppliers of automotive components offer less technical and more labor-intensive components to the local assemblers; whereas, other sophisticated components are imported from overseas suppliers or from the mother company. Hence, most of the local component suppliers produce according to the assembler's specifications and have a solid base for research and development (R&D) in order to meet the expectations of the local automotive assemblers in Egypt (Business Studies and Analysis Center, 2011).

With respect to the target of the auto-feeding industry (i.e., up-stream ASC), local automotive components companies are supplying three different markets: (a) local vehicle assemblers in Egypt; (b) selling to spare parts outlets; and (c) exporting (Business Studies and Analysis Center, 2011).

Practically speaking, Oxford Business Group (2011) discussed different successful case studies of automotive supply chains operating in Egypt that are effectively and efficiently managing their SC and taking significant steps towards integrating their ASC into the global ASC. For example:

1. Mercedes-Benz succeeded to produce auto parts in Egypt of high level of quality, as they have a good location, equipped facilities, affordable labor costs, in addition to government support in the form of tax exemptions and inexpensive land (Oxford Business Group, 2011);
2. GM not only produces components in Egypt for export, but also acts as an industrial incubator for smaller manufacturers to collaborate with each other, together with other original equipment manufacturers that produce auto components, which are branded under different names (Oxford Business Group, 2011); and
3. GB Auto, after succeeded in penetrating the Algerian market in 2009 and entering the Iraqi market in 2010 (Business Studies and Analysis Center, 2011), planned to export buses to other MENA countries and sub-Saharan Africa in 2011; followed by Eastern Europe and Turkey in 2013; then recently the Western Europe in 2014 (Oxford Business Group, 2011).

The fieldwork conducted for this thesis verifies the positive performed role by different automotive manufacturers (e.g., GM, BMW, and Mercedes-Benz) to provide technical and managerial support to their own supply-bases (i.e., up-stream SCI with local auto-components manufacturers), which makes it an attractive emerging market.

According to the Industrial Development Authority (IDA) (2009), there are 17 main categories of auto-components, which attract investment and can be locally manufactured (cited in Business Studies and Analysis Center, 2011):

Table 5.7. Top Automotive Components Categories for Investment

Component Category	Items
Body Parts	Panels, Bumpers, Frames, Mirrors, Windshields
Brake System	Lining, Drums, Calipers
Climate Control	Air Conditioners and Heaters
Drive Train	Axles, Drive Shafts
Electrical	Batteries, Audio System, Lights and Instrument
Engine Components	Camshafts, Cylinder Heads, Pistons
Engine/Electrical Parts	Alternators, Ignition, Starters
Exhaust System	Catalytic Converters, Mufflers
Fuel System	Filters, Injectors, Pumps, Turbochargers
Generic	Bearings, Wires, Fasteners, Hoses
Passenger Restraint	Seat belts, Air bags
Seating	Seat assemblers, Covers, Padding
Steering	Steering Columns, tie rods, Power rods, Power steering
Suspension	Shock absorbers, Strings, Struts
Transaxle	Clutches, Differentials, Transmission
Trim	Carpeting, Head liners, Ornaments
Wheels and Tires	Hubs, Wheels, Tires, Hub Caps

Source: Industrial Development Authority (IDA), 2009; cited in Business Studies and Analysis Center AmCham, 2011

Different companies in Egypt from various sectors (i.e., 56 auto-parts manufacturers) (Egyptian Auto-feeders Association, 2010) supplying/feeding automotive components to automotive manufacturers and the after-sales market with total investments of L.E. 3 billion and offering 60,000 job opportunities (Industrial Modernisation Programme IMC, 2005; Business Studies and Analysis Center, 2011). In general, automotive components production in Egypt amounts for $500,000,000 (Business Studies and Analysis Center, 2011).

Table 5.8. Investments in the automotive feeding industry in Egypt

Field of Investment (thousand US$)	2009	2010
New Production Lines and Facilities	8,850	8,570
New Factories	43,548	25,548
Research and Development	800	200
Improve Material Flow	100	–
Lab Development	930	180
Office Facilities	740	1,030
Tool Design-Making and Training Center	2,000	–
Total	**56,968**	**35,528**

Source: The Egyptian Auto-Feeders Association (EAFA), 2008; cited in Business Studies and Analysis Center AmCham, 2011

One of these automotive suppliers is the German Leoni AG International (i.e., one of the interviewees in the current thesis as 2nd tier automotive supplier) that operates in Egypt and exports cable harnesses (i.e., automotive component) worldwide. According to Business Studies and Analysis Center AmCham (2011), Leoni is the largest manufacturing site worldwide with annual sales of €3 billion that was established in 1997; then in 2006 it expanded into three more factories.

On the other hand, the Egyptian government aims to exploit foreign technical expertise to enhance components exports; thereby, the number of car components plants will continue to increase in Egypt (Business Studies and Analysis Center, 2011). According to the Egyptian Automotive Feeders Association (EAFA), investments in the automotive components industry were planned to reach $35,500,000 by the end of 2010 with 72% of the investments targeting the establishment of new factories (Business Studies and Analysis Center, 2011).

In spite of the obvious growth in the auto-feeding industries over the past few years in Egypt, it has grown at a slower rate than that of the whole automotive supply chain (Business Studies and Analysis Center, 2011). Therefore, the Egyptian government (i.e., Ministry of Trade and Industry) launched the National Suppliers Development Program (NSDP) in association with GM in 2005 for the purpose of supporting the local components industry and helping local suppliers maintain international standards; thus, integrating them into the global ASC (Oxford Business Group, 2011).

GM through this program: (1) suggested an upgrade in production standards among its network of local suppliers; (2) placed these local suppliers on the global network of suppliers; and (3) allowed the supply of Egyptian local parts to other countries. Finally, a total of 20 suppliers were selected under the NSDP, supplying a total of 14 components (Business Studies and Analysis Center, 2011).

Table 5.9. Suppliers under the National Suppliers Development Program (NSDP) in Egypt

Suppliers	Components/Parts
1. Afico	1. Seats
2. AKL	2. Glass
3. Auto Cool	3. Stamping
4. Commercial	4. Structure and Closures
5. Dr .Greiche	5. Painted Planting Parts
6. EEI	6. Carpets
7. Egyptian Axle	7. Audio Systems
8. El Kady	8. HVAC Module
9. EL Teriak	9. Lighting
10. Engin	10. Hoses and Pipes
11. GTI	11. Chassis
12. Fimco	12. Wiring Harnesses
13. Hamenz	13. Fuel Tank
14. ICDI	14. Seat Belts
15. IDACO	
16. Ind. Control	
17. Inde	
18. Misriat	
19. Mobica	
20. Traxx	

Source: Business Studies and Analysis Center, 2011

In summary, if this above-mentioned development program of the local suppliers is effectively and efficiently implemented, Egypt can act as a motivating force for auto-parts manufacturing in the region that successfully meet the international quality-based standards (Business Studies and Analysis Center, 2011).

5.2.2.3.3.b. Imports: CBU and CKD

As mentioned before, vehicles sold in Egypt are either completely built units (CBU) imported from the international market, or completely knocked down units (CKD) assembled by local automotive manufacturers (Business Studies and Analysis Center, 2011). In general, complete vehicles or auto parts can be manufactured in one country and imported by another country, either in the form of CBU (i.e., complete fully assembled imported car) or CKD (i.e., vehicles parts manufactured in the exporting country and assembled in the target/importing country).

According to the Automotive Marketing Information Council (AMIC) (2012a), the CKD sales in YTD 2012 are higher than Year 2011 by 6%; also, the CBU sales in YTD 2012 are higher than 2011 by 15%.

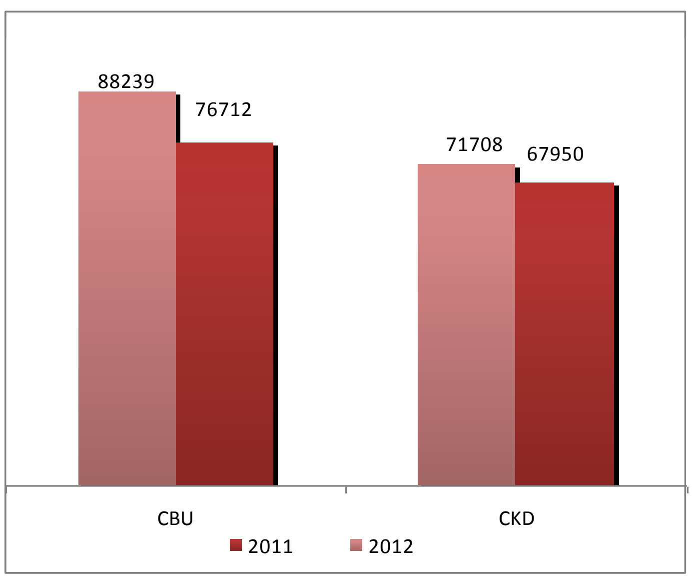


Figure 5.27. Total Automotive Market Volume by Origin (YTD 2011 – YTD 2012)
Source: Automotive Marketing Information Council (AMIC), 2012a

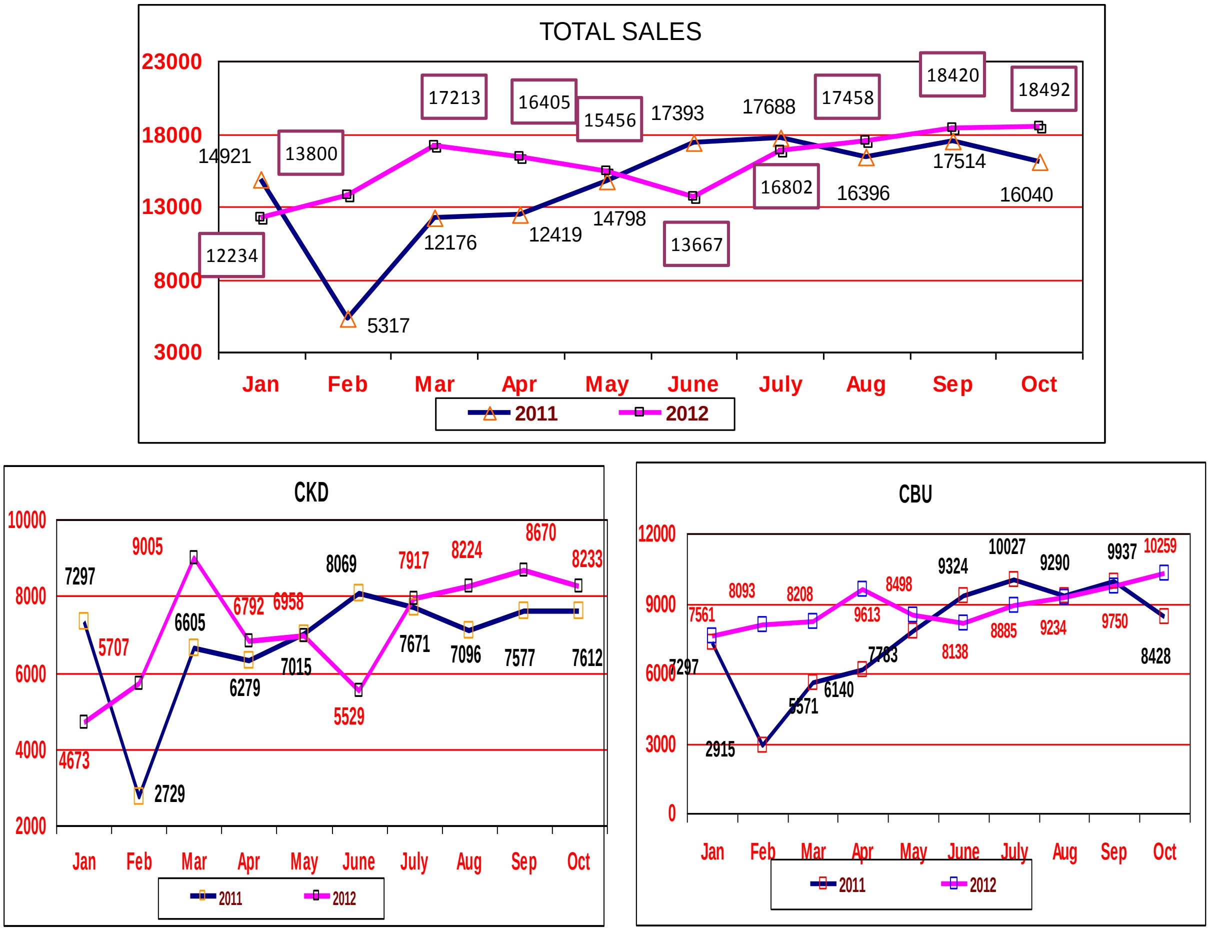


Figure 5.28. Total Automotive Market Seasonality in Volume by Origin (YTD 2011 – YTD 2012)

Source: Automotive Marketing Information Council (AMIC), 2012a

5.2.2.4. SWOT Analysis of Automotive Supply Chains in Egypt

A. Strengths

- Egypt possesses one of the largest automotive markets in the MENA region (Oxford Business Group, 2011).
- The country's unique geographic location that is close to other emerging and developed markets (Business Studies and Analysis Center, 2011).
- The Egyptian automotive industry's competitive advantage arises from the availability of skilled labor with affordable cost compared to its competitors (Business Studies and Analysis Center, 2011).
- The availability of relatively lower cost components suppliers (i.e., regarding some vehicle parts) (Business Studies and Analysis Center, 2011).
- The existence of automotive supply base for many OEMs operating in Egypt (e.g., GM, BMW, and Mercedes) (Business Studies and Analysis Center, 2011). Practically, the obtained findings from the fieldwork of the present study revealed that many automotive companies in Egypt are assembling CVs that contain not less than 70-80% locally manufactured components and each PC/CV manufacturer has its own supply-base, which makes it an attractive emerging market.
- ASCs in Egypt along with the Egyptian government develop programs that facilitate involvement of many producers with multinationals, which improved their automotive production process through installing new machinery and maintain technology transfer processes (Business Studies and Analysis Center, 2011).

B. Weaknesses

- The Egyptian automotive market is small (i.e., not large enough) compared with other developing markets of a similar size (Industrial Modernisation Programme IMC, 2005; Economist Intelligence Unit (EIU), 2012).

- Moving up-stream across the ASC operating in Egypt, the Egyptian automotive components/feeding industry is not fully integrated in the global ASC, as the Egyptian components companies (i.e., automotive local suppliers) sell primarily to vehicle assemblers in Egypt (Industrial Modernisation Programme IMC, 2005).
- Sales are constrained by high vehicles cost due to different reasons; one of these is that the local automotive market is too small to reach the economies of scale required to reduce average production costs (Economist Intelligence Unit, 2012).
- Heavy reliance on imported automotive components (Business Studies and Analysis Center AmCham, 2011).
- Egyptian component companies (i.e., local automotive Suppliers) are dependent on the local market (i.e., automotive Manufacturers operating in Egypt), which is insufficient for them (Industrial Modernisation Programme IMC, 2005).
- Egyptian Automotive Supply Chains (ASCs) are not sufficiently integrated within the global ASCs (e.g., through exports and FDI) (Industrial Modernisation Programme IMC, 2005).
- Limited international competitiveness (i.e., Egyptian ASCs have few sustainable competitive advantages internationally) (Business Studies and Analysis Center AmCham, 2011).
- Some automotive brands provide unsatisfying after-sale services to its customers in Egypt (Business Studies and Analysis Center AmCham, 2011).

C. Opportunities

- Availability of consumer finance (e.g., car loans) that will stimulate automotive demand (Business Studies and Analysis Center AmCham, 2011; Economist Intelligence Unit, 2011b).
- Vehicles replacement schemes (e.g., taxis, buses and potential plans for private cars) to enhance local automotive demand (Business Studies and Analysis Center AmCham, 2011).

- Increased multinationals interest in Egyptian automotive market will create healthy competition in favor of customers (i.e., downstream ASCs in Egypt) (Business Studies and Analysis Center AmCham, 2011) as the MENA Region is an attractive vehicle market for international automobile companies (Industrial Modernisation Programme IMC, 2005).
- The existence of original equipment manufacturers (OEMs) (i.e., upstream ASC) that assume ownership of their Egyptian operations and invest in its modernization and expansion (Industrial Modernisation Programme IMC, 2005).
- Potential growth in regional demand for buses assembled in Egypt (Industrial Modernisation Programme IMC, 2005).
- Variety of trade agreements that will further lower export duties (Business Studies and Analysis Center, 2011). Thus, encouraging Egyptian auto-component companies (i.e., upstream ASC feeding industry) to: (1) realize new sources of revenue through exports, (2) reach the economies of scale required to reduce average production costs, and (3) be able to survive and expand (Industrial Modernisation Programme IMC, 2005).
- Increased interest of budget automotive manufacturers (e.g., Chinese and Indian producers) in the Egyptian automotive market that suit large portion of local customers (Business Studies and Analysis Center, 2011; Business Monitor International BMI, 2012b).

D. Threats

- Reduced tariffs on imported components increase the pressure on local manufacturers (Business Studies and Analysis Center, 2011), who have to balance the tradeoff between lower cost imported components and local components/contents government regulations. In this case, it will be cheaper to import some automotive components than to buy them locally (Industrial Modernisation Programme IMC, 2005).

- Greater competition between oversees and local suppliers will force many automotive component companies in Egypt to loss considerable business (Industrial Modernisation Programme IMC, 2005).
- Foreign exchange fluctuations will have unfavorable impact on automotive assemblers in Egypt (Business Studies and Analysis Center, 2011).
- Increasing fuel prices negatively impact the car sales in general and especially the size preferences (i.e., large cars) (Business Studies and Analysis Center, 2011).
- Expensive fees of vehicle registration for large engine capacity cars negatively affect its purchase (i.e., reduce its potential demand) (Economist Intelligence Unit, 2011a; Business Studies and Analysis Center, 2011).
- Large portion of Egypt's population still can't afford vehicle ownership (Business Studies and Analysis Center, 2011).
- The automotive industry in Egypt suffers from stochastic demand (Industrial Modernisation Programme IMC, 2005).
- The existence of other emerging automotive markets in the region that succeeded in attracting foreign investment of different OEMs (Industrial Modernisation Programme IMC, 2005).
- Many high-end consumers do prefer imports (i.e., CBUs) rather than locally assembled vehicles (Business Studies and Analysis Center, 2011).

These abovementioned external and internal factors (i.e., opportunities, threats, strengths, and weaknesses), which have been detected throughout the prior research literature and the current research fieldwork are found to be positively/negatively affecting the hybrid lean-agile performance of the AISC in Egypt.

Thus, the findings of this thesis have different implications and suggested strategies for the supply chain managers of each sub-sector in the automotive industry in Egypt, which will be thoroughly discussed in chapter eight.

Figure 5.29. SWOT Analysis of Automotive Supply Chains in Egypt

STRENGTHS

- Egypt possesses one of the largest automotive markets in the MENA region (Oxford Business Group, 2011).
- The country's unique geographic location that is close to other emerging and developed markets (Business Studies and Analysis Center, 2011).
- The Egyptian automotive industry's competitive advantage arises from the availability of skilled labor with affordable cost compared to its competitors (Business Studies and Analysis Center, 2011).
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- The existence of automotive supply base for many OEMs operating in Egypt (e.g., GM, BMW, and Mercedes) (Business Studies and Analysis Center, 2011). Practically, the obtained findings from the fieldwork of the present study revealed that many automotive companies in Egypt are assembling CVs that contain not less than 70-80% locally manufactured components and each PC/CV manufacturer has its own supply-base, which makes it an attractive emerging market.
- ASCs in Egypt along with the Egyptian government develop programs that facilitate involvement of many producers with multinationals, which improved their automotive production process through installing new machinery and maintain technology transfer processes (Business Studies and Analysis Center, 2011).

WEAKNESSES

- The Egyptian automotive market is small (i.e., not large enough) compared with other developing markets of a similar size (Industrial Modernisation Programme IMC, 2005; Economist Intelligence Unit (EIU), 2012).
- Moving up-stream across the ASC operating in Egypt, the Egyptian automotive components/feeding industry is not fully integrated in the global ASC, as the Egyptian components companies (i.e., automotive local suppliers) sell primarily to vehicle assemblers in Egypt (Industrial Modernisation Programme IMC, 2005).
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- Egyptian component companies (i.e., local automotive Suppliers) are dependent on the local market (i.e., automotive Manufacturers operating in Egypt), which is insufficient for them (Industrial Modernisation Programme IMC, 2005).
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- Limited international competitiveness (i.e., Egyptian ASCs have few sustainable competitive advantages internationally) (Business Studies and Analysis Center AmCham, 2011).
- Some automotive brands provide unsatisfying after-sale services to its customers in Egypt (Business Studies and Analysis Center AmCham, 2011).

OPPORTUNITIES

- Availability of consumer finance (e.g., car loans) that will stimulate automotive demand (Business Studies and Analysis Center AmCham, 2011).
- Vehicles replacement schemes (e.g., taxis, buses and potential plans for private cars) to enhance local automotive demand (Business Studies and Analysis Center AmCham, 2011).
- Increased multinationals interest in Egyptian automotive market will create healthy competition in favor of customers (i.e., downstream ASCs in Egypt) (BSAC, 2011) as the MENA Region is an attractive vehicle market for international automobile companies (Industrial Modernisation Programme IMC, 2005).
- The existence of original equipment manufacturers (OEMs) (i.e., upstream ASC) that assume ownership of their Egyptian operations and invest in its modernization and expansion (Industrial Modernisation Programme IMC, 2005).
- Potential growth in regional demand for buses assembled in Egypt (Industrial Modernisation Programme IMC, 2005).
- Variety of trade agreements that will further lower export duties (Business Studies and Analysis Center, 2011). Thus, encouraging Egyptian auto-component companies (i.e., upstream ASC feeding industry) to: (1) realize new sources of revenue through exports, (2) reach the economies of scale required to reduce average production costs, and (3) be able to survive and expand (Industrial Modernisation Programme, 2005).
- Increased interest of budget automotive manufacturers (e.g., Chinese and Indian producers) in the Egyptian automotive market that suit large portion of local customers (Business Studies and Analysis Center, 2011).

THREATS

- Reduced tariffs on imported components increase the pressure on local manufacturers (Business Studies and Analysis Center, 2011), who have to balance the tradeoff between lower cost imported components and local components/contents government regulations. In this case, it will be cheaper to import some automotive components than to buy them locally (Industrial Modernisation Programme IMC, 2005).
- Greater competition between oversees and local suppliers will force many automotive component companies in Egypt to loss considerable business (Industrial Modernisation Programme IMC, 2005).
- Foreign exchange fluctuations will have unfavorable impact on automotive assemblers in Egypt (Business Studies and Analysis Center, 2011).
- Increasing fuel prices negatively impact the car sales in general and especially the size preferences (i.e., large cars) (Business Studies and Analysis Center, 2011).
- Expensive fees of vehicle registration for large engine capacity cars negatively affect its purchase (i.e., reduce its potential demand) (Business Studies and Analysis Center, 2011).
- Large portion of Egypt's population still can't afford vehicle ownership (Business Studies and Analysis Center, 2011).
- The automotive industry in Egypt suffers from stochastic demand (Industrial Modernisation Programme IMC, 2005).
- The existence of other emerging automotive markets in the region that succeeded in attracting foreign investment of different OEMs (Industrial Modernisation Programme IMC, 2005).
- Many High-end consumers do prefer imports (i.e., CBUs) rather than locally assembled vehicles (Business Studies and Analysis Center, 2011).

5.2.2.5. Automotive Supply Chain Management Challenges and Critical Success Factors

Many authors and researchers pinpointed the main challenges and obstacles that face automotive SC players/nodes while managing their supply chains. At the same time, other studies pointed out the critical factors that are crucial for supply chain management success. Based on reviewing the prior SCM literature and conducting in-depth interviews with leaders, managers and specialists that are empowered and responsible for SCM of different automotive companies operating in Egypt, the main SCM challenges and key success factors were identified as follows:

Table 5.10. Automotive SCM challenges and critical success factors

Automotive SCM Challenges	**SCM Critical Success Factors**
1. Managing a large pool of different automotive models and auto-parts (i.e., broad range of auto products/components) −driven by the intensified competition in automotive industry− represent a key challenge in ASCM. At the same time, reduced automotive PLC and the accelerated need for new product development requires effective and efficient management of different auto-spare parts, as well as common components, for both the new and discontinued earlier models (Balanced Scorecard in Automotive SCM for Maruti Suzuki, 2011). This challenge was obviously revealed throughout the conducted in-depth interviews for the current thesis.	1. Implementing information and communication technology (ICT) is considered by Rao *et al.* (2006) as a crucial strategic and operational success factor in SCM as it acts as a facilitator for effective and efficient SCI and IS both within each individual SC node and across different partners. Practically, ICT enables the development of an efficient, responsive, fast and flexible system, which links various SC stakeholders/parties as one integrated entity and coordinates all their performed activities in a seamless manner that overcomes time, physical and geographical boundaries (Kim and Im, 2002; Rao *et al.*, 2006). Practically speaking, the Supply Chain Manager (i.e., one of the interviewees with whom the researcher conducted an in-depth interview) of one of the automotive companies operating in Egypt said: “We use technology intelligence to be aware of the new and most suitable ICT packages that we can use (e.g., ERP). TI has a positive impact on updating our used technologies. Additionally, it

	does affect positively our communication with our suppliers and customers and facilitate our internal cross-functional coordination; thus, improving the performance of our entire SC".
2. The automotive industry is characterized by having a long and hierarchical supply chain that consists of multiple nodes and stakeholders (Kim and Im, 2002). Thus, one challenge of successful ASCM is integrating various automotive supply chain nodes (i.e., end-to-end SCI; up- and down-stream SCI), and managing different tiers of players as a single coordinated entity (Balanced Scorecard in Automotive SCM for Maruti Suzuki, 2011).	2. Level and quality of information sharing are required to improve overall SC performance (Li *et al.*, 2006). In a similar vein, information sharing (IS) was viewed by Koçoglu *et al.* (2011) as the mutual information-based exchanges between different SC players through using inter- and intra-organizational linkages, which acts as a key driver of effective and efficient SCM. Additionally, shared information should include not only cost information but also demand and forecast information, which provides SC nodes an opportunity to establish a sustainable competitive advantage through mutually beneficial efforts. Thus, effective and efficient information sharing enables streamlining the SC flow of materials, reducing the levels of inventory along the entire SC, replacing speculation and inaccurate IS, which in turn will enhance efficient SCM (Rao *et al.*, 2006). However, as for security purposes, each SC participant/node should have limited access according to the required information for carrying out its own role (Rao *et al.*, 2006).
3. Such an industry is a heterogeneous one that comprises different sub-sectors (i.e., auto-feeding industry, automotive MFG industry and CBUs market) (Business Studies and Analysis Center, 2011) and each one has its own SC with multiple nodes. In this way, sustaining up-stream SCI with multiple tiers of suppliers operating in different industries (e.g., glass, aluminum, textiles, rubber, plastics, and paints and coating) represent another challenge for automotive manufacturers (Business	3. Building long term customer-supplier relationships through conducting collaborative partnerships between various SC nodes, and maximizing the long-term performance of each partner in the supply chain (Rao *et al.*, 2006). Similarly, Li *et al.*, (2006) pointed out that strategic supplier partnership and long-term customer relationship are very crucial for effective and efficient SCM. Practically speaking in various Egyptian ASCs, as being identified by the Industrial Modernisation Programme IMC (2005) and verified throughout the current thesis qualitative interviews, the concerted effort

Studies and Analysis Center, 2011).	and collaboration among all supply chain stakeholders is considered as a critical SC success factor. Accordingly, this research focused on assessing the SCI especially down-stream SCI established −between automotive and higher education institutions− through universities-industries partnerships, which can improve the overall performance of both SCs.
4. Implementing the lean practices of automotive SCM (i.e., managing SC costs, achieving efficient use of materials and other resources, and removing/minimizing different types of wastes) (Balanced Scorecard in Automotive SCM for Maruti Suzuki, 2011). Based on the findings of this thesis, lean automotive SCP was found to be an important aspect of assessing hybrid SCP.	4. Flexibility (i.e., one dimension of agile SCP) and postponement (i.e., one aspect of leagile SCP) are considered as CSFs of SCM. As pinpointed by Rao *et al.* (2006), flexibility is another success factor to realizing effective relationships of the entire supply chain network. Flexibility can be defined as the ability of an organization/supply chain to efficiently and effectively adapt to customers/market changes (Rao *et al.*, 2006). While postponement was defined as the practice of delaying one or more operations/activities to a later point along the entire supply chain (Li *et al.*, 2006). Stated another way, postponement increases the ability of a supply chain in customizing different versions of the product according to changing customer needs (Li *et al.*, 2006). In a similar vein, Al-Turki *et al.*, (2008) discussed that late differentiation is a strategy in which a product remains in an incomplete generic form; then being finalized after receiving the customer order according to his/her specifications.
5. Another key SCM obstacle lies in the continuous need to effectively and efficiently manage/bridge the detected supply-demand gap in the automotive market (Balanced Scorecard in Automotive SCM for Maruti Suzuki, 2011).	5. Identifying performance measurements is an additional CSF of SCM. As argued by Rao *et al.* (2006), formulating and implementing plans related to the above-mentioned strategic and operational success factors is necessary. Similarly, developing performance measures for assessing the implementation of such factors has the same level of importance (Rao *et al.*, 2006). The sustainability of a better supplier-customer relationship depends on having

	reliable measures of performance at the organizational and SC levels (Rao *et al.*, 2006) (i.e., for each partner and the entire SC). Moreover, such organizational/SCP measures should be well-defined, assessable and periodically monitored (Rao *et al.*, 2006). Furthermore, performance measures facilitate problem solving efforts (Rao *et al.*, 2006) and open multiple rooms for potential improvements. Hence, the researcher in this thesis used – as shown in chapter Four and Seven− a multi-item measurement scale in order to measure, then suggest for improvement the effectiveness/efficiency of hybrid SCP carried out by different automotive and higher educational institutions in Egypt that serve as examples of manufacturing and service SCP.
6. Exceeding down-stream ASC customers' expectations (Balanced Scorecard in Automotive SCM for Maruti Suzuki, 2011).	6. High level of support and commitment of all supply chain stakeholders/participants (Industrial Modernisation Programme IMC, 2005).
7. Achieving the required levels of agility and leagility aspects of automotive SCP. Another key SCM challenge arises from the accelerated need to incentivize up-stream and down-stream SC members (i.e., oversees/local suppliers and distributors) to update their operations in order to cope with ever-changing customer needs (Balanced Scorecard in Automotive SCM for Maruti Suzuki, 2011).	7. Leadership, dedicated resources and empowerment (Industrial Modernisation Programme IMC, 2005).
8. Inbound logistics management and practical application of the JIT approach are considered as important SCM challenges especially for both automotive and auto-parts manufacturers, which requires timely, valid and reliable SCIS (Balanced Scorecard in Automotive SCM for Maruti Suzuki, 2011).	8. Effective and efficient planning, implementation and evaluation of SCM practices (Industrial Modernisation Programme IMC, 2005).

5.3. Essential Similarities and Key Differences between Global and Egyptian ASC

According to the Industrial Modernisation Programme conducted by the Industrial Modernization Center (IMC) (2005), there are similar characteristics and key differences between ASC operating in Egypt and global ASC, which can be summarized as follows:

Table 5.11. Similar Characteristics and Key Differences between Egyptian and Global ASC

<table>
<tr><th>Similar Characteristics</th><th>Key Differences</th></tr>
<tr><td rowspan="2">1. The automotive industry supply chain (AISC) is long and hierarchical, and its main product (i.e., car) involves around 20,000 parts (Kim and Im, 2002). Kim and Im (2002) defined the hierarchical supply chain as the one that has many tiers of suppliers (i.e., the producer out-sources main auto-components (e.g. exhaust systems, doors and carpets) from the first tier suppliers, who out-source the sub-parts (e.g., wires and cables) from the second and third tier suppliers).
One of the main sub-sectors of the automotive industry in Egypt is the auto-feeding industry and each vehicle manufacturer/assembler has its own supply-base (e.g., GM in Egypt has its own component supply base).</td><td>1. In fact, Egypt's automotive market is mainly based on the vehicle assembly (Economist Intelligence Unit, 2010a; 2010b; Business Studies and Analysis Center, 2011; Oxford Business Group, 2011).</td></tr>
<tr><td>2. The Egyptian automotive market is not large enough (i.e., relatively small to reach the economies of scale required to reduce average production costs) to incentivize more global automotive OEMs that it does worth investing in Egypt (Industrial Modernisation Programme IMC, 2005; Economist Intelligence Unit, 2009a; 2009b; 2012). Thereby, we have low automotive FDI compared to other developed markets (Industrial Modernisation Programme IMC, 2005).</td></tr>
<tr><td>2. In addition to being hierarchical and heterogeneous, Huang et al. (2002) and Turner and Williams (2005) indicated that the automotive industry supply chain (AISC) is a hybrid SC (i.e., it can be barely considered as either absolute efficient/lean or responsive/agile SC) that generates a hybrid product (e.g., vehicle) as it comprises a mixture of standard and innovative</td><td>3. Moving down-stream across the Egyptian ASC market, there is a low, yet increasing, demand and comparatively low purchasing power. This is because large portion of Egypt's population still can’t afford vehicle ownership (Industrial Modernisation Programme IMC, 2005).</td></tr>
</table>

components produced via different industries. In this way, the need for a hybrid lean-agile automotive SCM is justified and can be detected in the literature of contemporary SCM. Therefore, the researcher in this thesis was motivated to empirically investigate the direct/indirect effect of ICT on hybrid lean-agile SCP in terms of leanness, agility and leagility.	4. The existence of relatively few international players along the ASC operating in Egypt has led to limited linkages/integration within the global ASC (Industrial Modernisation Programme IMC, 2005).
3. As shown earlier in this chapter in figure 5.5, the Egyptian automotive industry SC possesses different tangible and intangible SC flows (e.g., information, HR, materials and product) that runs up along the backbone (i.e., supply chain) of the automotive industry in Egypt.	5. The Egyptian ASC mainly targets the local market (i.e., limited vehicles/auto-components exports) compared to other countries' ASCs −of similar automotive market size− that target the global automotive market (i.e., operates locally with little attention to the global automotive market) (Industrial Modernisation Programme IMC, 2005).
	6. The Egyptian ASC players don't place huge automotive R&D investments as much as the global ASCs do (Industrial Modernisation Programme IMC, 2005). Thus, the automotive local vehicle/auto-parts manufacturers in Egypt act as technology/market followers rather than leaders.

5.4. Conclusion

As for this chosen context of the current research, many reasons lie behind the selection of the Egyptian automotive emerging market that serves as an example of the manufacturing industries.

First, the automotive industry is characterized by having a long and hierarchical supply chain that consists of multiple nodes and many tiers of suppliers (Kim and Im, 2002), which justifies the need for effective and efficient SCM. As a result, many researchers (e.g., Uttamrao and Rajashree, 2009; Xia and Tang, 2011) pointed out that managing supply chains efficiently and effectively in the automotive industry represents a challenge for auto-parts/automobile companies that seek a sustainable competitive advantage in the global market.

Second, in addition to being hierarchical, Huang *et al.* (2002) and Turner and Williams (2005) indicated that the automotive industry supply chain (AISC) is a hybrid SC (i.e., it can be barely considered as either absolute efficient or responsive SC) that generates a hybrid product (e.g., vehicle) as it comprises a mixture of standard and innovative components produced via different industries. In this way, the need for a hybrid lean-agile automotive SCM is justified and can be detected in the literature of contemporary SCM.

Third, many academics and practitioners have studied supply chain technology (SCT) and SCM as being independent rather than interdependent fields, and very few have realized the importance of their integration, especially in the automotive sector (Kamaruddin and Udin, 2009).

Fourth, despite the abundance of research on different developed manufacturing sectors, the automotive emerging markets remain unexplored context of contemporary SCM research, especially those addressing the empirical issue of the applicability of hybrid lean-agile SC strategy.

Fifth, such an industry in Egypt is a heterogeneous industry that comprises three main sub-sectors and each one has its own SC with multiple nodes. Besides, Egypt possesses one of the largest automotive markets in the MENA region (Oxford Business Group, 2011). Additionally, it was found by different OEMs as an attractive pool for their investments (Business Studies and

Analysis Center, 2011). Hence, the Egyptian automotive emerging market was viewed to be an attractive context by the researcher.

Thus, as one of the current research contributions, the researcher illustrated in Figure 5.5 the Egyptian automotive industry SC, including its main players and three sub-sectors; namely (a) Egyptian auto-feeding industry (EAFI), (b) Egyptian automotive manufacturing (EAM), and (c) Completely built units (CBU) market.

As far as the researcher knows, this is the first study that maps the Egyptian automotive industry SC in order to depict a holistic view of the nature of this important industry in an emerging market, which serves as an example of an interesting yet uninvestigated context of contemporary SCM research. In an interdependent manner, this study draws its main players and sub-sectors, based on the qualitative analysis of the collected data throughout 94 conducted in-depth interviews within 89 different organizations in Egypt (i.e., 89 interviews within 84 auto-parts/automotive companies + 5 interviews within 5 educational institutions and research centers supplying these automotive companies with information/HR).

Based on the qualitative and quantitative data analysis for the current study and as being revealed within Table 5.10 and 5.11 throughout the prior research literature, different external and internal factors (i.e., opportunities, threats, strengths, and weaknesses) have been detected and found to be positively and negatively affecting the AISC in Egypt.

One of the detected weaknesses that is related to such an important industry in Egypt is that the Egyptian component companies (i.e., local automotive Suppliers) are not sufficiently enhancing their SCP to cope with the continuous SCM improvements carried out by many automotive manufacturers in Egypt.

On the other side, the fieldwork conducted for this study verifies the positive performed role by different automotive manufacturers (e.g., GM, BMW, and Mercedes-Benz) to provide technical and managerial support to their own supply-bases (i.e., up-stream SCI with local auto-components manufacturers), which makes it an attractive emerging market.

For example, one of these above-mentioned manufacturers is the Bavarian Auto Manufacturing Company in Egypt (i.e., Bavarian Auto Group (BAG)), which is one of the respondents in the current research. Figure 5.30 illustrates its planning and control process that is carried out by its supply chain management department, which was found to be performing its operations in an effective systematic manner and integrating its processes with its upstream and downstream stakeholders in an interdependent way.

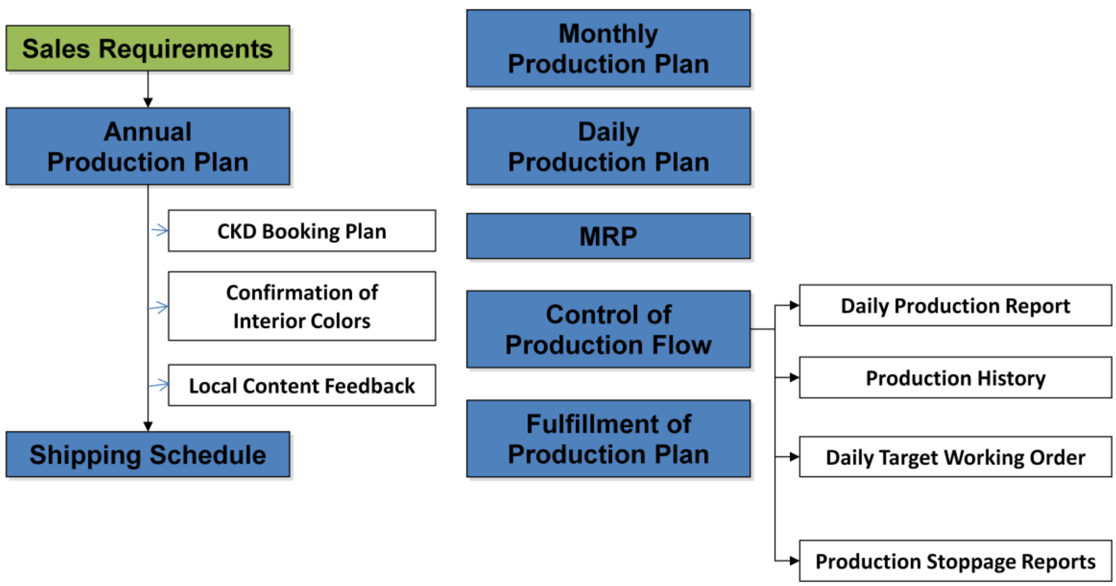


Figure 5.30. BAG-BMW Supply Chain Department Planning and Control in Egypt
Source: Supply Chain Management Department (BAG-BMW in Egypt), 2013

Consequently, the findings of this thesis have different implications for the supply chain managers of each sub-sector in the automotive industry in Egypt, which will be thoroughly discussed in chapter eight. One of these recommendations is that the Egyptian auto-feeding industry (i.e., auto-parts suppliers in the first sub-sector upstream the AISC) are advised to devote more resources towards improving their inter-organizational technologies, which will facilitate their SCIS and promote their LSCP and LEAGSCP.

CHAPTER SIX

Higher Education in Egypt: Using SCM Approach to Bridge the Gap between Academia and Industry

(Successful Global and National Education SCM Practices-Qualitative Analysis)

6.1. Introduction

Regarding the higher education sector in Egypt, two main gaps/research problems were detected related to:

(1) HR supply and demand: the existing gap between job market qualifications demand (JMQD) and education market qualifications supply (EMQS) (Al-Turki *et al.*, 2008; Kargaev, 2008; Abd-Elall *et al.*, 2011; Varma, 2012), which emerges from the information invisibility (i.e., absence of information synchronization and information sharing) that harms the ESC performance as SCIS is key but difficult to achieve in the education sector.

(2) Research supply and demand: the current weakness in the universities-industries research relationships (Geiger and Sá, 2005) related to different industries (i.e., linkage between contemporary theories and successful practices).

Moreover, many of the stakeholders/participants/nodes (e.g., schools, HEIs, job market/employers) of the higher education supply chains (HESCs) operating in Egypt are acting in their own best individual interests without considering the effectiveness and efficiency of the whole SC, which contributes to creating many problems in different sectors in Egypt.

Therefore, the researcher empirically studied the direct and indirect ICT-HSCP relationship via SCM (i.e., SCI and SCIS) and TI in the Egyptian higher education context (i.e., namely universities and academies). Thus, adding to the contemporary SCM research literature that addresses bridging the gap between HR/research supply and demand through better higher education supply chain management (HESCM).

Accordingly, the researcher used the triangulation approach in collecting qualitative and quantitative data to empirically investigate the research problem and proposed relationships, then developed a suggested HE SCM model (as shown in Figure 6.25) to bridge the detected gap between HR/research supply and demand.

The main sources of the quantitative and qualitative collected data for investigating the research problem are:

(1) Questionnaires: 41 HEIs accepted to participate, resulting in a response rate of 65.08%;

(2) Depth-interviews: 71 interviews with SMEs in 43 educational institutions at 15 governorates;

(3) Forums: participated in conducting three collaborative semi-structured forums at The American University in Cairo (AUC) with different SC academics and industry specialists from 15 different MFG/service organizations and HEIs;

(4) Conferences: attended and presented at two conferences –as mentioned before in chapter four− discussing linking the education market with the job market, and received valuable feedback from SMEs attending these conferences through presentations questions, discussions and participating in its workshops;

(5) Experimental case study: participated in applying different education SCM practices to MSA University (i.e., HEI operating in Egypt that accepted to participate in this experiment and where the researcher works) for the purpose of maintaining up-stream and down-stream ESC integration with its stakeholders (e.g., schools, employers, MFG and service organizations).

Consequently, the HEIs and research centers operating in Egypt are recommended by the researcher –as will be shown in chapter eight− to conduct effective and efficient education SCM (i.e., managing SC flow of HR) and collaborative research (i.e., managing SC flow of information/research) through universities-industries partnerships, based on:

(a) Following the studies of Lau (2007), Al-Turki *et al.* (2008), Kargaev (2008), Habib and Jungthirapanich (2008, 2009a, 2009b), Ang *et al.* (2010) and Abd-Elall *et al.* (2011) that discussed the importance of applying the SCM approach to the educational institutions and pioneered the ESCM stream line of research;

(b) The findings of the qualitative and quantitative data analysis of the current research (i.e., as will be shown in chapter six and seven); and

(c) The successful global and national SCM practices implemented in the higher educational sector and discussed throughout chapter three and six.

This way, the researcher added −by conducting this study− to the few detected attempts in the contemporary SCM research literature, which considers education management (EMgt) and SCM as interdependent areas of research. Moreover, according to the researcher's knowledge and as far as the literature has been investigated, this research pioneers the empirical investigation of the direct and indirect ICT/TI-SCM-HSCP relationship in the higher education market.

Accordingly, this chapter provides a background on the nature of the higher education sector in Egypt. It discusses various successful local and global SCM practices implemented in different HEIs operating in Egypt as well as abroad. Hence, this research can provide practical examples of using SCM approach to bridge the gap between academia and industry; thus, linking different higher education SC stakeholders together. Finally, it develops a new higher education SCM model and recommends its usage for improving the HSCP of HEIs operating in Egypt.

6.2. Higher Education System and its Supply Chain in Egypt

Despite being a "cradle of civilization", Egypt became a consumer rather than a producer of technology (The Egyptian Center for the Advancement of Science, Technology and Innovation, 2014). The opportunity of sustaining a strong economy can be seized through innovation in science and arts, which can't be achieved without quality-based education and technology-based research (The Egyptian Center for the Advancement of Science, Technology and Innovation, 2014). Hence, the role of education in Egypt, especially higher education, is vital for building the future of Egypt (Oxford Business Group, 2012).

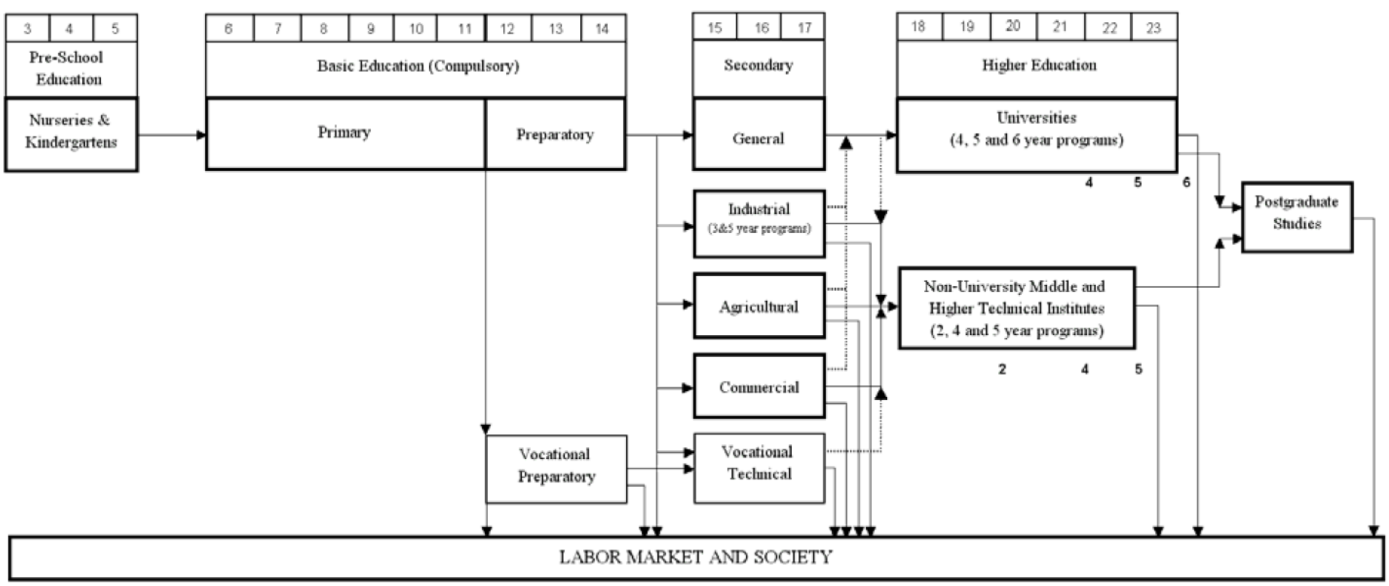


Figure 6.1. The education system in Egypt (2001) by level and age

Source: Projects Implementation Unit MHE, 2001;
The International Bureau of Education UNESCO, 2006;
Strategic Planning Unit MHE, 2008

According to Oxford Business Group (2012), there is a detected development at the primary and secondary education carried out by the ministry of education, in addition to the escalating growth in private education. However, Egypt is witnessing more favorable changes and improvements in its university education (Oxford Business Group, 2012). For this reason, in addition to the location of university education service providers at the centre of the ESC supplying its stakeholders with education and research as will be discussed later in this chapter, the researcher has chosen these HEIs –universities and academies– for the current study's empirical investigation.

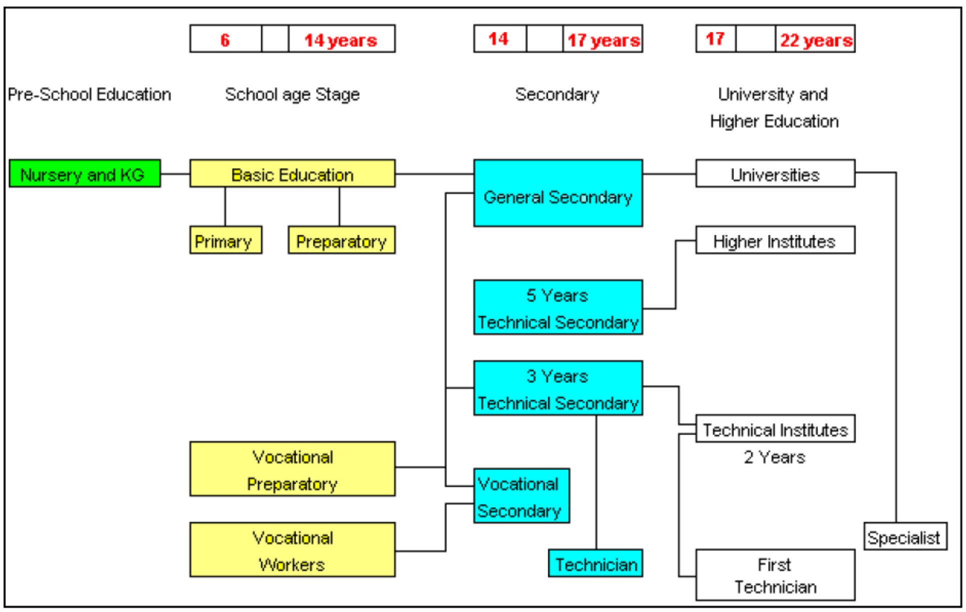


Figure 6.2. The education system in Egypt (1998) without including the labor market and the society as its stakeholders

Source: The International Bureau of Education UNESCO, 2006

Higher education in Egypt, which includes university and non-university higher education; namely higher and middle technical specialized institutes, is supplied by students that spent 12 years of formal education (i.e., basic and secondary education) (Projects Implementation Unit MHE, 2001; The International Bureau of Education UNESCO, 2006; Strategic Planning Unit MHE, 2008; Education, Audiovisual and Culture Executive Agency EU and National Tempus Office in Egypt, 2012). HEIs are managed by the Ministry of Higher Education (MHE), whereas the other educational institutions that offer basic and secondary education and act as their primary suppliers of HR are managed by the Ministry of Education (Oxford Business Group, 2012). Moreover, there is a separate Ministry for Scientific Research in Egypt. In this way, higher education and research will receive greater attention; thus, being more able to promote the required innovation in the country.

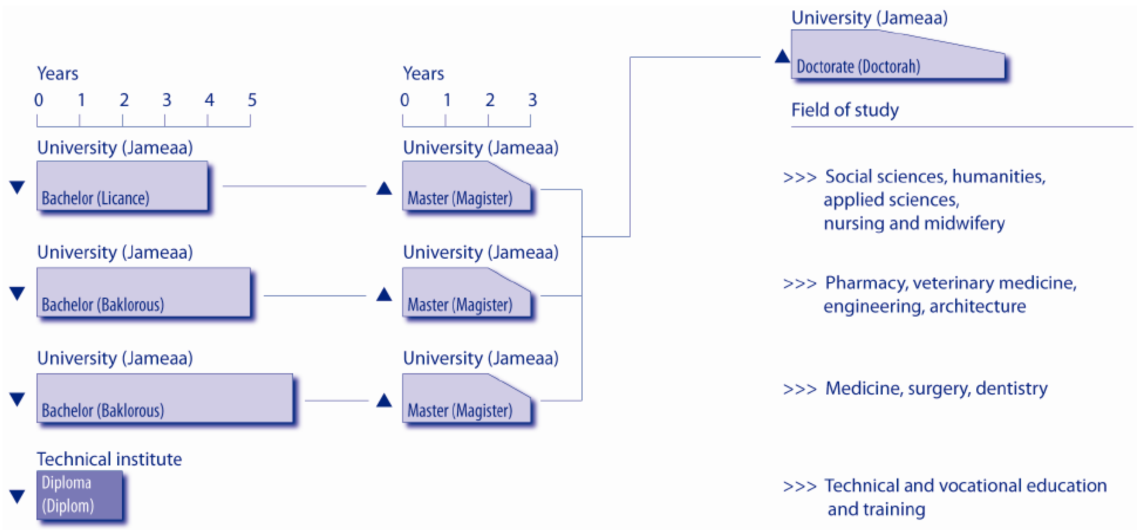


Figure 6.3. Higher education system in Egypt by program and field of study

Source: Education, Audiovisual and Culture Executive Agency EU and National Tempus Office in Egypt, 2012

There are 63 higher education institutions (HEIs) –universities and academies– operating in Egypt (i.e. 63 HEIs: 25 public universities, 23 private universities and 15 academies) (National Information Center (NIC) at the Central Agency for Public Mobilization and Statistics (CAPMAS), 2011a; 2011b; 2011c; 2012b; 2012c; 2014; Ministry of Higher Education (MHE), 2008; 2012; 2014; Egyptian Supreme Council of Universities (ESCU), 2012; Statistics Department at the Research Center of University Education Development at the ESCU, 2014).

After combining the contents of these aforementioned references together and removing any repetition, shutdowns and discontinued operations, the researcher developed a new up-dated list of 25 public universities (of which 15 responded/accepted to participate in the current study, 60% response rate), 23 private universities (of which 17 responded, 73.91% response rate), and 15 academies (of which 9 responded, 60% response rate).

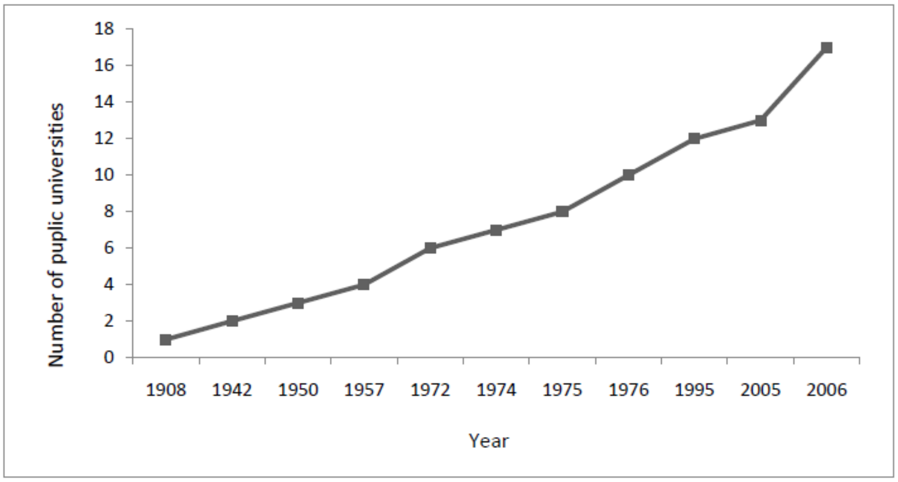


Figure 6.4. Number of public universities in Egypt is increasing from 1908 till 2006

Source: Strategic Planning Unit MHE, 2008

According to a report (Strategic Planning Unit, 2008) about the higher education in Egypt published by the Strategic Planning Unit at the Egyptian Ministry of Higher Education (MHE), the number of public and private universities is increasing so that university education can be easily available to greater number of students all over Egypt; thus, satisfying the demand growth for higher education.

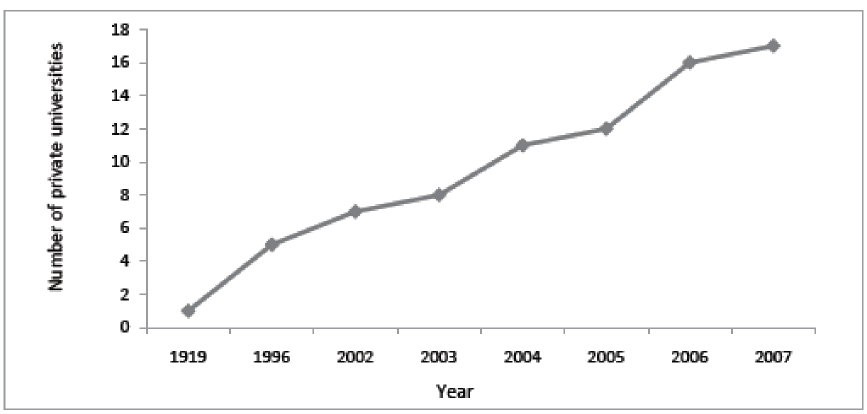


Figure 6.5. Number of private universities in Egypt is increasing from 1919 till 2007

Source: Strategic Planning Unit MHE, 2008

There are three main roles for universities in Egypt while acting as the higher educational service providers that supply their societies with: (a) education (i.e., for under- and post-graduate students), (b) community-based services (i.e., university-industry-community relationship), and (c) research that is conducted primarily at its institutions and research centers (Education, Audiovisual and Culture Executive Agency EU and National Tempus Office in Egypt, 2012).

Table 6.1. HEIs in Egypt with the highest TEMPUS participation throughout TEMPUS IV (2008-2012)

Institutions	Total	Number of projects JP*	Number of projects SM **
Alexandria University	14	14	0
Ain Shams University (Cairo)	13	12	1
Helwan University	10	10	0
Cairo University	8	8	0
Assiut University	5	5	0
Suez Canal University	5	5	0
American University in Cairo	4	4	0
El Zagazig University	4	4	0
El Mansoura University	3	3	0

* Joint Projects ** Structural Measures

Source: Education, Audiovisual and Culture Executive Agency EU
and National Tempus Office in Egypt, 2012

Regarding the horizontal SC integration of different HEIs together, Tempus acts as a facilitator for horizontal inter- and intra-ESCI. It is a program conducted by the European Union in order to support and incentivize the innovation of higher education across the participating countries (e.g., Eastern Europe, Mediterranean region, and central Asia) via cooperation projects among universities (Education, Audiovisual and Culture Executive Agency EU and National Tempus Office in Egypt, 2006; 2012).

The importance of this program and the fruitful output of its projects were revealed throughout the conducted in-depth interviews with SMEs in various HEIs operating in Egypt.

Table 6.2. Digital databases accessible to public universities as a result of HEEP

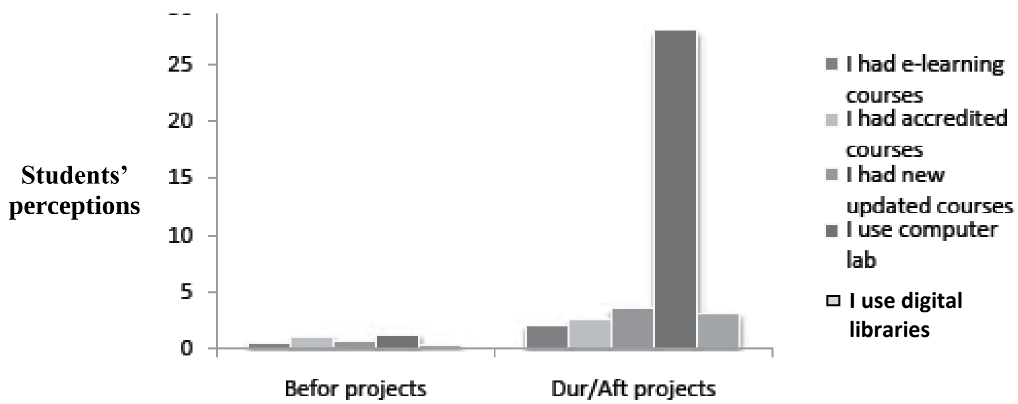
Knowledge Resources		
Description	No of Item	Source
Fulltext -Dissertations & Theses	2.4 million	Proquest
Fulltext journal - e-book	5120	Springer Link
Fulltext journal	2000	Science Direct
Fulltext journal - Abstract	10,000	ASC
Fulltext journal	500	LISTA
Fulltext journal	4,800	MEDLINE
Fulltext journal - Abstract	388,700	GreenFILE
Fulltext journal	1,243,000	ERIC
Fulltext journal-Abstract-patent abstract	13,014,050	Scopus
Fulltext journal - title	500	Wilson Humanities
Fulltext journal	128	IEEE

Source: Strategic Planning Unit MHE, 2008

In regard to other SCM practices applied in relation to the higher educational reform programs in Egypt, the Strategic Planning Unit (2008) at the Ministry of Higher Education revealed that one of the main objectives of the higher education enhancement project (HEEP) is to encourage the usage of ICT and blended and/or e-learning techniques at universities.

As was discussed before in chapter three, ICT can act as a facilitator for improving the educational SCI, SCIS and SCP, which can benefit HEIs in Egypt to sustain their inter- and intra-linkages with its different stakeholders (e.g., students, staff, job market and community in large) as will be elaborated throughout the rest of the chapter.

(a)



(b)

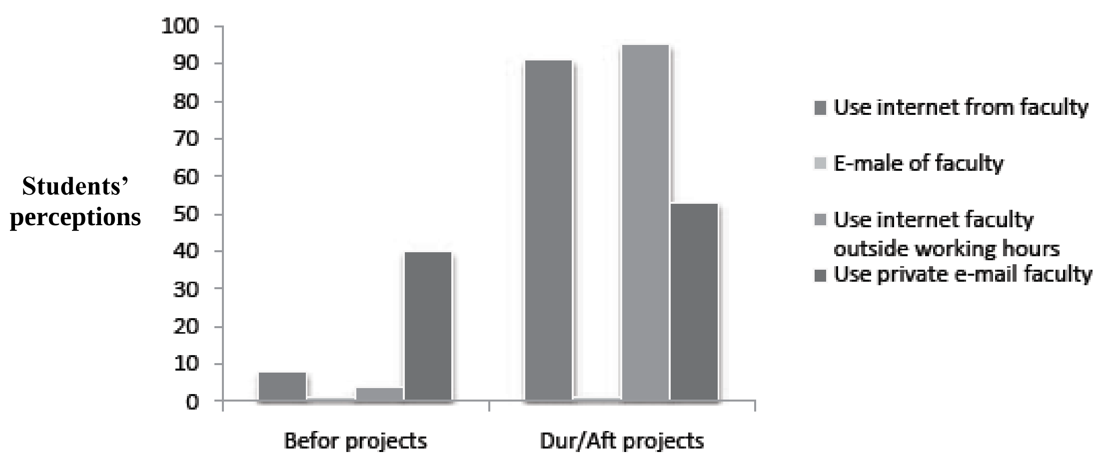


Figure 6.6. The perceptions of students about the higher education enhancement project (HEEP)

Source: Adapted from Strategic Planning Unit MHE, 2008

Furthermore, based on the quantitative data analysis of the current thesis, the direct and indirect effect of ICT on hybrid SCP of the HEIs in Egypt was supported. Additionally, the moderation effect of TI on the relationship between ICT and SCI of the HEIs in Egypt was also supported. Thus, the importance of using ICT in improving the performance of HEIs, which was highlighted in the prior research literature, was confirmed by the current study.

However, there is a detected HR/research gap –in terms of quantity and quality– between supply (i.e., by HEIs) and demand (i.e., from job market, research customers and the community) in Egypt, which is caused by the current weakness in the university-industry relationships (The Organisation for Economic Co-operation and Development and The World Bank, 2010; Education, Audiovisual and Culture Executive Agency EU and National Tempus Office in Egypt, 2012; The Egyptian Center for the Advancement of Science, Technology and Innovation, 2014). This problem/gap is caused by different reasons; some of these can be witnessed in the lack of effective communication, trust and collaboration between the universities and different industries in Egypt (The Organisation for Economic Co-operation and Development and The World Bank, 2010; Education, Audiovisual and Culture Executive Agency EU and National Tempus Office in Egypt, 2012; The Egyptian Center for the Advancement of Science, Technology and Innovation, 2014).

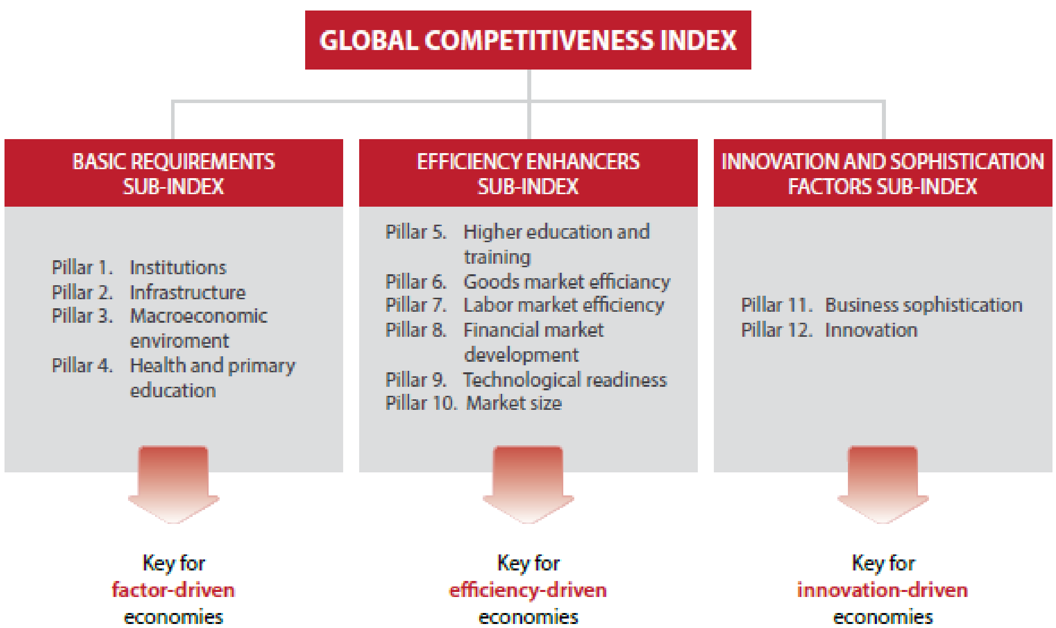


Figure 6.7. The framework of the Global Competitiveness Index

Source: The Global Competitiveness Report, 2013-2014; cited in The Egyptian Center for the Advancement of Science, Technology and Innovation, 2014

Table 6.3. GCI rank of Egypt in science, technology and innovation

Pillars directly influencing the STI Egyptian Ecosystem (according to the 2013-2014 GCI/148 countries)	Egypt	Jordan	Israel	Malaysia	Turkey
Health and Primary Education	100	65	38	**33**	59
Primary enrollment	58	96	45	55	**23**
Quality of primary education	148	44	71	**33**	92
Higher Education and Training	118	56	**34**	46	65
Secondary education enrollment	102	79	**28**	105	89
Tertiary education enrollment	82	70	**32**	62	46
Quality of the educational system	145	27	56	**19**	91
Quality of math and science education	145	30	78	**27**	101
Quality of management schools	145	47	42	**35**	101
Internet access in schools	125	44	39	**36**	63
Availability of research and training services	103	43	34	**20**	70
Extent of staff training	138	83	49	**11**	65
Labor Market Efficiency	146	101	57	**25**	130
Redundancy costs, weeks of salary	136	**14**	124	110	128
Reliance on professional management	137	86	50	**21**	66
Capacity to retain talent (brain drain)	133	53	49	**20**	78
Innovation	120	53	**3**	25	50
Capacity for innovation	111	69	**4**	15	45
Quality of scientific research institutions	127	62	**1**	27	63
Company spending in R&D	123	90	**6**	17	68
University – industry collaboration in R&D	133	85	**8**	16	52
Gov. procurement of advancement tech products	116	51	9	**4**	23
Availability of scientists and engineers	54	**7**	8	19	53
PCT patents. application/million pop.	74	87	**5**	31	41

Source: The Global Competitiveness Report, 2013-2014; cited in The Egyptian Center for the Advancement of Science, Technology and Innovation, 2014

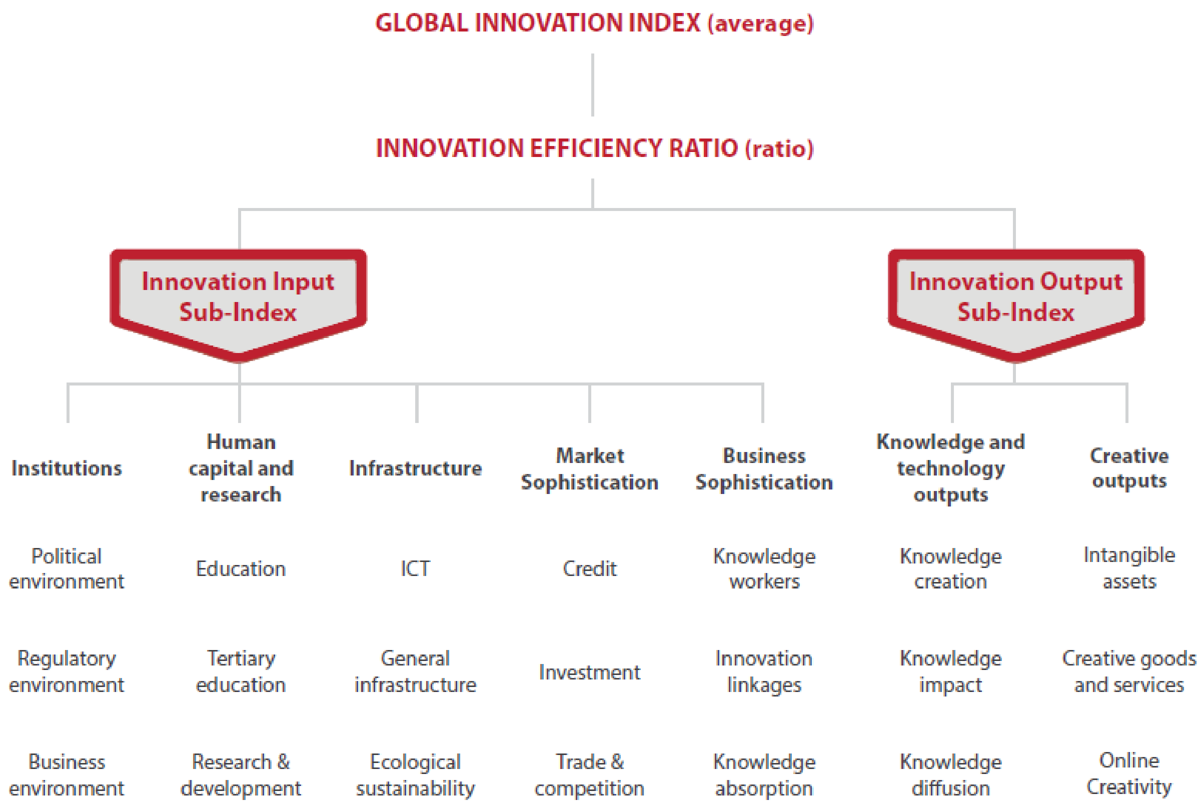


Figure 6.8. The framework of the Global Innovation Index

Source: The Global Innovation Index, 2013; cited in The Egyptian Center for the Advancement of Science, Technology and Innovation, 2014

The level of innovation in terms of science, technology and university-industry collaboration in Egypt can be assessed through different international indices (e.g., Global Innovation Index, Global Competitiveness Index, and Human Development Index) (The Egyptian Center for the Advancement of Science, Technology and Innovation, 2014).

Unfortunately, the rank of Egypt in many of these indicators has decreased according to the afore-mentioned reports compared to other countries in the region. Thus, effective and efficient higher educational SC integration and information sharing are greatly needed to maintain the required collaboration and fruitful partnership between HEIs and its up-stream and down-stream stakeholders (e.g., other educational institutions and industry).

Table 6.4. GII rank of Egypt in science, technology and university-industry research collaboration

Pillars directly influencing the STI Egyptian ecosystem (according to the 2013 GII / 142 countries)	Egypt	Jordan	Israel	Malaysia	Turkey
Human Capital and Research	81	53	8	40	76
Education	73	45	46	**84**	**102**
Public expenditure/pupil, %GDP/capita	70	n/a	**59**	**61**	**94**
Tertiary education	103	56	36	15	78
Tertiary enrolment, % gross	73	67	30	58	43
Research & development	56	57	3	41	43
Researchers, headcounts/mn pop.	51	37	n/a	60	41
Gross expenditure on R&D. %GDP	82	62	1	49	38
QS university ranking, average score top 3	45	55	21	29	42
Business sophistication	99	47	5	27	**108**
Knowledge workers	67	79	11	43	81
Knowledge-intensive employment	34	n/a	28	**65**	**76**
Firms offering formal training	85	**82**	n/a	30	67
R&D performed by business	n/a	n/a	1	32	37
R&D financed by business	n/a	n/a	41	1	31
Innovation linkages	74	18	2	52	**111**
University/industry research collaboration	**122**	91	8	17	69
State of cluster development	78	49	35	11	51
R&D financed by abroad	n/a	n/a	6	**86**	**80**
Knowledge absorption	**132**	91	**73**	3	**115**
FDI net inflows, % GDP	**139**	42	48	56	90
Knowledge and technology outputs	113	75	3	24	49
Knowledge creation	69	51	11	68	40
Domestic resident patent	63	67	29	50	34
Citable documents H index	48	82	15	52	36
Knowledge Impact	114	92	20	30	29
Growth rate of PPP$ GDP/worker, %	107	**92**	**70**	34	6
New businesses/th pop. 64–15	95	70	26	42	64
Computer software spending, % GDP	67	32	**38**	25	7
Knowledge Diffusion	108	59	2	17	**109**
Royalty & license fees receipts, % service exports	48	n/a	17	38	n/a
FDI net outflows, % GDP	70	84	43	11	66
Creative Outputs	114	59	23	38	69
Creative goods and services	92	39	21	30	50
Online Creativity	108	90	16	59	56

Source: The Global Innovation Index, 2013; cited in The Egyptian Center for the Advancement of Science, Technology and Innovation, 2014

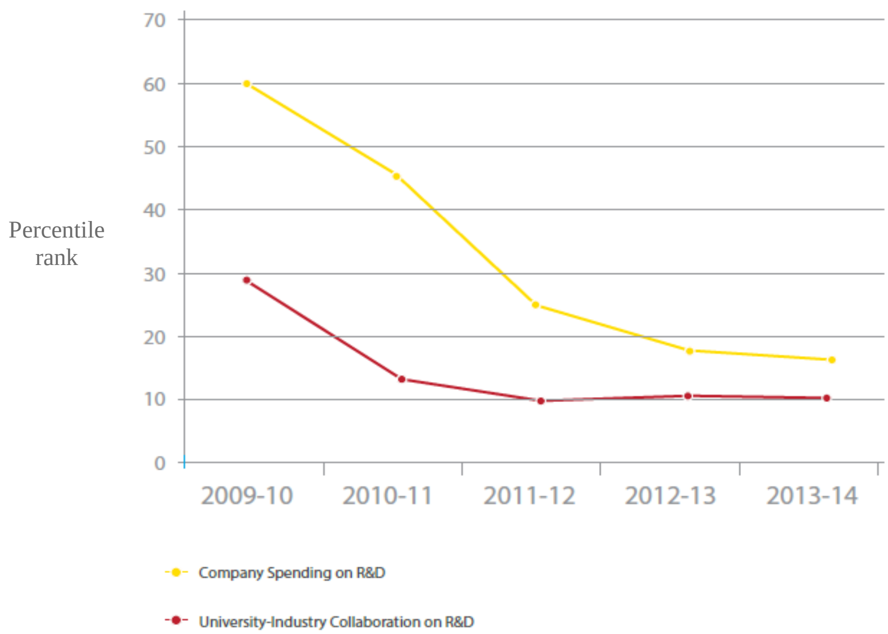


Figure 6.9 shows that Egypt's percentile rank declined from 60th to 17th in company spending on R&D and from 28th to 10th in university-industry collaboration on R&D.

In other words, Egypt scored higher than only 17% of all countries in the first dimension and ranked greater than only 10% of all countries in the second aspect.

Figure 6.9. The GCI (2009-2013) percentile rank of Egypt in R&D indicators

Source: The Global Competitiveness Report, 2009-2013; cited in The Egyptian Center for the Advancement of Science, Technology and Innovation, 2014

Further, it is vital for improving the university-industry relationship in Egypt to know the rank of Egypt according to the Human Development Index (HDI). It is a composite index that assesses the average achievement of a country in three main dimensions of human development; namely long and healthy life, knowledge, and decent standard of living (United Nations Development Programme, 2014).

Table 6.5. Human Development Index (HDI) rank of Egypt in command over and allocation of resources (e.g., on R&D)

									DEBT			PRICES		
HDI rank	GDP (2011 PPP $ billions) 2012	GDP per capita (2011 PPP $) 2012	Gross fixed capital formation (% of GDP) 2005–2012[a]	General government final consumption expenditure: Total (% of GDP) 2005–2012[a]	General government final consumption expenditure: Average annual growth (%) 2005–2012	Taxes on income, profit and capital gain (% of total tax revenue) 2005–2012[a]	Research and development expenditure (% of GDP) 2005–2012[a]	Share of agriculture, hunting, forestry and fisheries (% of GDP) 2012	Domestic credit provided by the banking sector (% of GDP) 2012	External debt stock (% of GNI) 2005–2012[a]	Total debt service (% of GNI) 2012	Consumer price index (2005=100) 2012	Domestic food price level: Index 2013	Domestic food price level: Volatility index 2013
MEDIUM HUMAN DEVELOPMENT														
103 Maldives	3.8	11,270	40.4	16.8	..	3.1	..	4.1	70.3	50.2	5.12	174	1.7 [b]	55.4
103 Mongolia	23.2	8,288	51.7	14.1	9.4	15.3	0.2	17.1	30.8	32.7	1.44	211	1.8 [b]	59.0
103 Turkmenistan	64.5	12,460	54.1	9.5	..	..	..	13.8	..	2.0	0.49	..	..	..
106 Samoa	0.9	4,935	..	..	..	..	..	9.8	45.7	58.5	1.95	141	..	..
107 Palestine, State of	..	..	25.7	32.6	8.5	2.1	..	5.6	..	..	..	119 [b]	..	..
108 Indonesia	2,186.3	8,856	33.1	8.9	2.3	35.6	0.1	14.4	42.6	26.0	3.80	160	2.0	23.5
109 Botswana	28.9	14,443	36.1	19.3	2.2	28.5	0.5	3.0	14.9	13.8	0.46	181	2.0	64.6
110 Egypt	862.5	10,685	16.0	11.6	3.1	29.7	0.2	14.8	79.3	15.7	1.51	204	2.0	102.7
111 Paraguay	48.3	7,215	14.7	12.2	21.0	13.8	0.1	20.9	37.2	25.7	1.83	157	1.7	66.7
112 Gabon	29.4	17,997	25.9	8.9	13.6	..	0.6	2.7	13.0	19.7	2.48	117	2.5 [b]	19.7
113 Bolivia (Plurinational State of)	59.3	5,650	18.2	13.5	4.9	9.6	0.2	12.3	48.7	27.6	2.00	157	1.6 [b]	35.9
114 Moldova (Republic of)	14.8	4,146	23.4	20.6	11.1	1.0	0.5	12.8	42.2	72.0	6.18	173	1.5	46.8
115 El Salvador	46.9	7,445	14.2	11.2	2.5	24.3	0.1	11.4	66.1	53.5	5.52	127	..	..

Source: United Nations Development Programme, 2014

Table 6.6. HDI rank of Egypt in Education

HDI rank	Literacy rates: Adult (% ages 15 and older)	Literacy rates: Youth (% ages 15–24)	Population with at least some secondary education (% ages 25 and older)	Gross enrolment ratios: Pre-primary (% of children of pre-school age)	Gross enrolment ratios: Primary (% of primary school-age population)	Gross enrolment ratios: Secondary (% of secondary school-age population)	Gross enrolment ratios: Tertiary (% of tertiary school-age population)	Primary school dropout rates (% of primary school cohort)	Education quality: Primary school teachers trained to teach (%)	Education quality: Performance of 15-year-old students: Mathematics[a]	Reading[b]	Science[c]	Education quality: Pupil–teacher ratio (number of pupils per teacher)	Education expenditure (% of GDP)
	2005–2012[d]	2005–2012[d]	2005–2012[d]	2003–2012[d]	2003–2012[d]	2003–2012[d]	2003–2012[d]	2003–2012[d]	2003–2012[d]	2012	2012	2012	2003–2012[d]	2005–2012[d]
MEDIUM HUMAN DEVELOPMENT														
103 Maldives	98.4	99.3	14.9	95	98	72	13	..	81	..	..	..	12	7.2
103 Mongolia	97.4	95.7	84.7 [g]	86	117	103	61	7.0	99	..	..	..	29	5.5
103 Turkmenistan	99.6	99.8	..	..	..	..	..	..	..	..	..	..	..	..
106 Samoa	98.8	99.5	62.1	34	105	86	..	10.0	..	..	..	..	30	5.8
107 Palestine, State of	95.3	99.3	56.7	42	94	83	49	0.7	100	..	..	..	24	..
108 Indonesia	92.8	98.8	44.5	42	109	81	27	12.0	..	375	396	382	16	2.8
109 Botswana	85.1	95.2	75.5 [g]	18	106	82	7	7.0	100	..	..	..	25	7.8
110 Egypt	73.9	89.3	51.2 [g]	27	109	76	29	1.1	..	..	..	..	28	3.8
111 Paraguay	93.9	98.6	38.8	35	97	68	35	17.4	..	..	..	..	28	4.1
112 Gabon	89.0	97.9	24.0 [g]	35	165	..	..	..	100	..	..	..	25	..
113 Bolivia (Plurinational State of)	91.2	99.4	53.1	51	94	77	38	13.8	..	..	..	..	24	7.6

Source: United Nations Development Programme, 2014

Table 6.7. HDI rank of Egypt in social competencies (unemployment rate)

HDI rank	Employment and vulnerability: Employment to population ratio (% ages 25 and older)	Vulnerable employment (% of total employment)	Youth unemployment (% ages 15–24)	Unemployment rate (% ages 15 and older)	Child labour (% ages 5–14)	Share of working poor (PPP $2 a day) (% of total employment)	Mandatory paid maternity leave (days)	Birth registration (% under age 5)	Old age pension recipients[a] (% of statutory pension-age population): Total	Female	Male	Suicide rate (per 100,000): Female	Male
	2012	2003–2012[b]	2008–2012[b]	2004–2013[b]	2005–2012	2003–2010[b]	2013	2005–2012[b]	2004–2013[b]	2004–2013[b]	2004–2013[b]	2003–2009[b]	2003–2009[b]
MEDIUM HUMAN DEVELOPMENT													
103 Maldives	67.4	29.6	..	11.7	..	11.2	..	92.5	99.7	..	..	0.0	0.7
103 Mongolia	69.3	54.9	11.9	9.9	10.4	..	120	99.0	100.0	..	..	..	..
103 Turkmenistan	62.1	..	..	4.0	..	..	..	95.5	..	..	..	..	..
106 Samoa	..	38.1	16.1	..	..	..	..	47.7	49.5	..	..	..	..
107 Palestine, State of	40.3	26.7	38.8	22.9	5.7	..	70	99.3 [d]	8.0	..	..	..	..
108 Indonesia	70.7	57.2	22.2	6.2	6.9 [d]	52.0	90	67.0	8.1	..	..	..	..
109 Botswana	74.5	..	..	17.6	9.0 [d]	..	84	72.2	100.0	100.0	100.0	..	..
110 Egypt	51.2	23.1	24.8	9.0	9.3	14.4	90	99.0	32.7	8.0	61.7	0.0	0.1
111 Paraguay	71.5	..	11.2	5.7	14.6	11.0	63	76.0	22.2	20.0	24.9	2.0	5.1
112 Gabon	63.2	52.9	..	20.4	13.4	14.2	98	89.6 [e]	38.8	..	..	..	..
113 Bolivia (Plurinational State of)	78.5	..	6.2	5.2	26.4 [d]	23.4	84	75.8 [d]	100.0	100.0	100.0	..	..
114 Moldova (Republic of)	42.7	28.6	13.1	5.6	16.3	10.9	126	100.0 [e]	72.8	77.0	63.7	5.6	30.1
115 El Salvador	64.5	..	12.4	6.4	10.4 [d]	12.1	84	98.6	18.1	10.3	31.6	3.6	12.9

Source: United Nations Development Programme, 2014

Table 6.8. HDI rank of Egypt in personal insecurity (long-term unemployment rate)

HDI rank	Vulnerable groups: Refugees by country of origin[a] (thousands) 2012	Vulnerable groups: Internally displaced persons[b] (thousands) 2012	Vulnerable groups: Homeless people (% of population) 2009	Vulnerable groups: Orphaned children (thousands) 2012	Vulnerable groups: Prison population (per 100,000 people) 2002–2013[c]	Vulnerable groups: Long-term unemployment rate (% of the labour force) 2005–2012[c]	Depth of food deficit (kilocalories per person per day) 2011/2013	Homicide rate (per 100,000) 2008–2011	Attitudes: Justification of wife beating (% of women ages 15–49) 2005–2012[c]	Attitudes: Justification of wife beating (% of men ages 15–49) 2005–2012[c]
MEDIUM HUMAN DEVELOPMENT										
103 Maldives	0.0	..	13.9	..	307 [o]	..	35	1.6	30.8 [j]	14.3 [j]
103 Mongolia	2.1	..	0.0	..	287	3.4	188	9.5	10.1	8.8 [j]
103 Turkmenistan	0.7	..	..	..	224	..	15	..	37.7 [j]	..
106 Samoa	0.0	..	16.0	..	228	..	23	1.1	60.8	45.7
107 Palestine, State of	5,366.7 [p]	144.5	..	..	..	..	211	..	..	..
108 Indonesia	10.1	170	0.8	..	59	..	64	0.6	35.0 [j]	17.0 [j]
109 Botswana	0.1	..	2.0	160	205	10.4	187	14.5	..	..
110 Egypt	10.0	..	0.1	..	80	7.7	8	3.3	39.3	..
111 Paraguay	0.1	..	0.2	..	118	..	157	11.4	..	..
112 Gabon	0.2	..	0.0	61	196	..	35	13.8	50.2	39.7
113 Bolivia (Plurinational State of)	0.6	..	0.8	..	140	1.3	140	7.7	16.1	..
114 Moldova (Republic of)	6.1	..	..	..	188 [q]	1.7	..	8.6	20.8	21.7 [j]
115 El Salvador	8.2	..	0.0	..	422	..	78	70.2	..	..
116 Uzbekistan	7.1	3.4	..	..	152	..	38	3.1	69.6	59.4 [j]
117 Philippines	1.0	72 [r]	3.3	..	111	0.1	100	5.4	14.1	..
118 South Africa	0.4	..	0.1	4,000	294	8.1	13	30.9	..	..
118 Syrian Arab Republic	728.2	6500	0.0	..	58	..	38	2.3	..	..

Source: United Nations Development Programme, 2014

Table 6.9. HDI rank of Egypt in international integration (e.g., communication-internet users)

HDI rank	Trade: Remoteness (kilometres) 2012	Trade: International trade (% of GDP) 2012[b]	Financial flows: Foreign direct investment, net inflows (% of GDP) 2012[b]	Financial flows: Private capital flows (% of GDP) 2012[b]	Financial flows: Net official development assistance received[a] (% of GNI) 2011	Financial flows: Remittances, inflows (% of GDP) 2011[c]	**Total reserves minus gold** (% of GDP) 2012[b]	Human mobility: Net migration rate (per 1,000 people) 2010/2015[d]	Human mobility: Stock of immigrants (% of population) 2013	Human mobility: International inbound tourists (thousands) 2011	Communication: Internet users (% of population) 2012	Communication: International telephone traffic (minutes per person) Incoming 2006–2011[e]	Communication: International telephone traffic (minutes per person) Outgoing 2006–2011[e]
MEDIUM HUMAN DEVELOPMENT													
103 Maldives	9,236	214.4	13.1	–12.8	2.7	0.14	0.8	0.0	24.4	931	38.9	..	327.6
103 Mongolia	7,108	127.8	53.8	–65.6	4.3	3.19	..	–1.1	0.6	457	16.4	38.6	19.1
103 Turkmenistan	6,842	123.2	11.4	..	0.1	..	..	–1.0	4.3	8	7.2	..	..
106 Samoa	12,241	90.5	2.3	–3.8	16.6	21.94	0.4	–13.4	3.0	121	12.9	..	..
107 Palestine, State of	..	..	..	..	..	..	1.0	–2.0	5.9 [o]	449	..	..	..
108 Indonesia	10,862	50.1	2.3	–2.7	0.1	0.82	3.6	–0.6	0.1	7,650	15.4	..	..
109 Botswana	10,458	95.1	2.0	–1.5	0.2	0.41	26.3	2.0	7.2	2,145	11.5	..	31.3
110 Egypt	6,859	44.8	–0.2	–0.2	0.2	6.07	1.0	–0.5	0.4	9,497	44.1	69.8	6.9
111 Paraguay	11,491	93.5	1.6	–3.4	0.4	3.43	0.4	–1.2	2.7	524	27.1	76.5	14.3
112 Gabon	8,696	..	3.9	..	0.5	..	1.0	0.6	23.6	..	8.6	11.0	17.7
113 Bolivia (Plurinational State of)	11,042	85.1	3.6	–2.6	0.5	4.36	0.7	–2.4	1.4	807	34.2	83.7	6.8
114 Moldova (Republic of)	6,007	128.1	2.3	–2.1	6.0	22.81	..	–5.9	11.2 [p]	11	43.4	224.1	62.7
115 El Salvador	9,153	74.9	1.1	–5.9	1.3	15.84	4.2	–7.1	0.7	1,184	25.5	258.4	234.8
116 Uzbekistan	6,879	64.4	3.1	..	0.5	..	0.3	–1.4	4.4	975	36.5	..	..
117 Philippines	9,442	64.8	1.1	–1.8	–0.1	10.25	1.4	–1.4	0.2	3,917	36.2	..	..

Source: United Nations Development Programme, 2014

Table 6.10. HDI rank of Egypt in perceptions of well-being (e.g., on education quality, job and local labor market)

	Perceptions of individual well-being							Perceptions about community			Perceptions about government		
	Education quality	Health care quality	Standard of living	Job	Safety	Freedom of choice	Overall life satisfaction index	Local labour market	Trust in other people	Community	Efforts to deal with the poor	Actions to preserve the environment	Trust in national government
	(% satisfied)	(% satisfied)	(% satisfied)	(% satisfied)	(% answering yes)	(% satisfied)	(0, least satisfied, to 10, most satisfied)	(% answering good)	(% answering can be trusted)	(% answering yes)	(% satisfied)	(% satisfied)	(% answering yes)
HDI rank	2012	2008–2012[a]	2007–2013[a]	2007–2012[a]	2007–2012	2007–2012	2007–2012[a]	2007–2012[a]	2009–2011[a]	2007–2012[a]	2007–2013[a]	2007–2013[a]	2007–2012[a]
MEDIUM HUMAN DEVELOPMENT													
103 Maldives	..	..	..	..	..	..	..	..	..	..	..	..	..
103 Mongolia	55	40	59	81	46	59	4.9	12	14	76	16	22	31
103 Turkmenistan	..	64	89	86	77	63	5.5	57	27	94	38	61	..
106 Samoa	..	..	..	..	..	..	..	..	..	..	..	..	..
107 Palestine, State of	67	62	47	64	63	53	4.6	8	9	76	39	40	47
108 Indonesia	82	80	63	77	89	70	5.4	38	21	90	28	54	67
109 Botswana	68	56	36	52	35	79	4.8	32	9	61	74	67	66
110 Egypt	40	35	63	71	57	44	4.2	10	25	63	31	20	60
111 Paraguay	76	69	86	89	44	75	5.8	60	12	92	33	46	30
112 Gabon	36	29	29	50	35	56	4.0	35	..	45	26	49	36
113 Bolivia (Plurinational State of)	70	48	71	85	40	85	6.0	50	10	84	56	58	44
114 Moldova (Republic of)	55	40	45	64	46	55	6.0	6	12	73	18	19	21
115 El Salvador	78	67	72	80	53	67	5.9	35	18	85	43	50	31

Source: United Nations Development Programme, 2014

6.3. Using SCM Approach to Bridge the Gap between Academia and Industry: Successful Global and National HESCM Practices

Before suggesting the usage of SCM approach in the HEIs in Egypt to bridge the detected gap between academia and industry, this chapter presents some global and local examples that successfully implemented higher educational SCM practices. These trials can highlight different effective and efficient ESCM strategies that facilitate the implementation of SCM practices in the HEIs in Egypt; thus, improving their hybrid SCP. As was discussed before in chapter three, despite the abundance of studies which have focused on applying SCM practices to different manufacturing industries, few studies were concerned about the application of contemporary SCM practices to the service sector (Ellram *et al.*, 2004; Habib and Jungthirapanich, 2009b; Lin *et al.*, 2010; Giannakis, 2011); particularly the education sector (Habib and Jungthirapanich, 2009b) in spite of knowing that its SC affects either positively or negatively many other different sectors/industries.

Hence, Lin *et al.* (2010, 2012) were motivated to precisely define the service supply chain (SSC) and service supply chain management (SSCM). As shown in the following figure, the SSC is a net/chain of suppliers, service providers, other parties and customers, through which different resources are used in providing services to various customers (Lin *et al.*, 2010). In regard to the concept of SSCM, it was defined by Lin *et al.* (2010, 2012) as the effective management of tangible and intangible resources (e.g., information) as well as different processes across different nodes/partners of the entire SSC from the suppliers till the customers.

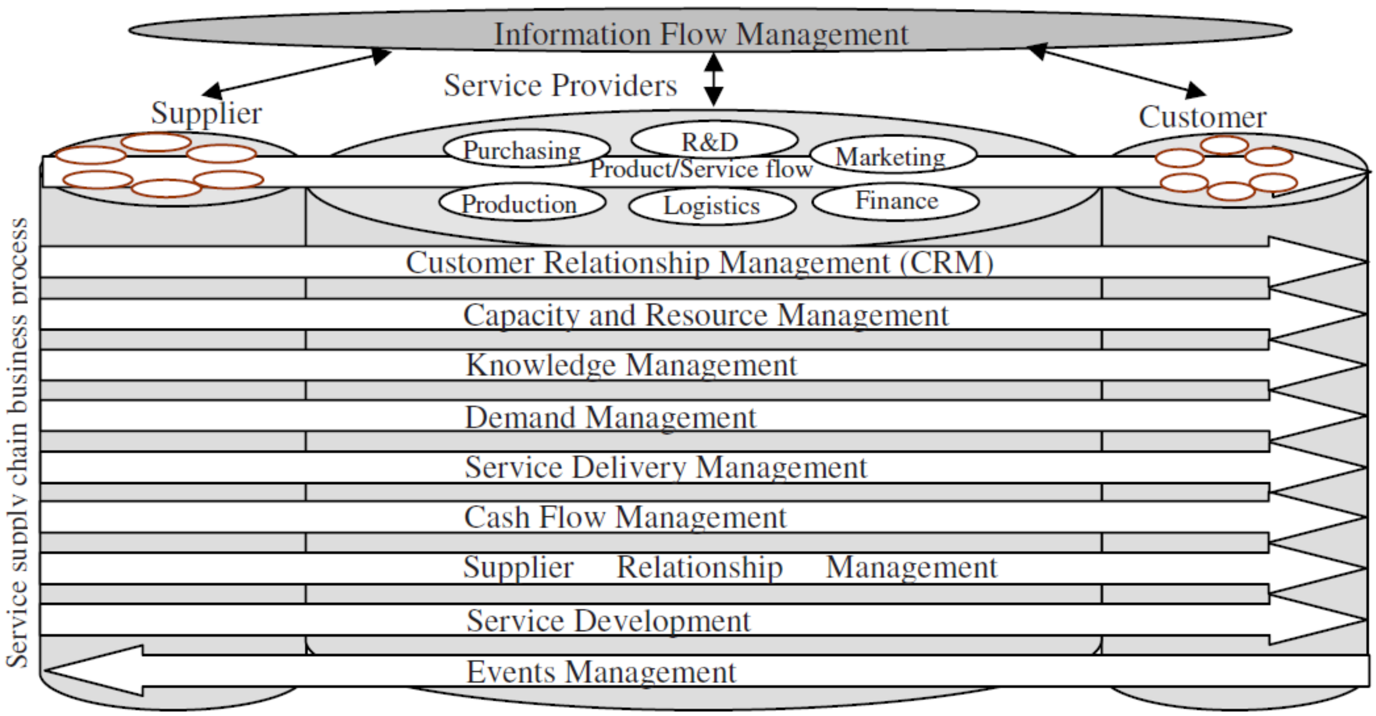


Figure 6.10. Service supply chain and its process structure

Source: Lin *et al.*, 2010

After applying the concept of SSCM to the educational service by few studies (e.g., Lau, 2007; Al-Turki *et al.*, 2008; Kargaev, 2008; Habib and Jungthirapanich, 2008; 2009a; 2009b; Ang *et al.*, 2010; Abd-Elall *et al.*, 2011), Ang and Griffin (2008) and Varma (2012) depicted a very simplified form of an educational supply chain (ESC) in terms of input, process and output, which can help Egyptian HEIs in understanding the concept of ESC. At this point, it is important to mention once more a clear definition of an ESC. It is a chain of suppliers (e.g., general education system), service provider and customers (e.g., workforce market and job market), where HEIs (i.e., main service provider) are located at the centre of a coordinated integrated network of shared information, other resources, practices and different functions (Al-Turki *et al.*, 2008; Abd-Elall *et al.*, 2011).

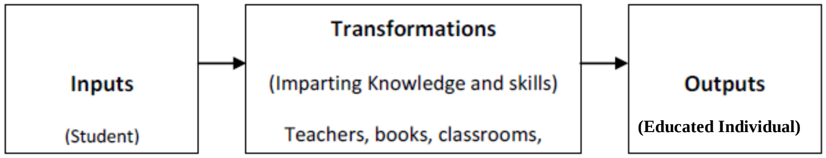


Figure 6.11. Higher education system as a factory/producer of educated HR
Source: Ang and Griffin, 2008

The linkage between ESC nodes (i.e. general and higher educational institutions, workforce market and job market) can be described as a chain/network of suppliers, customers and other stakeholders (Al-Turki *et al.*, 2008; Abd-Elall *et al.*, 2011).

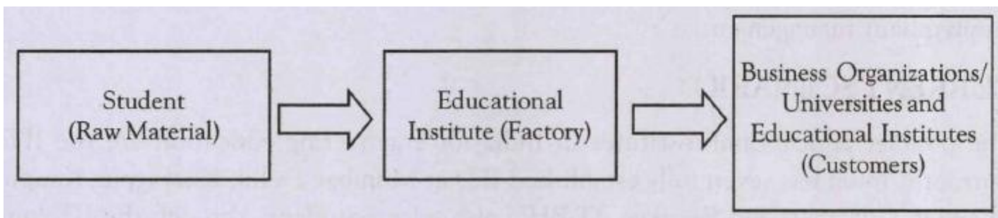


Figure 6.12. Simplified form of an educational supply chain
Source: Varma, 2012

Afterward, Varma (2012) suggested the usage of ESCM approach in closing the detected supply-demand gap for qualified staff (i.e., supply flow of HR) in higher education especially the Indian Institutes of Technology (IITs).

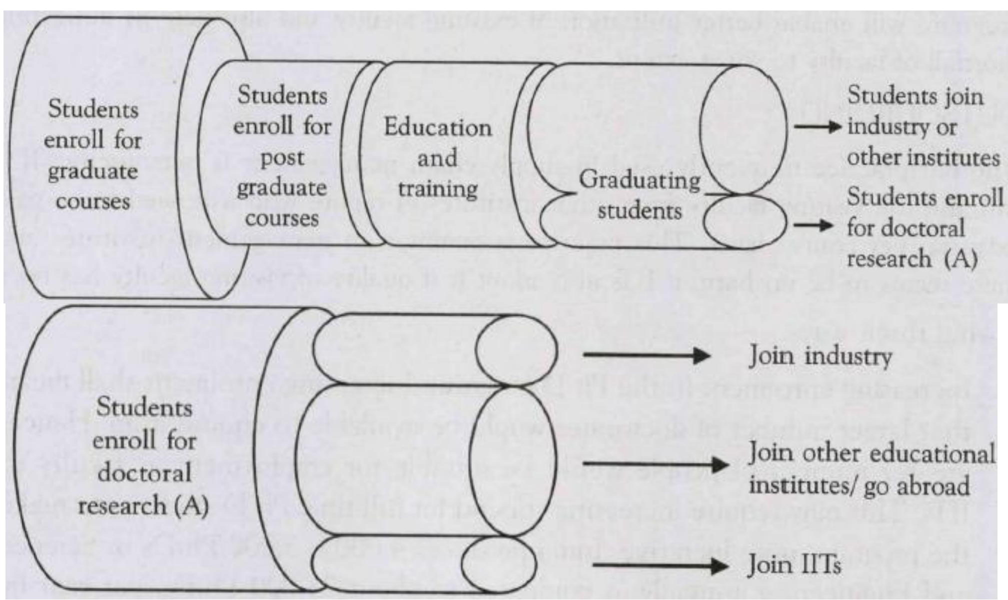


Figure 6.13. Using SCM approach in closing the supply-demand gap for staff in higher education especially Indian Institutes of Technology (IITs)
Source: Varma, 2012

This above-mentioned study can benefit HEIs in Egypt that suffer from a gap between supply and demand of HR/staff in terms of quality and quantity, which was obviously revealed throughout the carried-out in-depth interviews for the current thesis.

As for the suppliers of ESC, Habib and Jungthirapanich (2008) identified the different types of suppliers as follows: suppliers of HR (e.g., students, teaching and administrative staff); suppliers of funds (e.g., individuals and organizations); and suppliers of materials and equipments needed for the educational process.

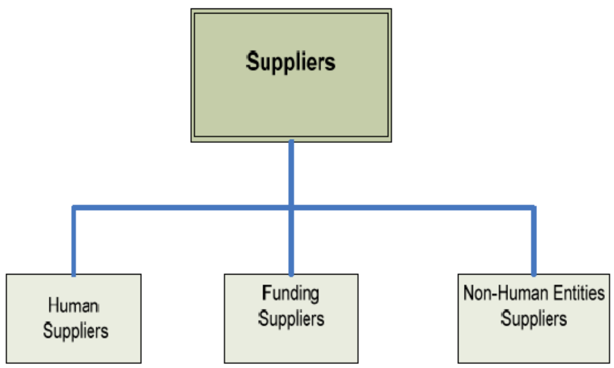


Figure 6.14. Different types of suppliers in an educational SC

Source: Habib and Jungthirapanich, 2008

Moreover, Lau (2007), Habib and Jungthirapanich (2009b, 2010), Habib (2011) and Pathik *et al*. (2012a, 2012b) added the research process to the higher education SC. In this way, HEIs in Egypt can effectively and efficiently manage the detected gap between information/research supply (e.g., contemporary theories) and demand (e.g., successful practices) after sustaining the required integration and information sharing between the interested parties in the form of supplier-customer relationship (as shown in Figure 6.25).

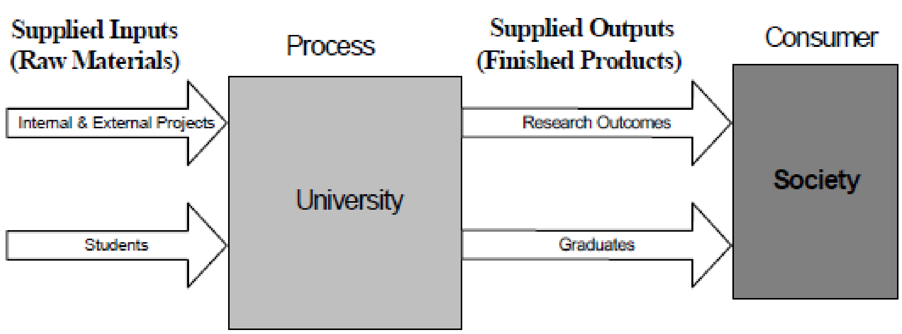


Figure 6.15. An education supply chain model after adding the research process

Source: Habib and Jungthirapanich, 2010;
Habib, 2011; Pathik *et al.*, 2012a

Additionally, HEIs in Egypt via ESCM can maintain an active participation with the industry and their communities in order to promote the required innovation in the society. Furthermore, they will be able to deliver an enhanced value to the higher education supply chain (HESC) stakeholders, including the society in large, through contributing by qualified graduates and community-based research output (Geiger and Sá, 2005; Lau, 2007).

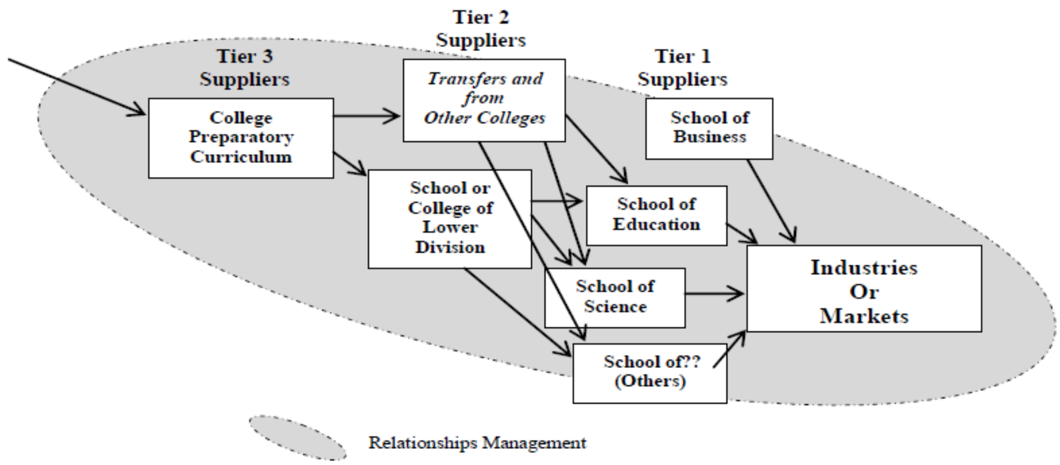


Figure 6.16. Different tiers of suppliers in the higher education supply chain framework
Source: Ang and Griffin, 2008; Ang *et al.*, 2010

Based on the prior research literature (Lau, 2007; Al-Turki *et al.*, 2008; Ang and Griffin, 2008; Habib and Jungthirapanich, 2008; 2009a; 2009b; Ang *et al.*, 2010; Abd-Elall *et al.*, 2011; Lin *et al.*, 2012) and the aforementioned reports (Projects Implementation Unit MHE, 2001; The International Bureau of Education UNESCO, 2006; 2012; Strategic Planning Unit MHE, 2008), the researcher of this study identified the main higher education SC nodes in Egypt.

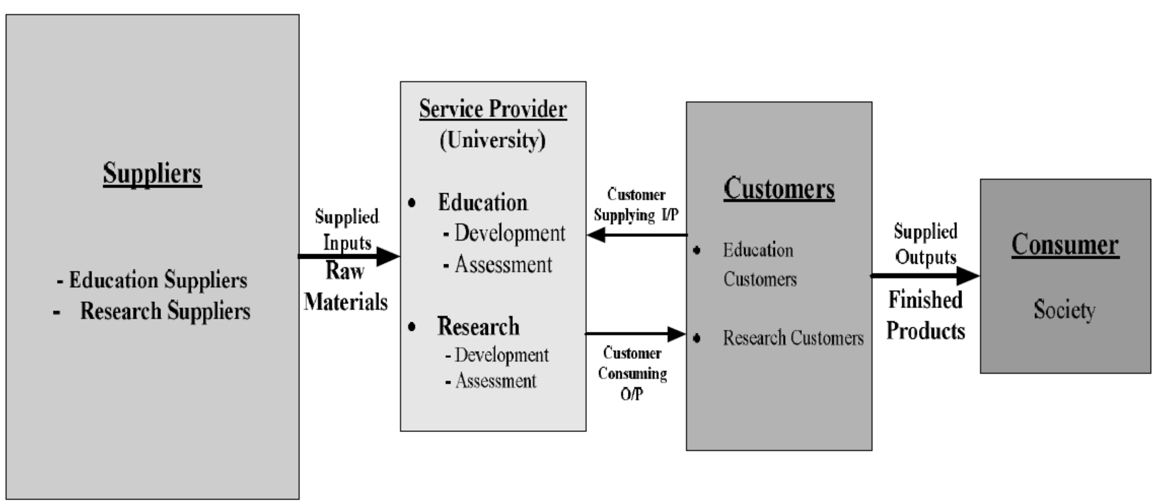


Figure 6.17. Two-way communication process in a university education supply chain
Source: Habib and Jungthirapanich, 2009b; Habib and Jungthirapanich, 2010;
Pathik *et al.*, 2012b

As for up-stream the HESC in Egypt, the main suppliers are: (a) the suppliers (e.g., educational and non-educational institutions) of HR (e.g., students, teaching and administrative staff); (b) the suppliers of funds (e.g., individuals, organizations, government); (c) suppliers of information/research (e.g., individuals and organizations); and (d) suppliers of materials, equipments and other tangible resources.

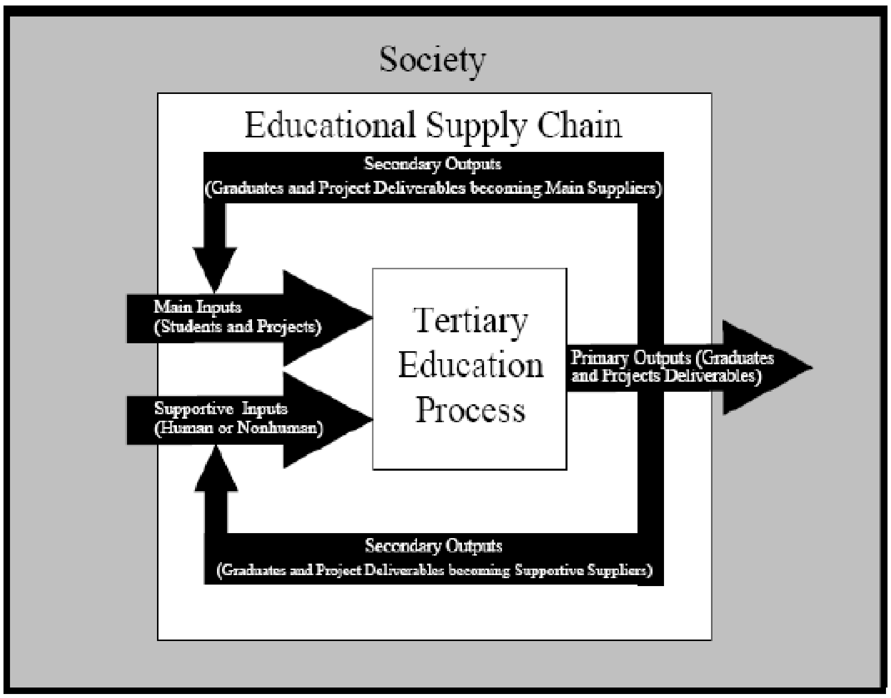


Figure 6.18. Supply chain model for tertiary education
Source: Habib and Jungthirapanich, 2008

Then, the HEIs act as the main educational/research service provider that is located at the center of the HESC.

With regard to down-stream the HESC in Egypt, its main customers are the job market (e.g., employers of different MFG/service industries) and the research customers (e.g., individuals, organizations, government).

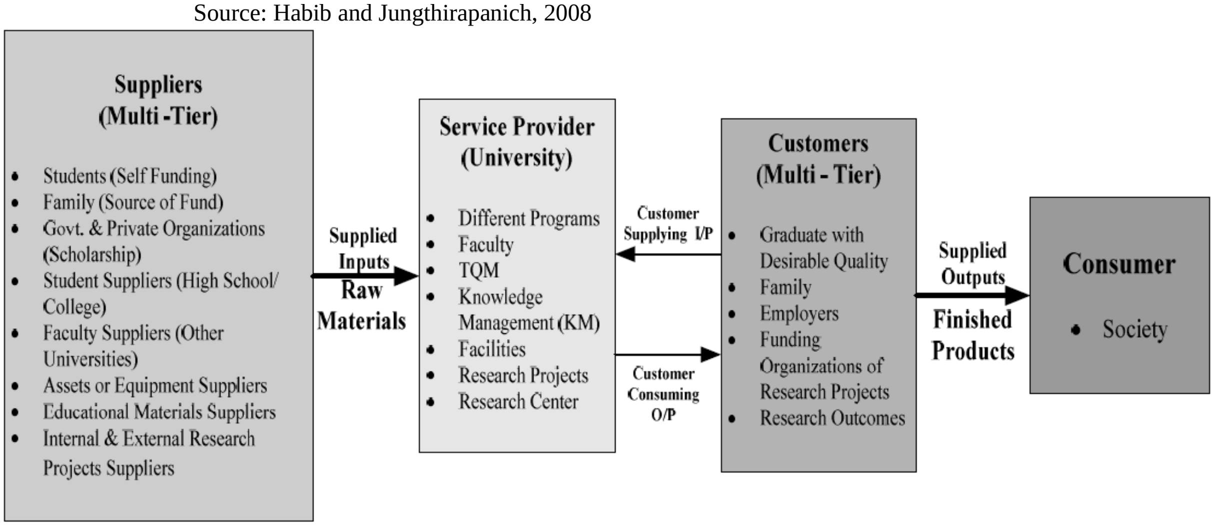


Figure 6.19. Multiple nodes and tiers of suppliers/customers in an educational SCM model
Source: Habib and Jungthirapanich, 2008

In summary, HESC in Egypt include many stakeholders (e.g., faculty staff, students, alumni, administration, local/international partners, product and equipment suppliers, government, other educational institutions such as basic/secondary schools, third-party business, competitors, society in large, and other intermediaries/nodes) (Projects Implementation Unit MHE, 2001; The International Bureau of Education UNESCO, 2006; Comm and Mathaisel, 2008; Strategic Planning Unit MHE, 2008).

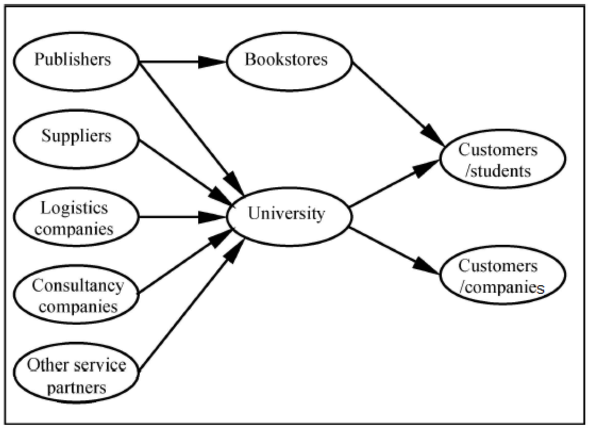


Figure 6.20. Service SC for the higher education industry
Source: Lin *et al.*, 2012

Similarly but from a value-chain perspective, Van der Merwe and Cronjé (2004) and Pathak and Pathak (2010) discussed the importance of viewing the performed functions and activities at an educational institution in the form of chain that aims at value generation to customers (as shown in Figures 6.21 and 6.22).

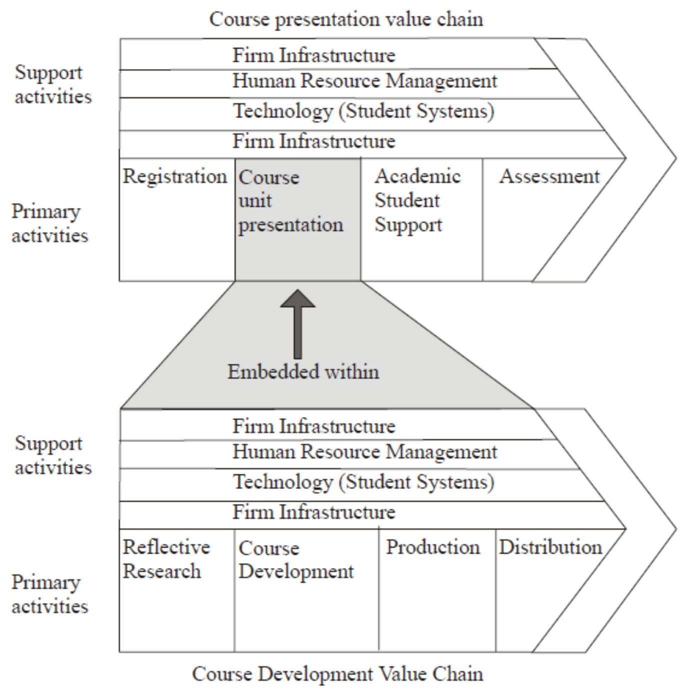


Figure 6.21. Education value chain to streamline some processes
Source: Van der Merwe and Cronjé, 2004

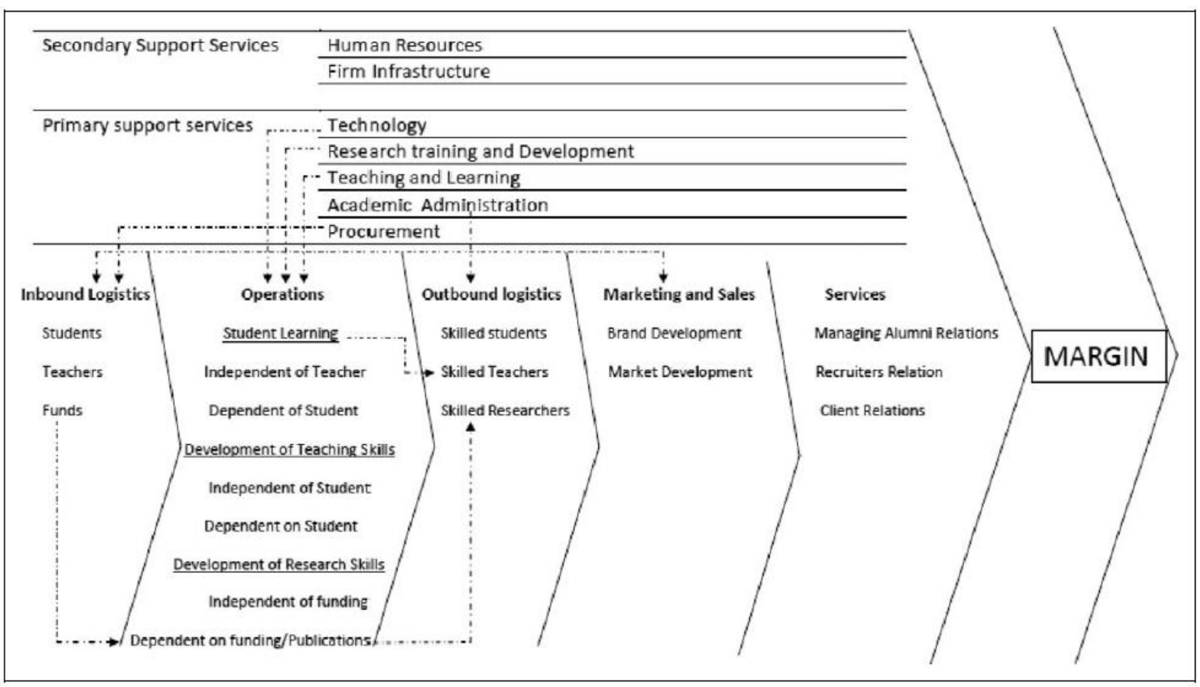


Figure 6.22. Higher education value chain in terms of in/outbound logistics
Source: Pathak and Pathak, 2010

As was pinpointed before in chapter two, SCM refers to the systematic integration and coordination (Sheffi and Klaus, 1997; Li *et al.*, 2006) of all the activities related to the transformation and flow of a certain product across different nodes/partners in one chain, including suppliers, manufacturers, distributors and customers (Bowersox and Closs, 1996; Huang *et al.*, 2002; Kainuma and Tawara, 2006), which are linked together via a seamless dynamic flow of materials, information (Bowersox and Closs, 1996; Naylor *et al.*, 1999; Huang *et al.*, 2002; Kainuma and Tawara, 2006; Li *et al.*, 2006; Al-Turki *et al.*, 2008), finance (Huang *et al.*, 2002) and HR that moves within and among these integrated entities (Al-Turki *et al.*, 2008).

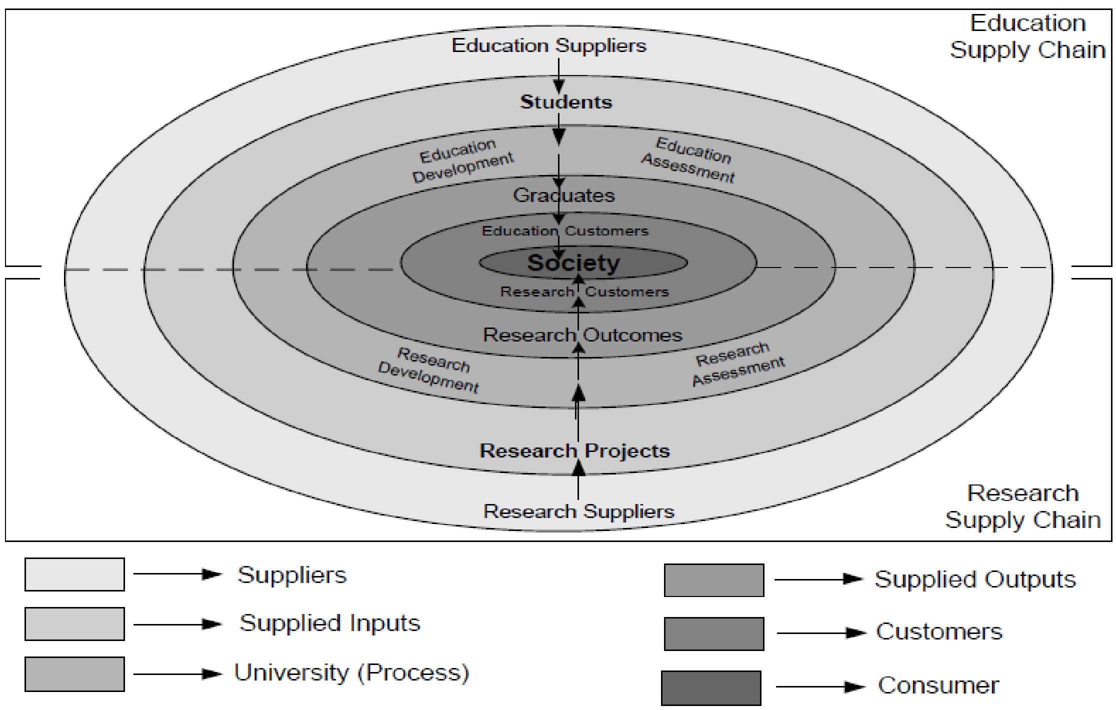


Figure 6.23. Two integrated education and research supply chains in higher education
Source: Habib and Jungthirapanich, 2009a, 2009b; Habib *et al.*, 2011;
Pathik *et al.*, 2012b

Based on the above-mentioned definition and in the light of the SSCM definition (Lin *et al.*, 2010, 2012), educational SCM can be defined as the effective/efficient coordination of the performed functions and activities that are needed to deliver a certain service along the entire network/chain of suppliers, service providers, customers and other stakeholders, which are integrated together via tangible and intangible SC flows that pass within/across many members playing one symphony yet each player has a different role.

Based on the qualitative and quantitative data analysis of the current research, HEIs in Egypt are recommended to use effective and efficient ESCM in order to enhance their hybrid education SCP (i.e., in terms of leanness, agility and leagility) and bridge the gap between HR/research supply and demand.

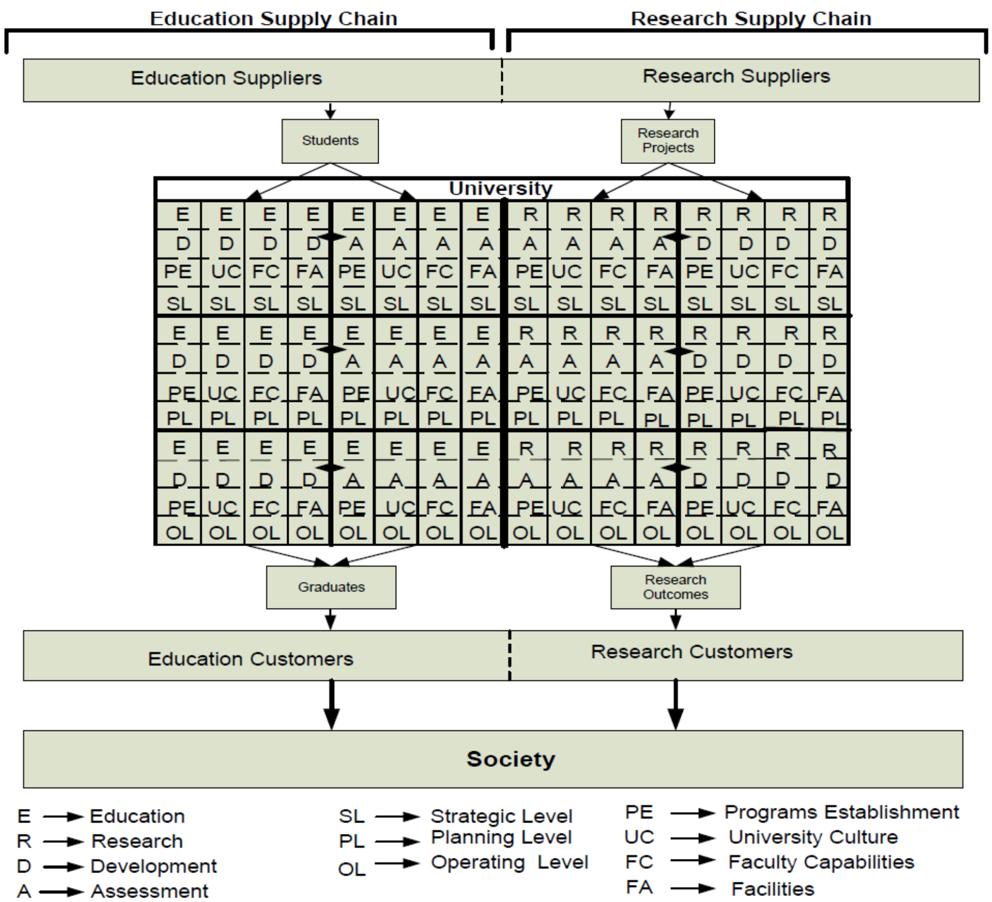


Figure 6.24. Different levels of decision making in an educational SC model

Source: Habib and Jungthirapanich, 2010;
Habib, 2011; Pathik *et al.*, 2012b

Moreover, ICT can act as a facilitator for improving the SCI, SCIS and SCP of the HEIs in Egypt. In general, ICT can help in improving SCP through synchronizing and orchestrating different tangible and intangible SC flows (Kim and Im, 2002) that pass throughout many SC nodes. In relation to the ESC, few studies (e.g., Comm and Mathaisel, 2008; Evoh, 2010; Abd-Elall *et al.*, 2011; Ilie-Zudor *et al.*, 2011) discussed the importance of using ICT for more enhanced higher education SCP and more streamlined operations along the entire ESC nodes (e.g., educational institutions, learners, instructors and employers/employees from the industry).

In summary, this study views the Egyptian educational and research service as a spinal cord (i.e., a cord of different SC flows: information, research and HR) that runs up along the backbone (i.e., supply chain) of various manufacturing industries, including automotive sector, and other service industries in Egypt.

In regard to the locally implemented HESCM principles, the researcher noticed that different ESCM practices are successfully but partially (i.e., either up- or down-stream the HESC) applied at public and private HEIs in Egypt (e.g., Cairo University, Ain Shams University, Kafrelsheikh University, The American University in Cairo, Heliopolis University for Sustainable Development, Egyptian E-Learning University, Nile University, The Arab Academy for Science, Technology and Maritime Transport).

Moreover, after reviewing the prior research Egyptian literature that discussed integrating academia with the industry, the researcher found a Master's thesis conducted at Alexandria University by Shehata (2007). Shehata (2007) investigated the relationship between the university as a producer of knowledge (i.e., in terms of supply) and the corporate sector as its user (i.e., in terms of demand). However, he studied only the linkage maintained along downstream the SC of a higher educational institution and ignored the relationship between such university and their suppliers (i.e., upstream integration). Additionally, he empirically examined such relationship using a case study approach on only one public university (i.e., Alexandria University) on a sample of 115 teaching staff working in three faculties only (i.e., faculties of engineering and commerce, and the institute of post-graduate studies and research). Thereby, it negatively affected the generalization to the entire higher education sector in Egypt.

At this point, it is important to reveal that the researcher participated in applying different educational SCM practices to MSA University (i.e., HEI operating in Egypt that accepted to participate in this experiment and where the researcher works) for the purpose of maintaining up-stream and down-stream ESC integration with its stakeholders. The researcher investigated the impact of SCM practices on improving MSA HSCP in terms of leanness, agility and leagility through conducting five depth interviews with leaders/SMEs empowered/responsible for applying these practices at the university.

These educational SCM practices included:

(1) Conducting "Sharing Experience Seminars", in which group of professionals and business entrepreneurs are sharing their best practices and experiences with MSA students to help them in understanding the business work environment and applying the studied principals (theory) with real-life cases (practice);
(2) Offering students training opportunities and research internships at different local employers and other HEIs abroad;
(3) Organized fieldtrips to various organizations (e.g., MFG and service industries, and research centers);
(4) Brought guest speakers from different fields (academics and practitioners);
(5) Adding to the main courses list of each faculty two courses prerequisite for graduation called "Graduation Practical Projects I and II" (i.e., applied to the Egyptian context);
(6) Conducted different agreements about post-graduate scholarships at international universities;
(7) Organized multidisciplinary and interdisciplinary conferences engaging different faculties and industries;
(8) Created new inter/multidisciplinary prerequisite courses, electives and minors;
(9) Conducted periodic employment fairs;
(10) Established social development and community based projects (e.g., Lebaladna charity association) to serve the community;
(11) Implemented blended e-learning approach in its education process that involves ICT in SCIS with the aid of Modular Object-Oriented Dynamic Learning Environment (Moodle) and Interactive Learner Centered Teaching (ILCT) techniques; and
(12) Organized different activities with schools (e.g., schools trips to the university, workshops at schools or at the university, summer courses to different schools' students) to sustain upstream SCI.

Consequently, after applying these educational SCM practices to MSA; results showed that inter- and intra-organizational integration and information sharing (i.e., upstream/downstream SCI and SCIS) with different stakeholders were improved leading to enhanced level of HSCP in terms of leanness, agility and leagility.

6.4. New Higher Education-Industry SCM Model suggested by the Current Research

Based on reviewing the related prior research literature in addition to the conducted qualitative data analysis (71 interviews in 43 educational institutions) for the current research, this study considers −from a conceptual perspective via the following model− the Egyptian educational/research service providers as one of the strategic suppliers (i.e., a spinal cord supplying different SC flows: information, research and HR along the entire backbone/supply chain) to various MFG industries (e.g., automotive sector) and other service sectors in Egypt.

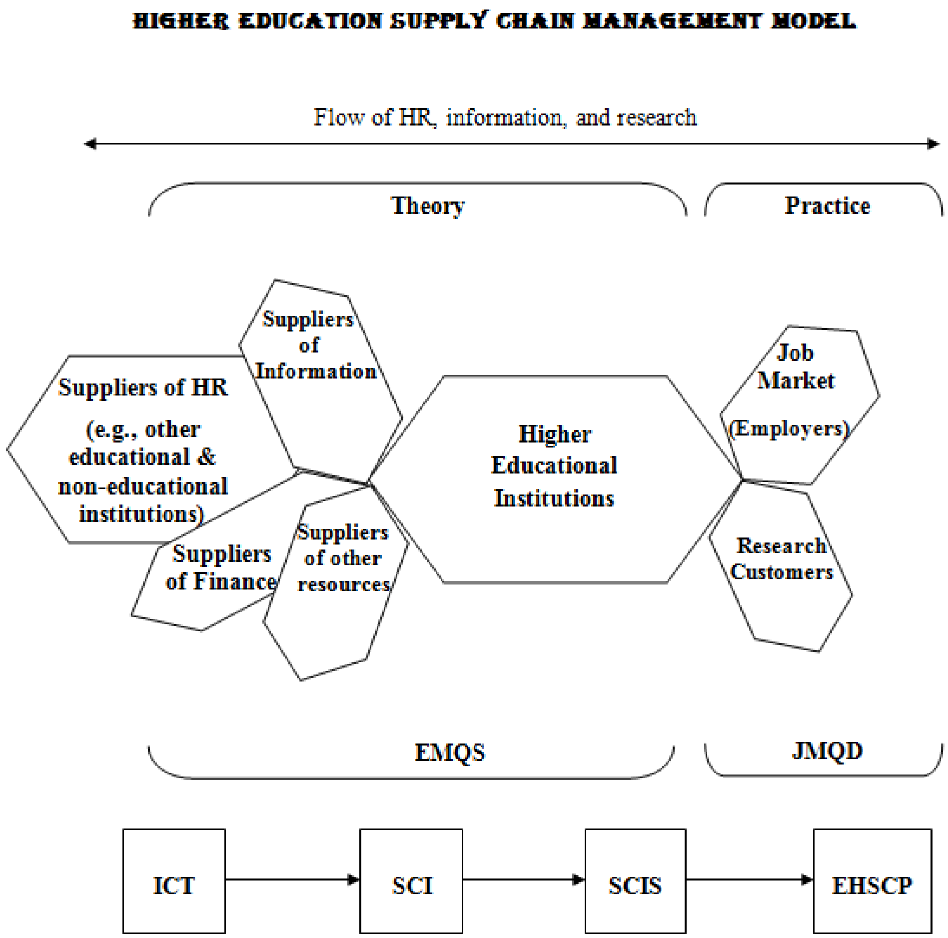


Figure 6.25. The suggested higher educational SCM model by the current research to bridge the detected gap between HR/research supply and demand

Moreover, from an empirical perspective, its main findings –as will be revealed in chapter seven and eight− showed that ICT employment has a positive and significant effect on SCI, SCI has a positive and significant effect on SCIS, and ICT employment and SCIS have positive and significant effect on higher education HSCP. In other words, the mediation effect of SCM (SCI and SCIS) on higher education HSCP is supported.

Therefore, based on the qualitative and quantitative data analysis of the current research, HEIs in Egypt are recommended to use effective and efficient ESCM, in addition to ICT and TI in order to enhance their hybrid education SCP (i.e., in terms of leanness, agility and leagility) and bridge the gap between HR/research supply and demand. In that way and through using effective and efficient SCM and ICT, HEIs can be able to bridge the detected gap between: (a) HR supply (i.e., supplied qualifications EMQS) and demand (i.e., needed qualifications JMQD), and (b) information/research supply (e.g., contemporary theories) and demand (e.g., successful practices) (as shown in Figure 6.25).

Based on the prior research literature and the conducted qualitative/quantitative data analysis for the current research, the findings of this thesis have different implications for the leaders of different HESC nodes/stakeholders:

1) Active participation is needed of HEIs and its corresponding job market (i.e., various organizations from different industries according to the specialization of each faculty) to conduct cooperative/collaborative research (CR) through university-industry partnerships (e.g., Research parks integrating universities, industries and the community).

2) Sustain knowledge-based systems working on a multidisciplinary qualification-database used to provide ESCs stakeholders with real-time qualifications demand and supply. ICT can be used to improve the effectiveness and efficiency of the information flow between students, educational institutions and employers.

3) Each ESC node should not be acting in its own best individual interest without considering the effectiveness and efficiency of the whole ESC. Otherwise, it will contribute to creating many problems in different sectors in Egypt.

4) Representatives from different manufacturing and service industries should be more involved in developing curricula in HEIs (i.e., bridging the gap between theory and practice).

5) Government should incentivize endowment funds, which are tax deductible for donors. Thus, many entrepreneurs will be motivated to finance different research centers and HEIs. However, industry should be the main investor in these UIP due to the direct positive impact of such relationship, which will support its sustainable innovation and HSCP improvement.

6) Develop community-based universities to better serve its stakeholders and conduct its researches on solving the problems of our society.

7) Change vision, mission, strategies and objectives of each HEI and MFG/service organization to maintain long term university-industry relationships.

8) Establish an Education-Industry Council that will be able to facilitate the cooperation between educational institutions and industry in Egypt. This recommendation was pointed out by Dr. Tarek Wahdan (i.e., one of the current research interviewees as shown in Appendix C/2) the Director of Operations at AUC Executive Education and Former Director of the Quality Management Institute at AUC Management Center.

9) Use ICT and encourage blended and e-learning in order to facilitate SCI and SCIS, which in turn will enhance hybrid ESCP in terms of leanness and agility.

10) Conduct collaborative projects that involve networks of public and private HEIs (e.g., Students/staff exchange, scholarships and research projects). At this point, it is important to mention that EU and many institutions providing funds to HEIs set it as a condition for financing them.

11) Develop interdisciplinary and multidisciplinary under/post graduate programs, which integrate related fields from different faculties.

12) Sustaining effective and efficient intra-organizational integration and information sharing with the HEIs students and staff is crucial for better HSCP of these institutions in Egypt.

By this interdependent manner, HEIs can be able to sustain SCI and SCIS with its different stakeholders. Thus, these SC strategies will facilitate bridging the detected gap between: (a) HR supply (i.e., supplied qualifications EMQS) and demand (i.e., needed qualifications JMQD), and (b) information/research supply (e.g., contemporary theories) and demand (e.g., successful practices) (as shown in Figure 6.25).

6.5. Conclusion

Regarding the second chosen context of the current research, many reasons lie behind the selection of the Egyptian higher education market that acts as one example of a service sector.

First, following the studies of Lau (2007), Al-Turki *et al.* (2008), Kargaev (2008), Ang *et al.* (2010) and Abd-Elall *et al.* (2011) that discussed the importance of conducting education SCM (i.e., managing SC flow of HR) and collaborative research (i.e., managing SC flow of information) through universities-industries relationships, the researcher considers the higher educational institutions (HEIs) as one of the strategic suppliers of information and HR to the automotive industry and many other sectors in Egypt. In this interdependent manner and through using effective and efficient education/research SCM, HEIs can bridge the gap between: (a) HR supply (i.e., supplied qualifications) and demand (i.e., needed qualifications) (Al-Turki *et al.*, 2008; Abd-Elall *et al.*, 2011); and (b) information/research supply (e.g., contemporary theories) and demand (e.g., successful practices) (Habib and Jungthirapanich, 2008; 2009a; 2009b).

Second, despite the abundance of studies which have focused on applying SCM practices to different manufacturing industries, few studies were concerned about the application of contemporary SCM practices to the service sector; particularly the education sector (Habib and Jungthirapanich, 2009b) in spite of knowing that its SC affects either positively or negatively many other different sectors/industries. Additionally, SCM researchers conducted various models for improving the industrial sector and many business organizations, while they should be more motivated to target their researches for sustaining the development of their own educational institutions (Lau, 2007; Habib and Jungthirapanich, 2008; 2009a; 2009b). This way, HEIs in Egypt can maintain an active participation in promoting the required innovation in the society. The main objective is to provide education supply chain (ESC) stakeholders, including the society in large, an enhanced value through contributing by qualified graduates and community-based research output (Lau, 2007).

Third, as far as the literature has been investigated, there is a lack of studies that empirically assessed the moderating effect of technology intelligence (TI) on education SCI and ICT-SCM-HSCP relationship in terms of leanness, agility and leagility in the context of higher education; especially in Egypt.

Thus, the researcher was motivated to add by conducting this study to the few detected attempts in the contemporary SCM research literature, which considers education management (EMgt), technology management (TM) and SCM as interdependent areas of research.

Thereby, from a conceptual perspective, this thesis views the Egyptian educational and research service as a spinal cord (i.e., a cord of different SC flows: information, research and HR) that runs up along the backbone (i.e., supply chain) of various manufacturing industries, including automotive sector, and other service industries in Egypt.

Afterwards, from an empirical perspective, its main findings –as will be revealed in chapter seven and eight− showed that ICT employment has a positive and significant effect on SCI, SCI has a positive and significant effect on SCIS, and ICT employment and SCIS have positive and significant effect on higher education HSCP. In other words, the mediation effect of SCM (SCI and SCIS) on higher education HSCP is supported.

Thus, based on the qualitative and quantitative data analysis of the current research, HEIs in Egypt are recommended to use effective and efficient ESCM, in addition to ICT and TI in order to enhance their hybrid education SCP (i.e., in terms of leanness, agility and leagility) and bridge the gap between HR/research supply and demand.

By this means and through using effective and efficient SCM and ICT, HEIs can be able to bridge the detected gap between: (a) HR supply (i.e., supplied qualifications EMQS) and demand (i.e., needed qualifications JMQD), and (b) information/research supply (e.g., contemporary theories) and demand (e.g., successful practices). Moreover, HEIs in Egypt can maintain an active participation in promoting the required innovation in the society. Furthermore, they will be able to provide higher education supply chain (HESC) stakeholders, including the society in large, an enhanced value through contributing by qualified graduates and community-based research output.

CHAPTER SEVEN

Quantitative Data Analysis and Findings: Automotive vs. Higher Education Sectors in Egypt (Comparative Approach)

7.1. Introduction

This chapter presents the data analysis and findings of the two sectors; namely the automotive and education SCs serving as two examples of the manufacturing and service industries. For data reduction, factor analysis was used in grouping the items/measured variables –for ICT, SCI, SCIS and HSCP– into a smaller set of manageable factors, whose unidimensionality, validity and reliability were assessed and confirmed (via AMOS software, SmartPLS software, LISREL software, and SPSS software). Additionally, SEM was used –with AMOS software and SmartPLS software– to examine the proposed relationships between the specified variables of the suggested model. Moreover, one-way ANOVA (via SPSS) and SEM (via AMOS) were used in this research to test for differences between the three AISC sub-sectors (EAFI, EAM and CBUM) regarding their hybrid SCP in terms of leanness, agility and leagility. Afterwards, the researcher comparatively investigated the differences of the measurement results between the two main sectors using Excel sheets.

7.2. Data Analysis and Findings of the Automotive Sector (ASC)

For data reduction, the researcher used factor analysis (CFA/SEM) in grouping 71 items/measured variables –for ICT, SCI, SCIS and HSCP– into a smaller set of 11 manageable factors, whose validity and reliability were assessed and confirmed. According to Hair *et al.* (2010), validity refers to the degree of measurement accuracy of a conducted research. As for the construct validity of a suggested model, it was defined as the degree of representation that a set of indicators/item-measures possesses towards its underlying theoretical unobserved construct (Hair *et al.*, 2010). In this study, different tests of construct validity were conducted. In order to assess the convergent validity among the observed variables of the proposed model, various ways were sought for this purpose. The first way the researcher chose, for the purpose of measuring the degree of similarity among the measured variables of each construct factor, was to use CFA/SEM –based on the study of Anderson and Gerbing (1988) – in exploring whether the standardized loading of each item is exceeding twice the number of its standard error (i.e., testing its significance). Moreover, the large sizes of the standardized loadings (i.e., each item's standardized regression weight should be ≥ 0.5) (Hair *et al.*, 2010) and the t-values (Chen *et al.*, 2004; Li *et al.*, 2009; Hair *et al.*, 2010), which are regarded as indicators of adequate convergent validity, were investigated and verified. In summary, the researcher found –as shown in Table 7.1– that all the standardized regression weights that range from 0.574 to 0.944 exceedingly double their standard errors, and the t-values that range from 5.498 to 14.191 greatly exceed its tabled t-value at a significance level of 0.0001. Thus, based on the CFA/SEM results presented in Table 7.1, the 71 observed variables significantly reflect their underlying eleven unobserved factors.

Another way for assessing the convergent validity was through computing the average variance extracted (AVE), which is the sum of the squared multiple correlations (i.e., squared standardized regression weights, Table 7.1) divided by the number of indicators/items used (Hair *et al.*, 2010). The present study measured the AVE for each latent construct factor. As shown in Table 7.2, the AVE of all the eleven factors in the model ranges from 0.538 to 0.731 with an average of 65.5 percentage of variation explained among a total of 71 items (i.e., AVE > 0.5); thus, indicating sufficient convergence. As pinpointed by Hair *et al.* (2010), an AVE that is greater than or equal o.5 can be considered as an indicator of sufficient convergence.

Furthermore, Hair *et al.* (2010) asserted that reliability is a necessary condition for validity. Accordingly, two reliability estimates were computed for the measurement model factors, following Hair *et al.* (2010), the first one is the Cronbach's alpha (calculated via SPSS software) and the second is the construct reliability (CR) (calculated through using CFA/SEM with AMOS software). Results in Table 7.2 reveal that these two estimates greatly exceed o.7 (Cronbach's alpha = 0.992 and CR = 0.993), thus indicating good reliability. As according to Hair *et al.* (2010), each of these two reliability estimates should be greater than or equal o.7 in order to be regarded as an indicator of adequate internal consistency and convergent validity.

Practically, the first test of construct validity assessed for this research model was the content/face validity, which was defined by Hair *et al.* (2010) as the degree of consistency between the measured items of each latent construct and its theoretical definition. Hardesty and Bearden (2004) as well as Hair *et al.* (2010) contended that content/face validity can be tested based on the researcher and experts' judgments. For this study, content validity was firstly assessed through five in-depth personal interviews with SMEs in Egypt before data collection.

Then, based on their valuable comments, the measured items were modified. Later, the content validity of the measured variables was secondly verified through the carried out face-to-face interviews with the rest of the 94 SMEs working in 84 different auto-parts/automobile companies and 5 educational institutions/research centers and representing different SC members/nodes (e.g., tier 1/2 supplier, manufacturer, distributor and customer) across the AISC in the Egyptian emerging market.

After confirming the content/face validity and before examining the convergent validity, the unidimensionality was assessed through using CFA/SEM following Hair *et al.* (2010). Since, an observed item/measure is said to be unidimensional, after satisfying two requirements, if and only if it is significantly and empirically related to a specific construct, and at the same time it cannot be associated with any other constructs except that single construct (Gerbing and Anderson, 1988; Chen *et al.*, 2004; Li *et al.*, 2009; Hair *et al.*, 2010). Therefore, after satisfying these two conditions, the existence of unidimensionality among the indicators was ensured through assessing the overall fit of the CFA model using various indices (e.g., CFA model fit indices: Normed Chi-Square (χ^2/d.f.) = 3.537, RMR = 0.03, GFI = 0.835, AGFI = 0.821, CFI = 0.856, RMSEA = 0.085) as suggested by Hair *et al.* (2010). Table 7.1 summarizes the results of this confirmatory factor analysis.

Table 7.1. Results from confirmatory factor analysis (CFA/SEM) using AMOS software

Factors and item-measures	**Estimated loadings**	**Standardized Loadings**	**SE**	**t-value**	**Squared multiple correlations**
Factor (1). Inter-organizational level of ICT employment (INTEROL)					
$ICT_1/INTEROL_1$	1.000	0.862	–[a]	–[a]	0.743
$ICT_2/INTEROL_2$	0.789	0.838	0.073	10.871[b]	0.702
$ICT_3/INTEROL_3$	0.394	0.757	0.041	9.602[b]	0.573
$ICT_4/INTEROL_4$	0.833	0.944	0.060	13.798[b]	0.891
$ICT_5/INTEROL_5$	0.758	0.724	0.088	8.662[b]	0.524
$ICT_6/INTEROL_6$	0.891	0.829	0.083	10.716[b]	0.687
Factor (2). Intra-organizational level of ICT employment (INTRAOL)					
$ICT_7/INTRAOL_1$	1.000	0.858	–[a]	–[a]	0.736
$ICT_8/INTRAOL_2$	0.819	0.804	0.079	10.352[b]	0.646
$ICT_9/INTRAOL_3$	0.945	0.900	0.075	12.547[b]	0.810
$ICT_{10}/INTRAOL_4$	0.743	0.833	0.068	10.944[b]	0.694
$ICT_{11}/INTRAOL_5$	1.445	0.875	0.121	11.904[b]	0.766
$ICT_{12}/INTRAOL_6$	1.060	0.837	0.096	11.038[b]	0.701

Factor (3). Upstream integration with suppliers (UI)					
SCI_1/UI_1	0.847	0.658	0.118	7.188[b]	0.433
SCI_2/UI_2	0.870	0.769	0.102	8.541[b]	0.591
SCI_3/UI_3	0.856	0.848	0.090	9.526[b]	0.719
SCI_4/UI_4	0.855	0.782	0.098	8.703[b]	0.612
SCI_5/UI_5	1.000	0.766	–[a]	–[a]	0.587
Factor (4). Downstream integration with customers (DI)					
SCI_6/DI_1	1.128	0.771	0.111	10.128[b]	0.594
SCI_7/DI_2	1.075	0.837	0.093	11.579[b]	0.701
SCI_8/DI_3	0.968	0.847	0.081	11.887[b]	0.717
SCI_9/DI_4	0.974	0.851	0.081	11.984[b]	0.724
SCI_{10}/DI_5	0.569	0.678	0.066	8.598[b]	0.460
SCI_{11}/DI_6	1.000	0.883	–[a]	–[a]	0.780
Factor (5). Intra-organizational integration (II)					
SCI_{12}/II_1	2.789	0.816	0.387	7.203[b]	0.666
SCI_{13}/II_2	2.608	0.861	0.348	7.501[b]	0.741
SCI_{14}/II_3	2.644	0.901	0.341	7.757[b]	0.812
SCI_{15}/II_4	2.998	0.898	0.387	7.738[b]	0.806
SCI_{16}/II_5	1.000	0.623	–[a]	–[a]	0.388
Factor (6). Upstream information sharing with suppliers (UIS)					
$SCIS_1/UIS_1$	1.000	0.792	–[a]	–[a]	0.627
$SCIS_2/UIS_2$	1.237	0.865	0.122	10.152[b]	0.748
$SCIS_3/UIS_3$	0.706	0.690	0.094	7.525[b]	0.476
$SCIS_4/UIS_4$	1.048	0.889	0.100	10.531[b]	0.790
$SCIS_5/UIS_5$	1.377	0.806	0.149	9.211[b]	0.650
$SCIS_6/UIS_6$	1.056	0.826	0.110	9.558[b]	0.682
$SCIS_7/UIS_7$	1.039	0.898	0.097	10.693[b]	0.806
Factor (7). Downstream information sharing with customers (DIS)					
$SCIS_8/DIS_1$	1.000	0.796	–[a]	–[a]	0.634
$SCIS_9/DIS_2$	0.931	0.893	0.088	10.516[b]	0.797
$SCIS_{10}/DIS_3$	0.772	0.920	0.070	10.997[b]	0.846
$SCIS_{11}/DIS_4$	0.904	0.780	0.104	8.685[b]	0.608
$SCIS_{12}/DIS_5$	0.732	0.889	0.070	10.441[b]	0.790
$SCIS_{13}/DIS_6$	0.913	0.898	0.086	10.596[b]	0.806
$SCIS_{14}/DIS_7$	1.049	0.842	0.108	9.674[b]	0.709
$SCIS_{15}/DIS_8$	0.566	0.796	0.063	9.036[b]	0.634
Factor (8). Intra-organizational information sharing (IIS)					
$SCIS_{16}/IIS_1$	1.000	0.914	–[a]	–[a]	0.835
$SCIS_{17}/IIS_2$	0.822	0.813	0.072	11.473[b]	0.661
$SCIS_{18}/IIS_3$	1.051	0.843	0.086	12.210[b]	0.711
$SCIS_{19}/IIS_4$	1.071	0.897	0.075	14.191[b]	0.805
$SCIS_{20}/IIS_5$	1.226	0.798	0.113	10.884[b]	0.637
$SCIS_{21}/IIS_6$	1.176	0.825	0.101	11.633[b]	0.681
$SCIS_{22}/IIS_7$	1.321	0.883	0.097	13.608[b]	0.780
$SCIS_{23}/IIS_8$	1.279	0.862	0.100	12.827[b]	0.743

Factor (9). Lean supply chain performance (LSCP)					
$HSCP_1/LSCP_1$	1.399	0.574	0.246	5.678[b]	0.329
$HSCP_2/LSCP_2$	1.110	0.659	0.168	6.613[b]	0.434
$HSCP_3/LSCP_3$	1.452	0.676	0.213	6.815[b]	0.457
$HSCP_4/LSCP_4$	1.565	0.916	0.160	9.772[b]	0.839
$HSCP_5/LSCP_5$	1.537	0.742	0.203	7.574[b]	0.551
$HSCP_6/LSCP_6$	1.207	0.791	0.148	8.169[b]	0.626
$HSCP_7/LSCP_7$	1.115	0.715	0.154	7.250[b]	0.511
$HSCP_8/LSCP_8$	1.000	0.746	–[a]	–[a]	0.557
Factor (10). Agile supply chain performance (ASCP)					
$HSCP_9/ASCP_1$	0.935	0.837	0.120	7.809[b]	0.701
$HSCP_{10}/ASCP_2$	0.971	0.597	0.177	5.498[b]	0.356
$HSCP_{11}/ASCP_3$	1.120	0.738	0.163	6.863[b]	0.545
$HSCP_{12}/ASCP_4$	1.267	0.720	0.190	6.671[b]	0.518
$HSCP_{13}/ASCP_5$	0.928	0.671	0.149	6.207[b]	0.450
$HSCP_{14}/ASCP_6$	1.112	0.887	0.134	8.299[b]	0.787
$HSCP_{15}/ASCP_7$	0.987	0.907	0.116	8.501[b]	0.823
$HSCP_{16}/ASCP_8$	0.712	0.798	0.094	7.546[b]	0.637
$HSCP_{17}/ASCP_9$	1.000	0.720	–[a]	–[a]	0.518
Factor (11). Leagile supply chain performance (LEAGSCP)					
$HSCP_{18}/LEAGSCP_1$	0.696	0.633	0.098	7.132[b]	0.401
$HSCP_{19}/LEAGSCP_2$	0.821	0.798	0.092	8.892[b]	0.637
$HSCP_{20}/LEAGSCP_3$	1.000	0.760	–[a]	–[a]	0.578

[a] Not estimated as loading was set to fixed value 1.000.
[b] Significance at the level of $p \leq 0.0001$.

In addition, Table 7.2 shows the results of KMO and Bartlett's test, which indicate high value of KMO statistics (range from 0.793 to 0.934) and the significance of Bartlett's test statistics ($p \leq 0.0001$) of the four latent constructs.

Finally, for the purpose of investigating the nomological validity, the researcher tested the research hypotheses using SEM with Asset Management Operating System (AMOS) software. According to Hair *et al.* (2010), this validity test can be established through ensuring the existence of logical/reasonable correlations –based on aforementioned prior studies– between the latent constructs of the research model. The main structural equation model fit indices are: χ^2/d.f. = 2.362, RMR = 0.002, GFI = 0.892, AGFI = 0.746, NFI = 0.978, NNFI = 0.974, IFI = 0.987, CFI = 0.987. Since, these aforementioned values are within the suggested range by Hair *et al.* (2010). Thus, the model is considered to be satisfactory and can be used in testing the main hypotheses.

Figure 7.1 presents the standardized results of the structural equation model, which indicate that ICT employment has a positive and significant effect on SCI ($\beta = 0.89$, $t = 45.135$, $p < 0.0001$), and SCI has a positive and significant effect on SCIS ($\beta = 0.81$, $t = 67.725$, $p < 0.0001$). Therefore, H2 and H3 are supported. Additionally, H1 is supported as ICT employment has a positive and significant effect on HSCP ($\beta = 0.58$, $t = 2.441$, $p < 0.05$). However, based on the results of the SEM model –shown in Figure 7.1– there is a positive but insignificant effect of SCIS on HSCP ($\beta = 0.43$, $t = 1.091$, $p = 0.275$).

Table 7.2. Summary of measurement results using SPSS software and AMOS software

Latent construct	**KMO and Bartlett's test statistics significance**	**Factors**	**No. of items**	**AVE**	**CR**	**Cronbach's alpha**
ICT	0.793	INTEROL	6	0.687	0.929	0.910
	0.000	INTRAOL	6	0.725	0.941	0.931
SCI		UI	5	0.588	0.877	0.856
	0.896	DI	6	0.663	0.921	0.914
	0.000	II	5	0.683	0.914	0.898
SCIS		UIS	7	0.683	0.937	0.930
	0.934	DIS	8	0.728	0.955	0.945
	0.000	IIS	8	0.731	0.956	0.950
HSCP		LSCP	8	0.538	0.902	0.911
	0.900	ASCP	9	0.593	0.928	0.916
	0.000	LEAGSCP	3	0.538	0.776	0.751
Overall AVE and reliability indices			71	0.655	0.993	0.992

For further analyses and in-depth understanding of the direct effect of ICT and the mediation effect of SCM (SCI and SCIS) on HSCP in terms of leanness, agility and leagility (i.e., direct ICT-HSCP relationship and indirect relationship via SCM), the researcher used SEM to test the sub-hypotheses of H1 (i.e., H1a, H1b, H1c) and H4 (i.e., H4a, H4b, H4c). Results showed that H4 is partially supported as H4c is accepted because there is a positive and significant effect of SCIS on leagile SCP ($\beta = 0.664$, $t = 2.445$, $p < 0.05$). Moreover, results indicated that H1a and H1b are accepted due to the positive and significant relationships between ICT and lean SCP ($\beta = 0.770$, $t = 3.303$, $p < 0.0001$), and ICT and agile SCP ($\beta = 0.819$, $t = 2.812$, $p = 0.005$). On the other hand, the researcher found out that H1c, H4a and H4b are not supported.

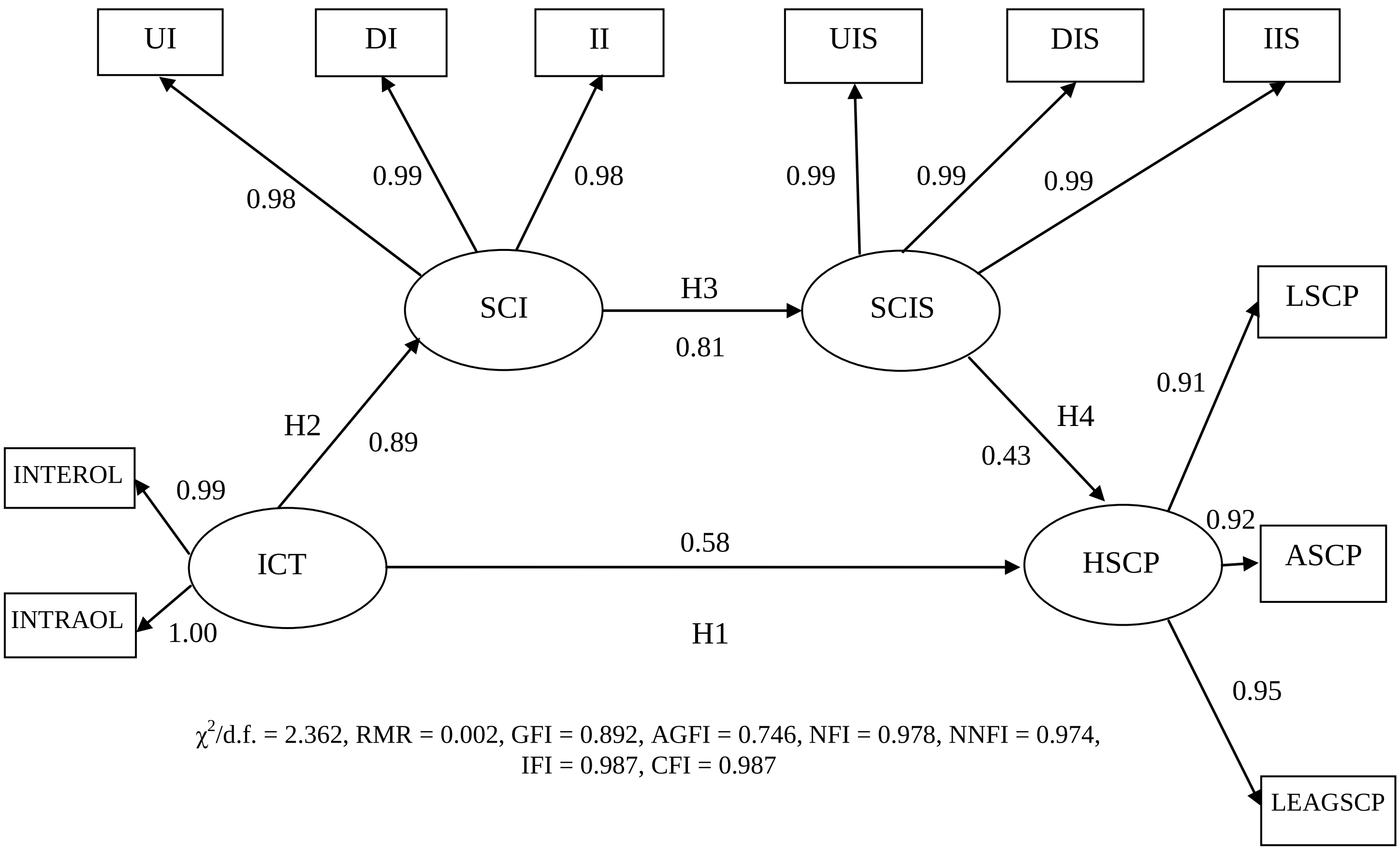


Figure 7.1. Standardized results of structural equation model
using AMOS software

In summary, the researcher can conclude that the direct effect of ICT on lean and agile SCP and the mediation effect of SCM (SCI and SCIS) on leagile SCP are supported. Meanwhile, the direct effect of ICT on leagile SCP and the mediation effect of SCM (SCI and SCIS) on lean and agile SCP are not supported. Many reasons can lie behind these findings; one of these can be due to the need for the mediation effect of SCM practices (e.g., SCI and SCIS) for more effective and efficient leagile SCP in terms of mass-customization and postponement. Thus, the researcher concluded that these results support the hybridized strategy of SCP in terms of leanness, agility and leagility.

Furthermore, the researcher used one-way ANOVA (via SPSS) and SEM (via AMOS) to test for differences between the three AISC sub-sectors (EAFI, EAM and CBUM) regarding their hybrid SCP in terms of leanness, agility and leagility. Results showed that there are significant differences among the HSCP of the three groups. In other words, after conducting three tests of one-way ANOVA across the three AISC nodes/sub-sectors with respect to their LSCP, ASCP and LEAGSCP, the researcher found that (1) there are significant differences among the mean of LSCP between the three groups ($F = 12.736$, $p < 0.0001$); (2) there are significant differences among the mean of ASCP between the three groups ($F = 3.910$, $p < 0.05$); and (3) there are significant differences among the mean of LEAGSCP between the three groups ($F = 9.308$, $p < 0.0001$).

In order to obtain detailed analyses of the direct and indirect (via SCM) effects of inter- and intra-organizational levels of ICT employment on lean, agile and leagile SCP across the three groups/sub-sectors, the researcher used SEM to test these causal relationships. In respect to the Egyptian auto-feeding industry (i.e., auto-parts suppliers in the first sub-sector upstream the AISC), the researcher found that the inter-organizational level of ICT employment has a positive and significant effect on LSCP ($\beta = 0.58$, $t = 7.538$, $p < 0.0001$), SCIS has a positive and significant effect on LSCP ($\beta = 0.75$, $t = 5.346$, $p < 0.0001$), and inter-organizational level of ICT employment has a positive and significant effect on LEAGSCP ($\beta = 0.67$, $t = 2.604$, $p < 0.01$). While with regard to the Egyptian automotive manufacturers (i.e., second sub-sector), the researcher discovered that the inter-organizational level of ICT employment has a positive and significant effect on LEAGSCP ($\beta = 0.30$, $t = 2.633$, $p < 0.01$). In relation to the CBU market (i.e., CBU distributors in the third sub-sector), the researcher noticed that there is an indirect positive significant effect of ICT employment through SCIS on ASCP ($\beta = 0.47$, $t = 2.298$, $p < 0.05$). However, regarding the EAM, the researcher found no significant effect of ICT on ASCP; and in regard to CBUM, there was no significant effect of ICT on LEAGSCP. This could be due to the unequal size of the three groups, the small size of the last two groups of respondents (i.e., 18 EAM and 21 CBUM), and in general the small population size of automotive companies in Egypt.

In summary, after investigating the hybrid lean-agile SCP of automotive industry in Egypt, results showed that the three main sub-sectors of this emerging market are using a blended strategy that hybridizes attributes of leanness (e.g., cost-minimization, waste-reduction, continuous improvement) together with that of agility (e.g., speed, flexibility, responsiveness) and leagility (e.g., mass-customization, postponement). Besides, the percentage of the hybridized lean component is higher, upstream the AISC (i.e., automotive suppliers in the EAFI), than the agility component in the same sub-sector/SC node; compared to the SC market-interface (i.e., vehicle distributors downstream the AISC), which operates in a more agile-manner. Therefore, the researcher can conclude that these results support the newly suggested hybridized strategy of SCP in terms of leanness, agility and leagility. At this point, it is important to mention that the agility performed in the CBUM during the last two years has decreased as a result of the economical instability in Egypt, which was confirmed throughout the conducted interviews with SMEs in this sector. The Product Manager (i.e., one of the interviewees) of one of the automotive companies operating in this sub-sector (i.e., CBUM) in Egypt said: “We were performing in a more agile manner before the recent political issues; however, now we prefer to depend more on the leanness component of our SCP strategy until we reach an economical stability”.

7.3. Data Analysis and Findings of the Higher Education Sector (HESC)

Regarding the higher education sector, two more factors were added to the above-mentioned 11 factors (i.e., 13 manageable factors, whose validity and reliability were assessed and confirmed) –namely the Technology Intelligence (TI) and the University-Industry Partnership (UIP) – representing 83 items/measured variables. As for assessing the construct validity of the suggested model, different tests of construct validity (i.e., convergent validity, content/face validity, discriminant validity and nomological validity) were conducted and verified. All the loadings were found to be greater than 0.5 and exceedingly double their standard errors, and the t-values –as shown in Table 7.3– greatly exceed its tabled t-value; thus, these are regarded as indicators of adequate convergent validity (Chen *et al.*, 2004; Li *et al.*, 2009; Hair *et al.*, 2010).

Another way for assessing the convergent validity was through computing the average variance extracted (AVE) (Hair *et al.*, 2010) using the SmartPLS software. As shown in Table 7.3, the AVE of all the five latent constructs in the model ranges from 0.632 to 0.881 with an average of 81.104 percentage of variation explained among a total of 83 items (i.e., AVE > 0.5); thus, indicating sufficient convergence. As asserted by Hair *et al.* (2010), an AVE that is greater than or equal o.5 can be considered as an indicator of sufficient convergence.

Additionally, Hair *et al.* (2010) pointed out that reliability is a necessary condition for validity. Accordingly, two reliability estimates were computed for the measurement model constructs, following Hair *et al.* (2010), the first one is the Cronbach's alpha (calculated via SmartPLS software and SPSS software) and the second is the Composite Reliability (CR) (calculated through using SmartPLS software). Results in Table 7.3 reveal that these two estimates of each construct greatly exceed o.7 (Cronbach's alpha of the 83 items = 0.977), thus indicating good reliability. As according to Hair *et al.* (2010), each of these two reliability estimates should be greater than or equal o.7 in order to be regarded as an indicator of adequate internal consistency and convergent validity.

For this research, content validity was firstly assessed through five in-depth personal interviews with SMEs in Egypt before data collection. Then, based on their valuable comments, the measured items were modified. Later, the content validity of the measured variables was secondly verified through the carried out face-to-face interviews with the rest of the 71 SMEs working in 43 different educational institutions/research centers and representing different SC members/nodes (e.g., supplier, service provider, and customer/stakeholder) across the ESC in Egypt.

Regarding the KMO and Bartlett's test, Table 7.3 shows its results (using SPSS software), which indicate high value of KMO statistics (range from 0.625 to 0.847) and the significance of Bartlett's test statistics ($p \leq 0.0001$) of the five latent constructs. According to Koçoglu *et al.* (2011), the Kaiser-Meyer-Olkin test of sampling adequacy indicates to what extent the used measured variables are adequate enough to measure its corresponding constructs. In addition, each factor's means and standard deviations revealed throughout Table 7.3 and calculated via SPSS software were found to be within the expected ranges.

Table 7.3. Summary of measurement results using SmartPLS software and SPSS software

Latent construct	KMO and Bartlett's test statistics significance	AVE	CR	Cronbach's alpha	Factors	No. of items	Mean	SD	Loadings	SE	T statistics
ICT	0.847 0.000	0.881	0.937	0.865	INTEROL	6	3.130	1.068	0.940	0.018	52.213
					INTRAOL	6	2.886	0.985	0.937	0.019	48.409
SCI	0.625 0.000	0.640	0.876	0.811	UI	5	2.966	0.935	0.782	0.058	13.514
					DI	6	3.342	0.939	0.792	0.074	10.713
					II	5	3.454	0.731	0.872	0.040	21.555
					UIP	6	2.866	1.008	0.749	0.096	7.794
SCIS	0.716 0.000	0.790	0.918	0.867	UIS	7	3.146	0.890	0.845	0.077	10.998
					DIS	8	3.439	0.865	0.915	0.022	41.395
					IIS	8	3.168	0.932	0.905	0.030	30.014
HSCP	0.792 0.000	0.780	0.914	0.858	LSCP	8	3.342	0.682	0.871	0.046	19.008
					ASCP	9	3.220	0.985	0.923	0.020	45.054
					LEAGSCP	3	3.317	0.803	0.854	0.043	20.062
TI	0.701 0.000	0.632	0.911	0.886	TI	6	3.065	0.968	0.817 0.780 0.846 0.815 0.778 0.728	0.051 0.058 0.059 0.046 0.101 0.131	16.071 13.450 14.432 17.716 7.703 5.549

With regard to investigating the nomological validity, the research hypotheses were tested using SEM with SmartPLS software. As discussed before in the section of automotive SC data analysis, this validity test can be established through ensuring the existence of logical correlations –based on aforementioned prior studies– between the latent constructs of the research model (Hair *et al.*, 2010). Figure 7.2 illustrates the results of the current research PLS structural equation model, which indicate that ICT employment has a positive and significant effect on SCI (β = 0.590, t = 4.173), and SCI has a positive and significant effect on SCIS (β = 0.812, t = 15.205).

Therefore, H2 and H3 are supported. Moreover, H1 is supported as ICT employment has a positive and significant effect on HSCP (β = 0.550, t = 3.579). Compared to automotive SC results, conversely, there is a positive and significant effect of SCIS on HSCP (β = 0.366, t = 2.393).

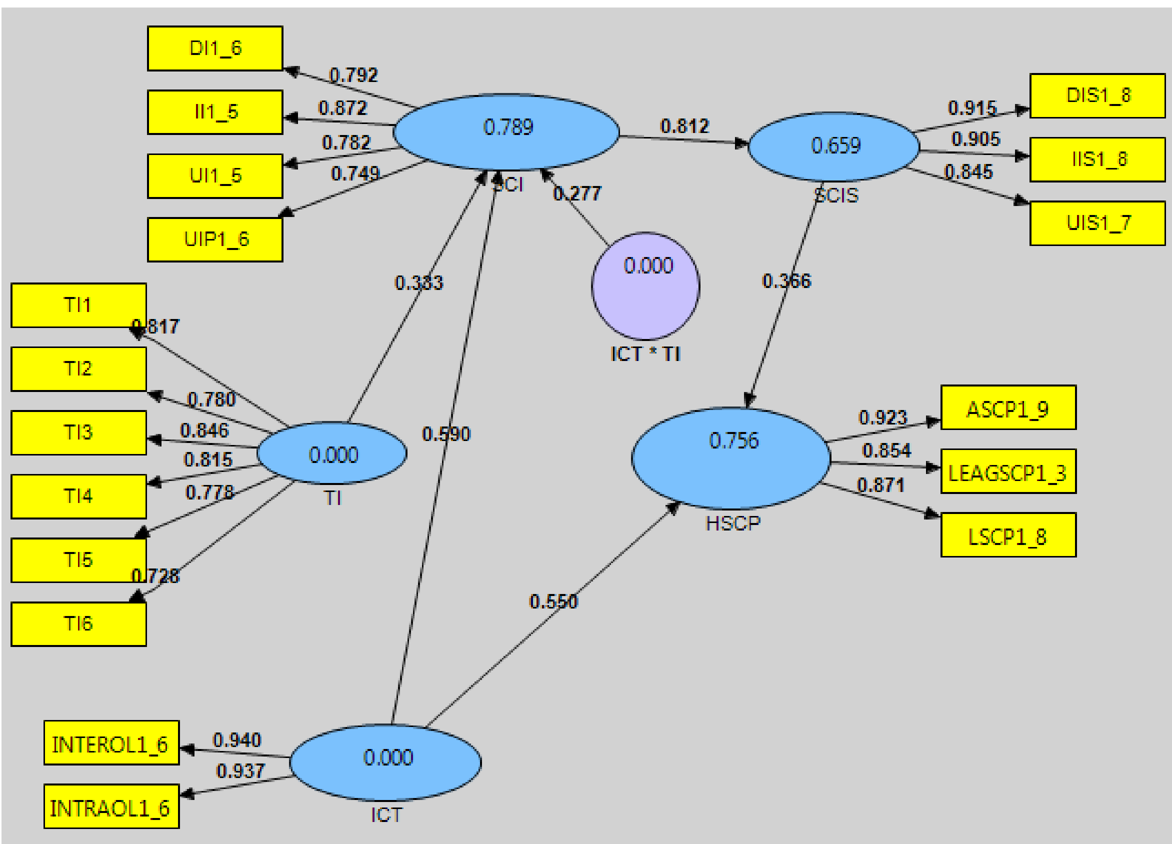


Figure 7.2. Results of partial least squares (PLS)-structural equation model (SEM) technique

For the purpose of in-depth investigation of the direct effect of ICT and the mediation effect of SCM (SCI and SCIS) on HSCP in terms of leanness, agility and leagility (i.e., direct ICT-HSCP relationship and indirect relationship via SCM), SEM was used to test the sub-hypotheses of H1 (i.e., H1a, H1b, H1c) and H4 (i.e., H4a, H4b, H4c).

Results showed that H1a, H1b and H1c are accepted due to the positive and significant relationships between ICT and lean SCP ($\beta = 0.505$, $t = 3.959$), ICT and agile SCP ($\beta = 0.367$, $t = 2.407$), and ICT and leagile SCP ($\beta = 0.602$, $t = 3.181$). In addition, H4a and H4b are accepted due to the positive and significant relationships between SCIS and lean SCP ($\beta = 0.306$, $t = 2.345$), and SCIS and agile SCP ($\beta = 0.506$, $t = 3.648$). On the other hand, H4c is not supported as there is a positive but insignificant relationship between SCIS and leagile SCP ($\beta = 0.137$, $t = 0.682$).

Thus, it can be concluded that the direct effect of ICT on lean, agile and leagile SCP and the mediation effect of SCM (SCI and SCIS) on lean and agile SCP are supported. Meanwhile, the mediation effect of SCM (SCI and SCIS) on leagile SCP is not supported. Many reasons can lie behind these findings; one of these can be due to the need for the mediation effect of SCM practices (e.g., SCI and SCIS) for more effective and efficient lean and agile SCP in terms of efficiency/cost-reduction, removal of wastes and continuous improvement; in addition to speed, flexibility, responsiveness.

Also, at this point it is important to mention that more than one interviewee of the educational institutions operating in this sector in Egypt said: “Mass-customization and postponement require different conducted procedures and agreements at the Egyptian Supreme Council of Universities”. Accordingly, other factors (e.g., regulations and policies) can significantly affect the educational leagile SCP in Egypt.

In summary, we can conclude that these results support the hybridized strategy of SCP in terms of leanness, agility and leagility.

Regarding the moderation effect of TI on the relationship between ICT and SCI (after adding the UIP dimension to SCI), both the SmartPLS software and SPSS software were used to test this effect. Results indicated that TI positively and significantly affects SCI ($\beta = 0.333$, $t = 2.241$).

Furthermore, the interaction between ICT and TI is also significant (β = 0.277, t = 2.274; p = 0.001), suggesting that the effect of ICT on SCI depends on the level of TI.

After conducting multicollinearity test (via SPSS) in order to inspect the existence of any collinear factors in the suggested model, following Field (2005, 2009), it was found that the VIF values are all lower than 10 (e.g., largest value = 4.302; its tolerance = 0.232). Additionally, the tolerance statistics of all the factors are more than 0.2 (i.e., range from 0.232 to 0.439). Thus, according to Field (2009), there is absence of collinearity among the collected data, which supports the discriminant validity. In regard to the discriminant validity, following Hair *et al.* (2010) and Yang and Liu (2012), χ^2 difference tests of each two latent constructs were established –using LISREL software– in order to assess then verify the discriminant validity. These χ^2 difference tests (i.e., ICT & HSCP = 33.97; ICT & SCIS = 48.06; ICT & TI = 20.5; SCI & SCIS = 10.74; SCI & HSCP = 34.6; SCI & TI = 4.29; SCIS & TI = 58.96; SCIS & HSCP = 69.41; TI & HSCP = 63.95) are found to be significant, which indicate sufficient discriminant validity of the research constructs.

Afterwards, the researcher comparatively investigated the differences of the measurement results between the two sectors.

7.4. Conclusion: Differences of SEM Results among the Two Sectors

The most obvious difference can be found in the relationship between SCIS and HSCP (i.e., mediation effect of SCM). After adding the UIP dimension to the SCI construct, the researcher empirically tested the mediation effect of SCM on the HSCP of the higher educational institutions. Compared to automotive SC results, conversely, there is a positive and significant effect of SCIS on HSCP (β = 0.366, t = 2.393); thus, it proves the need for UIP for more effective and efficient HSCP of educational institutions.

Despite the interaction between ICT and TI was proven to be significant (β = 0.277, t = 2.274; p = 0.001) in the educational sector, which suggests that the effect of ICT on SCI depends on the level of TI; there is a significant difference of the relationship coefficient –as shown in Table

7.4– between ICT and SCI and was found to be higher (i.e., significant difference β = 0.300, t = 3.231) in the automotive sector (i.e., before adding TI as a moderator).

Table 7.4. Differences of SEM results among the two sectors (Using AMOS software for automotive sector and SmartPLS software for education sector; Comparison via Excel)

<table>
<tr><th rowspan="3">Hypothesis/
Path</th><th colspan="6">Manufacturing vs. Service</th><th colspan="2" rowspan="2">Difference</th></tr>
<tr><th colspan="3">Automotive</th><th colspan="3">Education</th></tr>
<tr><th>Coefficient</th><th>T statistics</th><th>SE</th><th>Coefficient</th><th>T statistics</th><th>SE</th><th>Coefficient</th><th>T statistics</th></tr>
<tr><td>H1
ICT → HSCP</td><td>0.581</td><td>2.441</td><td>0.479</td><td>0.550</td><td>3.579</td><td>0.154</td><td>0.031</td><td>0.045</td></tr>
<tr><td>H2
ICT → SCI</td><td>0.890</td><td>45.135</td><td>0.022</td><td>0.590</td><td>4.173</td><td>0.141</td><td>0.300</td><td>3.231</td></tr>
<tr><td>H3
SCI → SCIS</td><td>0.810</td><td>67.725</td><td>0.015</td><td>0.812</td><td>15.205</td><td>0.053</td><td>0.002</td><td>0.057</td></tr>
<tr><td>H4
SCIS → HSCP</td><td>0.431</td><td>1.091</td><td>0.345</td><td>0.366</td><td>2.393</td><td>0.153</td><td>0.065</td><td>0.219</td></tr>
<tr><td>Population size</td><td colspan="3">101</td><td colspan="3">63</td><td colspan="2">Total of 164 organizations</td></tr>
<tr><td>Sample size</td><td colspan="3">84</td><td colspan="3">41</td><td colspan="2">Total of 125 surveys/questionnaires</td></tr>
<tr><td>Response rate</td><td colspan="3">83.16%</td><td colspan="3">65.08%</td><td colspan="2"></td></tr>
<tr><td>No. of in-depth face-to-face interviews</td><td colspan="3">89</td><td colspan="3">71</td><td colspan="2">Total of 160
in-depth interviews</td></tr>
<tr><td>No. of organizations accepted to participate in the interviews and surveys</td><td colspan="3">86 different organizations (i.e., 84 ACs + 2 stakeholders) representing multiple SC nodes (e.g., tier 1/2 supplier, manufacturer, distributor, stakeholder and customer)</td><td colspan="3">43
(i.e., 41 universities/academies + 2 stakeholders)</td><td colspan="2">Total of 129 organizations located in 15 Governorates in Egypt</td></tr>
</table>

However, regarding the rest/most of the model paths/research hypotheses (i.e., H1, H3 and H4), there are insignificant differences among their coefficients between the two sectors.

Therefore, it can be concluded that the empirical investigation of the research model relationships in the two sectors (serving as two examples of the manufacturing and service industries in Egypt) yield very close measurement results. Thus, it can be further concluded that these results support the new hybridized strategy of SCP in terms of leanness, agility and leagility in the automotive industry and HEIs as two examples of the manufacturing and service industries in Egypt.

CHAPTER EIGHT

Conclusion, Discussion, Limitations and Recommendations

(including a Suggested Higher Education-Industry SCM Model)

8.1. Introduction

This chapter summarizes the research findings and conclusions. Additionally, it discusses the main findings in the light of the conceptual and empirical contribution and managerial implications. Furthermore, it points out the research limitations and suggestions for future research. Regarding the higher education sector, it presents a new education SCM model –based on the research qualitative and quantitative data analysis– and recommends its usage for improving the SCP of HEIs operating in Egypt.

8.2. Main Findings and Conclusions

The purpose of this study was to investigate the direct effect of information and communication technology employment (i.e., direct ICT-HSCP relationship), the moderating effect of technology intelligence (TI) on ESCI and the mediation effect of SCM (i.e., supply chain integration and supply chain information sharing) on hybrid supply chain performance (i.e., indirect ICT-HSCP relationship via SCM) in terms of leanness, agility and leagility of the automotive companies and HEIs operating in Egypt.

A mixed methods approach was used to obtain a realistic and comprehensive picture of the type and structure of the hybrid performance carried out by multiple nodes across the AISC (i.e., different sub-sectors) and HESC in Egypt.

With regard to the automotive sector, the research findings show that ICT employment has a positive and significant effect on SCI, and SCI has a positive and significant effect on SCIS. Additionally, ICT employment has a positive and significant effect on HSCP. On the other hand, there is a positive but insignificant effect of SCIS on HSCP. However, based on further analysis, the researcher verified the direct positive significant effect of ICT on lean and agile HSCP and the mediation effect of SCM (SCI and SCIS) on leagile HSCP. Furthermore, the researcher used one-way ANOVA and SEM to test for differences between the three AISC nodes/sub-sectors (EAFI, EAM and CBUM) regarding their hybrid SCP in terms of leanness, agility and leagility. Results showed that there are significant differences among the HSCP of the three groups. Practically, it was evident from the results of the quantitative and qualitative data analyses that the three main sub-sectors of AISC in Egypt –one example of an emerging market– are using a blended strategy that hybridizes attributes of leanness (e.g., cost-minimization, waste-reduction, continuous improvement) together with that of agility (e.g., speed, flexibility, responsiveness) and leagility (e.g., mass-customization, postponement). Moreover, the percentage of the hybridized lean component is higher, upstream the AISC (i.e., automotive suppliers in the EAFI), than the agility component in the same sub-sector; compared to the SC market-interface (i.e., automotive distributors downstream the AISC), which operates in a more agile-manner.

For the higher education sector (universities and academies), results show that ICT employment has a positive and significant effect on SCI, SCI has a positive and significant effect on SCIS, and ICT employment has a positive and significant effect on education HSCP. Regarding the moderation effect of TI on the relationship between ICT and SCI, after adding the UIP dimension to SCI, results indicate that TI positively and significantly affects SCI. Furthermore, the interaction between ICT and TI is also significant, suggesting that the effect of ICT on SCI depends on the level of TI. Compared to automotive SC results, conversely, there is a positive and significant effect of SCIS on HSCP. However, regarding most of the research hypotheses (i.e., H1, H3 and H4), there are insignificant differences among their coefficients between the two sectors.

Therefore, it can be concluded that the empirical investigation of the research model relationships in the two sectors (serving as two examples of the manufacturing and service industries in Egypt) yield very close measurement results. Thus, it can be further concluded that these results support the new hybridized strategy of SCP in terms of leanness, agility and leagility in the automotive industry and HEIs as two examples of the manufacturing and service industries in Egypt.

8.3. Discussion and Managerial Implications

8.3.1. Discussion of the Conceptual and Empirical Contributions

This study contributes to the literature of contemporary supply chain management in many interdependent ways:

First, as a conceptual contribution, it conceptually adds to the active debate on the applicability of the blended lean-agile SC strategy by integrating two main streamlines of prior management research regarding this empirical issue; namely the leagility approach and the hybridized lean-agile manufacturing system, into one new hybridized approach. In other words, this thesis considers both lines of research as being complementary rather than competitive. It builds on the idea of having different attributes from each strategy (i.e., leanness and agility) in one organizational manufacturing system, which was revealed throughout the second line of research. However, it adds to this line of thinking the leagility component (i.e., in terms of mass-customization and postponement) and the impact of the organization position along the SC on the hybridized component/share of each strategy, which were extracted from the first streamline of research. As it was evident from the results of the quantitative and qualitative data analyses that the HEIs and the three main sub-sectors of AISC in Egypt –one example of the emerging markets– are using a blended strategy that hybridizes attributes of leanness (e.g., cost-minimization, waste-reduction, continuous improvement) together with that of agility (e.g., speed, flexibility, responsiveness) and leagility (e.g., mass-customization, postponement). In addition, after conducting multi-group/sub-sector analysis, the percentage of the hybridized lean component was found to be higher, upstream the AISC (i.e., automotive suppliers in the EAFI), than the agility component in the same sub-sector; compared to the SC market-interface (i.e., automotive distributors downstream the AISC), which operates in a more agile-manner.

Second as an empirical contribution, to the best of the researcher's knowledge, this research can be considered as the first attempt in the SCM literature to empirically investigate the direct and indirect impact of ICT on hybrid lean-agile supply chain performance of companies virtually located at different positions (i.e., multiple nodes) across the same AISC in Egypt as one example of an emerging automotive market.

Third, as far as the researcher knows, this is the first study that maps the Egyptian automotive industry SC in order to depict a holistic view of the nature of this important industry in an emerging market, which serves as an example of an interesting yet uninvestigated context of contemporary SCM research. In an interdependent manner, this thesis draws its main players and sub-sectors, based on the qualitative analysis of the collected data throughout 94 conducted in-depth interviews within 89 different organizations in Egypt (i.e., 89 interviews within 84 auto-parts/automotive companies + 5 interviews within 5 educational institutions and research centers supplying these automotive companies with information/HR).

Fourth, despite the fast growth of the SCM literature, there have been few trials –according to the researcher's knowledge– in the SCM literature to study the integration of ICT and SCM as two interdependent fields. Thus, this thesis contributes to the management research literature that tried to fill this knowledge gap from a seamless multidisciplinary perspective.

Finally, despite the abundance of studies which have focused on applying SCM practices to different manufacturing industries, few studies were concerned about the application of successful SCM practices to the service sector; particularly the education sector in spite of the fact that its SC affects either positively or negatively many other different sectors/industries. Moreover, as far as the literature has been investigated, there is a lack of studies that empirically assessed the ICT/TI-SCM-HSCP relationship in terms of leanness, agility and leagility in the context of higher education; especially in Egypt. Thus, this thesis adds to the few detected attempts in the contemporary SCM research literature, which considers education management (EMgt) and SCM as two interdependent fields.

8.3.2. Managerial Implications and Recommendations

The findings of this thesis have different implications for both sectors, namely the automotive and higher education sectors in Egypt.

8.3.2.a. Recommendations directed to the Automotive Sector in Egypt

In regard to the automotive sector, several implications were discussed −within this section− that are related to:

(1) The supply chain managers of the Egyptian automotive industry in general; and

(2) The supply chain managers of each automotive sub-sector/node.

First, managers who are studying the possibility of injecting more investments towards improving their HSCP are recommended to:

(a) Consider investing in inter- and intra-organizational technologies that in turn will enhance their hybrid SCP in terms of leanness and agility;
(b) Employ those types of information and communication technologies that facilitate end-to-end SCI and SCIS;
(c) Formulate, implement and evaluate innovative SCM (i.e., SCI and SCIS) strategies that will improve their automotive hybrid SCP in terms of mass-customization and postponement;
(d) Use more advanced tools and systems of TI in order to enhance SCI, improve SCIS and boost the effectiveness and efficiency of hybrid AISCP together with ESCP; and
(e) Consider the education market (i.e., educational institutions and research centers) as one of their strategic suppliers of information/research and HR.

By this means, they can help in bridging the gap between HR supply and demand, in addition to collaboratively conduct various researches that will solve many of their managerial problems through linking new theories with successful practices.

Second, this study highlights for each SC node the importance of choosing the appropriate attributes of its hybridized SC strategy in terms of leanness, agility and leagility according to its position across the AISC.

In respect to the Egyptian auto-feeding industry (i.e., auto-parts suppliers in the first sub-sector upstream the AISC), they are advised to devote more resources towards improving their inter-organizational technologies, which will facilitate their SCIS and promote their LSCP and LEAGSCP.

While with regard to the Egyptian automotive manufacturers (i.e., second sub-sector), more effective and efficient mass-customization and postponement can be achieved if they utilized the appropriate types of inter-organizational technologies for that purpose.

In relation to the CBU market (i.e., CBU distributors in the third sub-sector), in order to maximize their desired level of agility, more efforts and investments should be placed towards improving their inter- and intra-organizational information synchronization, visibility and sharing. Thus, the results of this research give different automotive supply chain nodes in Egypt greater insights on how they can effectively and efficiently compete and maintain sustainable development in a dynamic globalized business environment.

8.3.2.b. Recommendations directed to the Higher Education Sector in Egypt (New Higher Education-Automotive SCM Model suggested by this Research)

Regarding the higher education sector in Egypt, two main gaps/research problems were detected related to: (1) HR supply and demand: The existing gap between job market qualifications (KSA) demand and education market qualifications (KSA) supply, which emerges from the information invisibility (i.e., absence of information synchronization and information sharing) that harms the ESC performance as SCIS is key but difficult to achieve in the education sector; and (2) Research supply and demand: The current weakness in the universities-industries research relationships (e.g., technology-based researches related to different Industries). Moreover, many of the stakeholders/participants/nodes (e.g., schools, HEIs, job market/employers) of the education supply chains (ESCs) operating in Egypt are acting in their own best individual interests without considering the effectiveness and efficiency of the whole SC, which contributes to creating many problems in different sectors in Egypt. Therefore, the researcher empirically studied the direct and indirect ICT-HSCP relationship via SCM (i.e., SCI and SCIS) and TI in the Egyptian education context; thus, adding to the contemporary SCM research literature that addresses bridging the gap between HR/research supply and demand.

Accordingly, the researcher used the triangulation approach in collecting qualitative and quantitative data to empirically investigate the research proposed relationships and develop a suggested model to bridge the detected gap between HR/research supply and demand. The main sources of the quantitative and qualitative collected data for investigating the research problem are: (1) Questionnaires: 41 HEIs accepted to participate, resulting in a response rate of 65.08%; (2) Depth-interviews: 71 interviews with SMEs in 43 educational institutions at 15 governorates; (3) Forums: participating in conducting three collaborative semi-structured forums at The American University in Cairo (AUC) with different SC academics and industry specialists from 15 different MFG/service organizations and HEIs; (4) Conferences: attending and presenting at two conferences discussing linking the education market with the job market, and received valuable feedback from SMEs attending these conferences through presentations questions, discussions and participating in its workshops; (5) Experimental case study: participating in applying different education SCM practices to MSA University (i.e., HEI operating in Egypt that accepted to participate in this experiment and where the researcher works in) for the purpose of maintaining up-stream and down-stream ESC integration with its stakeholders.

Afterwards, regarding MSA experimental case study, the researcher investigated the impact of SCM practices on improving MSA HSCP in terms of leanness, agility and leagility through conducting five depth interviews with leaders/SMEs empowered/responsible for applying these practices at the university. These education SCM practices included: (1) Conducting “Sharing Experience Seminars”, in which group of professionals and business entrepreneurs are sharing their best practices and experiences with MSA students to help them in understanding the business work environment and applying the studied principals (theory) with real-life cases (practice); (2) Offering students training opportunities and research internships at different local employers and other HEIs abroad; (3) Organized fieldtrips to various organizations (e.g., MFG and service industries, and research centers); (4) Brought guest speakers from different fields (academics and practitioners); (5) Adding to the main courses list of each faculty two courses prerequisite for graduation called "Graduation Practical Projects I and II" (i.e., applied to the Egyptian context); (6) Conducted different agreements about post-graduate scholarships at international universities; (7) Organized multidisciplinary and interdisciplinary conferences engaging different faculties and industries; (8) Created new inter/multidisciplinary prerequisite courses, electives and minors; (9) Conducted periodic employment fairs; (10) Established social development and community based projects (e.g., Lebaladna charity association) to serve the community; (11) Implemented blended e-learning approach in its education process that involves ICT in SCIS (e.g., Interactive Learner Centered Teaching-ILCT); and (12) Organized different activities with schools (e.g., schools trips to the university, workshops at schools or at the university, summer courses to different schools' students) to sustain upstream SCI.

Consequently, after applying these educational SCM practices to MSA, results showed that inter- and intra-organizational integration and information sharing (i.e., upstream/downstream SCI and SCIS) with different stakeholders were improved leading to enhanced level of HSCP in terms of leanness, agility and leagility.

Finally, the HEIs and research centers operating in Egypt are recommended by the researcher to conduct effective and efficient education SCM (i.e., managing SC flow of HR) and collaborative research (i.e., managing SC flow of information/research) through universities-industries partnerships, based on:

(a) Following the studies of Lau (2007), Al-Turki *et al.* (2008), Kargaev (2008), Habib and Jungthirapanich (2008, 2009a, 2009b), Ang *et al.* (2010) and Abd-Elall *et al.* (2011) that discussed the importance of applying the SCM approach to the educational institutions and pioneered the ESCM stream line of research;
(b) The findings of the qualitative and quantitative data analysis of the current research (i.e., as shown in chapter six and seven); and
(c) The successful global (e.g., Geiger and Sá, 2005; Ponis and Koronis, 2005; Om *et al.*, 2007; Shultz, 2007; Worasinchai and Bechina, 2009, 2010; Habib, 2011; Van Hoek *et al.*, 2011; Pathik *et al.*, 2012a, b; Varma, 2012; Bak and Boulocher-Passet, 2013; Sohal, 2013)

and national SCM practices implemented in the higher educational sector and discussed throughout chapter three and six.

Based on the prior research literature and the conducted qualitative/quantitative data analysis for the current research, the findings of this thesis have different implications for the leaders of various ESC nodes/stakeholders in Egypt:

1) Active participation is needed of HEIs and its corresponding job market (i.e., various organizations from different industries according to the specialization of each faculty) to conduct cooperative/collaborative research (CR) through university-industry partnerships (e.g., Research parks integrating universities, industries and the community).

2) Sustain knowledge-based systems working on a multidisciplinary qualification-database used to provide ESCs stakeholders with real-time qualifications demand and supply. ICT can be used to improve the effectiveness and efficiency of the information flow between students, educational institutions and employers.

3) Each ESC node should not be acting in its own best individual interest without considering the effectiveness and efficiency of the whole ESC. Otherwise, it will contribute to creating many problems in different sectors in Egypt.

4) Representatives from different manufacturing and service industries should be more involved in developing curricula in HEIs (i.e., bridging the gap between theory and practice).

5) Government should incentivize endowment funds, which are tax deductible for donors. Thus, many entrepreneurs will be motivated to finance different research centers and HEIs in Egypt. However, industry should be the main investor in these UIP due to the direct positive impact of such relationship, which will support its sustainable innovation and HSCP improvement.

6) Develop community-based universities to better serve its stakeholders and conduct its researches on solving the problems of our society.

7) Change vision, mission, strategies and objectives of each HEI and MFG/service organization to maintain long term university-industry relationships.

8) Establish an Education-Industry Council that will be able to facilitate the cooperation between educational institutions and industry in Egypt. This recommendation was pointed out by Dr. Tarek Wahdan (i.e., one of the current research interviewees as shown in Appendix C/2) the Director of Operations at AUC Executive Education and Former Director of the Quality Management Institute at AUC Management Center.

9) Conduct collaborative projects that involve networks of public and private HEIs (e.g., Students/staff exchange, scholarships and research projects). At this point, it is important to mention that EU and many institutions providing funds to HEIs set it as a condition for financing them.

10) Use ICT and encourage blended and e-learning in order to facilitate SCI and SCIS, which in turn will enhance hybrid ESCP in terms of leanness and agility.

11) Develop interdisciplinary and multidisciplinary under/post graduate programs, which integrate related fields from different faculties.

12) Sustaining effective and efficient intra-organizational integration and information sharing with the HEIs students and staff is crucial for better HSCP of these institutions in Egypt.

As shown in Figure 8.1, from a conceptual perspective, this research views the Egyptian educational and research service as a spinal cord (i.e., a cord of different SC flows: information, research and HR) that runs up along the backbone (i.e., supply chain) of various manufacturing industries, including automotive sector, and other service industries in Egypt.

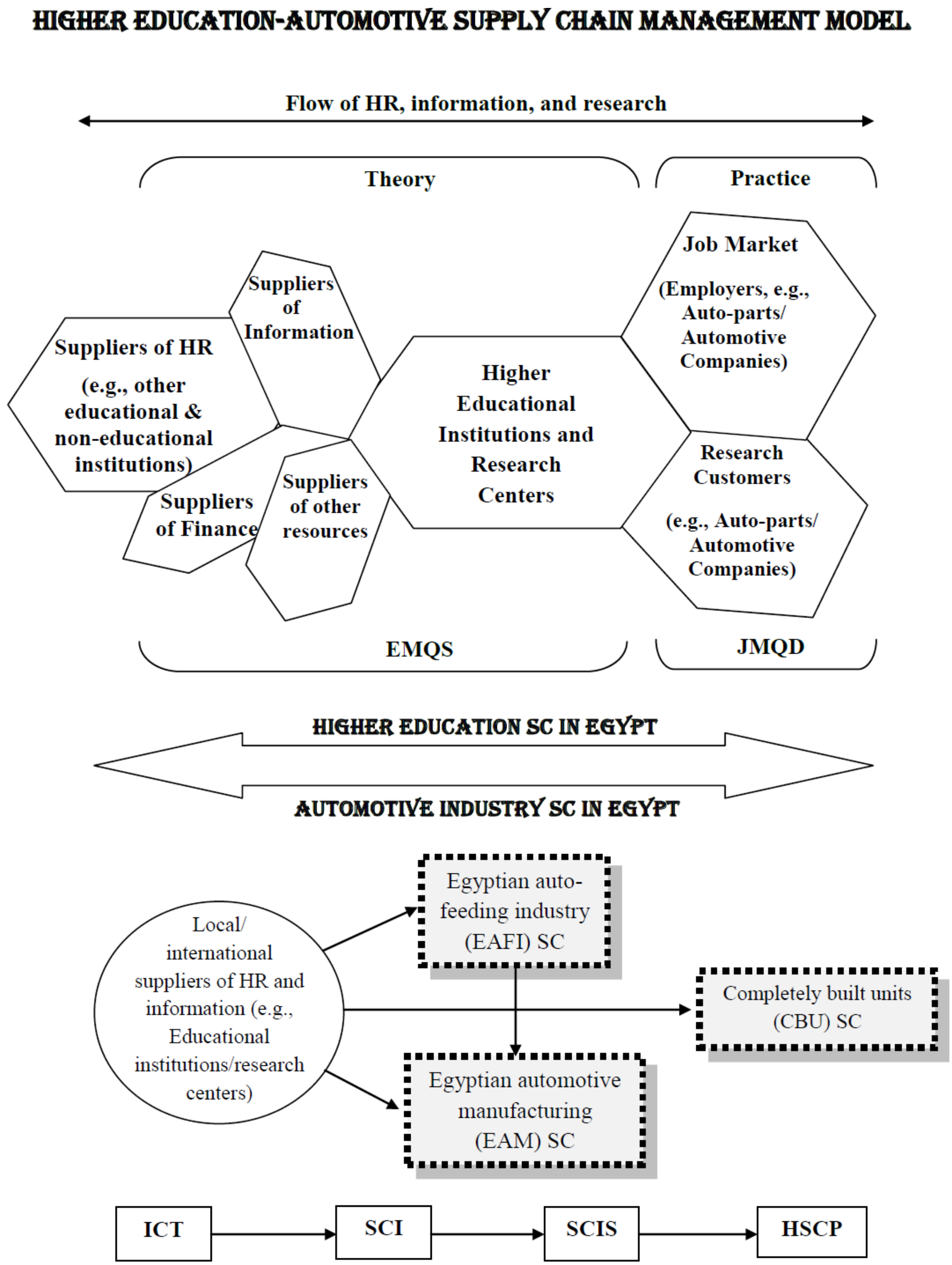


Figure 8.1. New higher education-automotive SCM model suggested by the findings of the current research to bridge the detected gap between HR/research supply and demand (academia-industry partnership)

Furthermore, from an empirical perspective, results showed that ICT employment has a positive and significant effect on SCI, SCI has a positive and significant effect on SCIS, and ICT employment and SCIS have positive and significant effect on education HSCP.

By this means, HEIs, research centers and automotive companies can be able to bridge the detected gap between: (a) HR supply (i.e., supplied qualifications EMQS) and demand (i.e., needed qualifications JMQD), and (b) information/research supply (e.g., contemporary theories) and demand (e.g., successful practices) (as illustrated in Figure 8.1).

8.4. Research Limitations and Direction for Future Research

One of the limitations of this study is that the impact of ICT and SCM on HSCP was studied for only one sector of the manufacturing industry (i.e., automotive sector) and another sector of the service industry (i.e., higher education) due to the importance of effectively and efficiently applying successful SCM practices to these two sectors, which was revealed throughout this research.

However, three main hybridized performance paradigms of SCs (i.e., lean, agile, and leagile SCP) were assessed related to public and private auto-parts/vehicles manufacturing and distributing companies –of three sub-sectors– operating in Egypt, in order to provide a large picture of the entire automotive industry SC in an emerging market. In addition, three main hybrid lean-agile SCP paradigms were assessed of profit and non-profit HEIs operating in Egypt.

Thus, the researcher suggests that future empirical research in respect to HSCP should be directed towards other manufacturing and service sectors in different emerging and developed markets.

Another limitation lies in the unequal size of the groups of respondents among the two sectors and between the AISC three sub-sectors due to the nature of the Egyptian automotive industry and higher education market; in addition to their small population sizes. Additionally, generalization to other markets might be limited due to the small size of population. However, its size is large enough in both sectors to provide a framework that can be used/modified in future studies.

Hence, this study targeted the entire population resulting in a high response rate –in spite of being geographically dispersed at different 15 governorates all over the country which made the data collection process an extremely difficult one– in order to minimize the negative effect of its small size on the statistical test power and results. Besides, this study used a mixed methods approach and conducted 160 in-depth interviews with SMEs working in 129 different organizations and representing multiple SC nodes (e.g., tier 1/2 supplier, manufacturer/service provider, distributor and customer) of both sectors, which provides management researchers with a comprehensive view of attractive yet unexplored contexts of contemporary management research.

Despite the large number of factors included in the research model (1^{st} and 2^{nd} order factors) that requires larger number of cases especially while using SEM in data analysis, each factor was measured by at least three items and had high positive communalities (AVE $\geq$ 0.5). Also, SmartPLS software was used for data analysis of the second sector due to its small sample size as it is designed to provide reliable results for small-to-medium sample sizes (Koçoglu *et al.*, 2011); thus, reducing the negative impact of this limitation.

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Appendices

Appendix (A)

Research Interview Question List (Automotive Supply Chain Questionnaire)

Appendix (A): Automotive Supply Chain Interview Question List

(Adopted/adapted from Azevedo *et al.*, 2011; Azevedo *et al.*, 2012; Boon-itt and Paul, 2006; Lau, 2007; Swafford *et al.*, 2008; Li *et al.*, 2006; Ibrahim and Ogunyemi, 2012; Lee *et al.*, 2007; Kim, 2009)

Part A: Firm characterization

Please indicate the following data that characterize your Organization:

Sector:	Primary Product(s):
Primary Customer(s):	Primary Supplier(s):
Your Job Title:	Your Organization's Position in the Supply Chain (Manufacturer/Supplier/Distributor):

Part B: Automotive SCM

- What is the main goal of supply chain management in your organization? (Efficiency/Flexibility and responsiveness/mass-customization)

- Rank the used SC performance paradigm in your organization:

  - Leanness
  - Agility
  - Leagility

- How does the supply chain start in your organization? Material and Informational

- How does it flow? Material and Informational

- What are the main SCM critical success factors in your organization?

- What are the main challenges/obstacles/roadblocks to effective and efficient SCM in your organization?

- Is your SCM main goal achieved? Why?

Part C: ICT, SCI, SCIS and HSCP

- What information and communications technology (ICT) that your organization have used and planning to use? How do you comment on these technologies?

- What are the different practices used by your organization to maintain/sustain university-industry relationships?

- Are the technologies employed in our organization new and up to date? Kindly specify the current (potential) ICT that your organization/SC is (will be) using

- What are the different sources of technology intelligence (TI) that your organization is using?

- For the following practices, please give information (i.e., draw ✓) on their implementation level in your organization (1 – Not implemented, …. , 5 – Totally implemented)

Construct/item	Description	1	2	3	4	5
Factor (1). INTEROL						
$ICT_1/INTEROL_1$	There are direct computer-to-computer links with our key trading partners					
$ICT_2/INTEROL_2$	Inter-organizational coordination is achieved using electronic links					
$ICT_3/INTEROL_3$	We have electronic mailing capabilities with our trading partners					
$ICT_4/INTEROL_4$	We use electronic transfer of data with our key trading partners					
$ICT_5/INTEROL_5$	We use ICT to integrate/coordinate activities with our key suppliers					
$ICT_6/INTEROL_6$	We use ICT to integrate/coordinate activities with our key customers					
Factor (2). INTRAOL						
$ICT_7/INTRAOL_1$	There is an effective usage of computers in manufacturing and/or operations and decision-making					
$ICT_8/INTRAOL_2$	We use ICT to integrate/coordinate activities in procurement					
$ICT_9/INTRAOL_3$	We use ICT to integrate/coordinate activities in order management					
$ICT_{10}/INTRAOL_4$	We use ICT to integrate/coordinate activities in logistics and distribution					
$ICT_{11}/INTRAOL_5$	We use enterprise resource planning (ERP) or supply chain planning software for managing/coordinating local and global supply chain activities					
$ICT_{12}/INTRAOL_6$	We have an information system and an integrated database for our main functional areas					
Factor (3). UI						
SCI_1/UI_1	We have a high degree of strategic partnership and long-term relationship with our suppliers					
SCI_2/UI_2	Our suppliers provide efficient and reliable delivery (inbound delivery) to our organization					
SCI_3/UI_3	There is a high degree of joint planning to obtain rapid response ordering process with our suppliers					
SCI_4/UI_4	We regularly solve problems jointly with our local and overseas suppliers					
SCI_5/UI_5	We have continuous improvement programs conducted jointly with our key suppliers					
Factor (4). DI						
SCI_6/DI_1	We have a high degree of long-term relationship with our customers					
SCI_7/DI_2	There is a high degree of joint planning and forecasting with our customers to anticipate demand					
SCI_8/DI_3	we provide efficient and reliable delivery (outbound delivery) to our distributors/customers					
SCI_9/DI_4	We actively involve our customers in setting our reliability, responsiveness and other standards					
SCI_{10}/DI_5	We regularly measure and evaluate customer satisfaction					
SCI_{11}/DI_6	We attempt to exceed customer expectations					
Factor (5). II						
SCI_{12}/II_1	We have a high-level of responsiveness in our organization towards satisfying internal customer's needs					
SCI_{13}/II_2	We have an integrated system in our organization to link our internal departments					
SCI_{14}/II_3	We have easy access to key operational data in our integrated database					
SCI_{15}/II_4	We have real-time access to inventory levels in our organization					
SCI_{16}/II_5	We have periodic interdepartmental meetings and plans among our internal functions					
Factor (6). UIS						
$SCIS_1/UIS_1$	We regularly provide our suppliers with reliable information about demand forecast					
$SCIS_2/UIS_2$	Our suppliers and we share business knowledge of core business processes					
$SCIS_3/UIS_3$	Our suppliers keep us fully informed about issues that affect our business					
$SCIS_4/UIS_4$	We inform our suppliers in advance of changing needs					
$SCIS_5/UIS_5$	There is timely information exchange between us and our suppliers					
$SCIS_6/UIS_6$	We can easily find accurate information about the products and prices of our suppliers					
$SCIS_7/UIS_7$	We can easily monitor the status of our orders					

Factor (7). DIS						
$SCIS_8/DIS_1$	Our customers regularly provide us with reliable information about demand forecast					
$SCIS_9/DIS_2$	Our customers inform us in advance of changing needs					
$SCIS_{10}/DIS_3$	Our customers and we keep each other informed about events and changes that may affect any of us					
$SCIS_{11}/DIS_4$	Our customers can easily find accurate information about our products and prices					
$SCIS_{12}/DIS_5$	Our customers can easily monitor the status of their orders					
$SCIS_{13}/DIS_6$	We provide our customers with any information that might help them					
$SCIS_{14}/DIS_7$	There is a high-level of information sharing with our customers about market information					
$SCIS_{15}/DIS_8$	We share delivery and logistics information with our customers					
Factor (8). IIS						
$SCIS_{16}/IIS_1$	Within our organization, we emphasize on communication and information flow among order, inventory management, sales, and distribution processes					
$SCIS_{17}/IIS_2$	When planning new products or product changes, we use a team approach that involves all functional areas in our organization					
$SCIS_{18}/IIS_3$	Within our organization, managers can easily share information on supply chain needs					
$SCIS_{19}/IIS_4$	We regularly circulate to all managers in our organization reports that provide information on our supply chain activities					
$SCIS_{20}/IIS_5$	We openly share at all levels in our organization ideas about improving cooperation among departments					
$SCIS_{21}/IIS_6$	We regularly disseminate at all levels in our organization customer satisfaction data					
$SCIS_{22}/IIS_7$	We regularly analyze unsuccessful organizational endeavors and widely communicate the lessons learned					
$SCIS_{23}/IIS_8$	Top management repeatedly emphasizes the importance of information sharing in our organization					
Factor (9). LSCP						
$HSCP_1/LSCP_1$	Our supply chain system reduces inbound costs					
$HSCP_2/LSCP_2$	Our supply chain system reduces outbound costs					
$HSCP_3/LSCP_3$	Our supply chain system reduces warehousing costs					
$HSCP_4/LSCP_4$	Our supply chain system reduces inventory-holding cost					
$HSCP_5/LSCP_5$	Our supply chain system increases RONA (net income/net assets)					
$HSCP_6/LSCP_6$	Our supply chain system removes waste/non-value adding activities					
$HSCP_7/LSCP_7$	Our supply chain system implements continuous improvement based on identified-value					
$HSCP_8/LSCP_8$	Our supply chain system synchronizes SCM efforts to drive efficiency					
Factor (10). ASCP						
$HSCP_9/ASCP_1$	Our supply chain system can easily adapt its processes to accommodate variability in customer demand					
$HSCP_{10}/ASCP_2$	Our supply chain system can quickly adapt its processes to accommodate demand for new types of products					
$HSCP_{11}/ASCP_3$	We have the ability to change quantity of suppliers' orders					
$HSCP_{12}/ASCP_4$	We have the ability to change delivery times of suppliers' orders					
$HSCP_{13}/ASCP_5$	Our supply chain system has the required speed in reducing production lead-time					
$HSCP_{14}/ASCP_6$	Our supply chain system has the required speed in increasing product customization levels					
$HSCP_{15}/ASCP_7$	Our supply chain system has the required speed in adjusting delivery capability					
$HSCP_{16}/ASCP_8$	Our supply chain system has the required speed in improving customer service					
$HSCP_{17}/ASCP_9$	Our supply chain system has the required speed in improving responsiveness to changing market needs					
Factor (11). LEAGSCP						
$HSCP_{18}/LEAGSCP_1$	Our products are designed for modular-assembly/delayed-differentiation					
$HSCP_{19}/LEAGSCP_2$	Our supply chain system delays final product assembly activities until customer orders have actually been received					
$HSCP_{20}/LEAGSCP_3$	Our supply chain system delays final product assembly activities until the last possible SC position (or nearest to customers)					

Appendix (B)

Research Interview Question List (Education Supply Chain Questionnaire)

Appendix (B): Education Supply Chain Interview Question List

Part A: Organization characterization

Please indicate the following data that characterize your organization:

Sector:	Primary Product(s):
Primary Customer(s):	Primary Supplier(s):
Your Job Title:	Your Organization's Position in the Supply Chain (Supplier/Service-provider/Customer):

Part B: Education SCM

- What is the main goal of supply chain management in your Organization? (Efficiency/Flexibility and responsiveness/mass-customization)

- Rank the used SC Performance Paradigm in your organization:

  - Leanness
  - Agility
  - Leagility

- How does the supply chain start in your organization? Educational and Research/Informational

- How does it flow? Educational and Research/Informational

- What are the main SCM critical success factors in your organization?

- What are the main challenges/obstacles/roadblocks to effective and efficient SCM in your organization?

- Is your SCM main goal achieved? Why?

Part C: ICT, TI, SCI, SCIS and HSCP

- What information and communications technology (ICT) that your organization have used and planning to use? How do you comment on these technologies?

- What are the different practices used by your organization to maintain/sustain university-industry relationships?

- Are the technologies employed in our organization new and up to date? Kindly specify the current (potential) ICT that your organization/SC is (will be) using

- What are the different sources of technology intelligence (TI) that your organization is using?

- For the following practices, please give information (i.e., draw ✓) on their implementation level in your organization (1 – Not implemented, …. , 5 – Totally implemented)

		1	2	3	4	5
1/1	There are direct computer-to-computer links with our key partners/stakeholders					
1/2	Inter-organizational coordination is achieved using electronic links					
1/3	We have electronic mailing capabilities with our partners/stakeholders					
1/4	We use electronic transfer of data with our key partners/stakeholders					
1/5	We use ICT to integrate/coordinate activities with our key suppliers					
1/6	We use ICT to integrate/coordinate activities with our key customers					
2/1	There is an effective usage of computers in operations and decision-making					
2/2	We use ICT to integrate/coordinate activities in procurement					
2/3	We use ICT to integrate/coordinate activities in order management					
2/4	We use ICT to integrate/coordinate activities in logistics and distribution					
2/5	We use enterprise resource planning (ERP) or supply chain planning software for managing/coordinating local and global supply chain activities					
2/6	We have an information system and an integrated database for our main functional areas					
3/1	We have a high degree of strategic partnership and long-term relationship with our suppliers					
3/2	Our suppliers provide efficient and reliable delivery (inbound delivery) to our organization					
3/3	There is a high degree of joint planning to obtain rapid response ordering process with our suppliers					
3/4	We regularly solve problems jointly with our local and overseas suppliers					
3/5	We have continuous improvement programs conducted jointly with our key suppliers					
4/1	We have a high degree of long-term relationship with our customers					
4/2	There is a high degree of joint planning with our customers					
4/3	We provide efficient and reliable delivery (outbound delivery) to our customers					
4/4	We actively involve our customers in setting our reliability, responsiveness and other standards					
4/5	We regularly measure and evaluate customer satisfaction					
4/6	We attempt to exceed customer expectations					
5/1	We have a high-level of responsiveness in our organization towards satisfying internal customer's needs					
5/2	We have an integrated system in our organization to link our internal departments					
5/3	We have easy access to key operational data in our integrated database					
5/4	We have real-time access to inventory levels in our organization					
5/5	We have periodic interdepartmental meetings and plans among our internal functions					
6/1	We regularly provide our suppliers with reliable information about demand					
6/2	Our suppliers and we share business knowledge of core business processes					
6/3	Our suppliers keep us fully informed about issues that affect our business					
6/4	We inform our suppliers in advance of changing needs					
6/5	There is timely information exchange between us and our suppliers					
6/6	We can easily find accurate information about the products and prices of our suppliers					
6/7	We can easily monitor the status of our orders					
7/1	Our customers regularly provide us with reliable information about demand forecast					
7/2	Our customers inform us in advance of changing needs					
7/3	Our customers and we keep each other informed about events and changes that may affect any of us					
7/4	Our customers can easily find accurate information about our products and prices					
7/5	Our customers can easily monitor the status of their orders					
7/6	We provide our customers with any information that might help them					
7/7	There is a high-level of information sharing with our customers about market information					
7/8	We share delivery and logistics information with our customers					

8/1	Within our organization, we emphasize on communication and information flow among order, inventory management, and marketing processes					
8/2	When planning new products or product changes, we use a team approach that involves all functional areas in our organization					
8/3	Within our organization, managers can easily share information on supply chain needs					
8/4	We regularly circulate to all managers in our organization reports that provide information on our supply chain activities					
8/5	We openly share at all levels in our organization ideas about improving cooperation among departments					
8/6	We regularly disseminate at all levels in our organization customer satisfaction data					
8/7	We regularly analyze unsuccessful organizational endeavors and widely communicate the lessons learned					
8/8	Top management repeatedly emphasizes the importance of information sharing in our organization					
9/1	Our supply chain system reduces inbound costs					
9/2	Our supply chain system reduces outbound costs					
9/3	Our supply chain system reduces warehousing costs					
9/4	Our supply chain system reduces inventory-holding cost					
9/5	Our supply chain system increases RONA (net income/net assets)					
9/6	Our supply chain system removes waste/non-value adding activities					
9/7	Our supply chain system implements continuous improvement based on identified-value					
9/8	Our supply chain system synchronizes SCM efforts to drive efficiency					
10/1	Our supply chain system can easily adapt its processes to accommodate variability in customer demand					
10/2	Our supply chain system can quickly adapt its processes to accommodate demand for new types of products					
10/3	We have the ability to change quantity of suppliers' orders					
10/4	We have the ability to change delivery times of suppliers' orders					
10/5	Our supply chain system has the required speed in reducing production lead-time					
10/6	Our supply chain system has the required speed in increasing product customization levels					
10/7	Our supply chain system has the required speed in adjusting delivery capability					
10/8	Our supply chain system has the required speed in improving customer service					
10/9	Our supply chain system has the required speed in improving responsiveness to changing market needs					
11/1	Our products are designed for delayed-differentiation					
11/2	Our supply chain system delays final product finishing activities until customer orders have actually been received					
11/3	Our supply chain system delays final product finishing activities until the last possible SC position (or nearest to customers)					
12/1	Technologies employed in our organization are new and up to date					
12/2	Our organization is able to monitor the recent technology trends in our field					
12/3	Our organization is able to assess the recent technology trends used by our competitors					
12/4	Our organization possesses the proper ICT Tools to collect, analyze and communicate the relevant information on technology trends, in order to support technological and other general decisions in the organization					
12/5	Our organization can predict/forecast the recent technology trends in our field					
12/6	Our organization can predict the recent technology trends used by our competitors					
13/1	We provide training opportunities to different trainees from/to various industries/other educational institutions					
13/2	We receive professional consulting from different industries					
13/3	We provide academic/professional consulting to different industries/other educational institutions					
13/4	We sponsor various projects conducted by our students at different industries/other educational institutions					
13/5	We conduct collaborative research with industries					
13/6	We have joint university-industry R&D Projects					

Appendix (C)

Research Data Collection/Fieldwork Tables

Appendix (C/1): Research data collection/fieldwork tables

Table AIII.1. The research data collection/fieldwork table (Automotive sector/ASC)

Serial No.	Organization	Location	Position in ASC	Primary Product	Respondent/ Interviewee	Research Approach	Data Collection Method
1	Nissan Motor Egypt S.A.E [100% Foreign Ownership]	3rd Industrial Zone, Plots 1 & 2, 6th of October City	Manufacturer/ Assembler (Main Activities: Importing CBUs & Spare Parts (i.e., through Nissan Import Egypt Ltd) – Manufacturing/ Assembling from Local Components and CKDs – Distributing (i.e., through	Nissan Passenger Cars (PCs) and Commercial Vehicles (CVs) (e.g., N_{16}, N_{17}, D_{22}, T_{30})	- Eng. Tarek Beidak (General Manager: Production Control and SCM) - Eng. Mohamed Salah Hemdan (MRP Engineer: PC and SCM)	Mixed methods approach - Qualitative approach	- Direct in-depth semi-structured interview, observation (fieldwork notes), and text and image analysis (documents, reports and media data)

			Nissan Auto Egypt, which is an Authorized Dealer of Nissan Motor Egypt)			- Quantitative approach	- Personal survey method
2	General Motors (GM) Egypt [Joint Venture (Egyptian/ Foreign)]	4th Industrial Zone, 6th of October City	Manufacturer/ Assembler (Main Activities: Manufacturing/ Assembling from Local Components and CKDs – Importing Spare Parts, CBUs and Distributing (i.e., through its Sole Distributor Al-Mansour Automotive)	PCs and CVs: Chevrolet (e.g., Spark Lite, Spark, Aveo, Lanos, Sonic, Optra, Cruze, Captiva, Move, T-Series, N-Series); Opel (e.g., Astra, Corsa)	- Eng. Mohamed Shawki Yousef (Supply Operations Manager: Global Purchasing and Supply Chain)		
3	Suzuki Egypt S.A.E [Joint Venture	4th Industrial Zone, 6th of	Manufacturer/ Assembler (i.e., The	PCs and CVs: Suzuki (e.g., Alto, Celerio,	- Eng. Tarek Metwally (Deputy General Manager for Technical and New Projects)		

	(Egyptian/ Foreign)]	October City	Assembling Process passes through the following Shops and sections: Welding Shop, Painting Shop, Assembly Shop, Quality Control, Power Station) (Main Activities: Manufacturing/ Assembling from Local Components and CKDs – Importing Spare Parts, CBUs and Distributing (i.e., through its Authorized Dealer Modern Motors)	Swift, and Super Carry)			

4	Aboul Fotouh (AF) Automotive S.A.E (Daewoo Motor Egypt) [Joint Venture (Egyptian/ Foreign)]	3rd Industrial Zone, St. 14, 6th of October City	Manufacturer/ Assembler (Main Activities: Manufacturing/ Assembling from Local Components and CKDs – Importing CBUs –Distributing through different authorized Dealers (e.g., Aboul Fotouh Service Center)	Speranza PCs (e.g., A113, A516, A620, Tiggo, M11, and M12)	- Eng. Khaled Osman (Localization Senior Manager) - Eng. Wesam Mahmoud Amer (Localization Manager: Supply Chain Sector)		
5	Al-AMAL Co. for Vehicles Manufacturing and Assembly (AVM) (Lada Egypt) [Egyptian	Kilo 58, 10th of Ramadan City, 3rd Industrial Zone	Manufacturer/ Assembler (Main Activities: Manufacturing/ Assembling from Local	Lada and Build Your Dreams (BYD) Vehicles	- Eng. Tarek Elmosallami (Factory Manager)		

	Company]		Components and CKDs – Importing CBUs and Spare Parts – Distributing)				
6	MOBICA (Advanced Industries)	3rd Industrial Zone, Plot 3, 6th of October City	1st Tier Supplier (Feeding Industry to Automotive Manufacturers operating in Egypt) (Main Activities: Importing – Manufacturing/ Assembling)	Seats, Door Panels and Carpets	- Eng. Mohamed Hassan Amer (Quality Manager)		
7	Bavarian Auto Manufacturing Co. (Bavarian Auto Group (BAG))	4th Industrial Zone, Area 1/10, 6th of October City	Manufacturer/ Assembler (Main Activities: Importing CBUs – Manufacturing/	Passenger Cars (PCs): BMW (e.g., BMW 3 Series, 5 Series, 7 Series , X_3	- Eng. Mohamed Zakaria Ibrahim (Deputy General Manager for Operations) - Eng. Mohamed Abdel Kader Mahmoud (Supply Chain Senior Manager)		

	[Egyptian Company]		Assembling from Local Components and CKDs and SKDs – Distributing)	and X_1; in addition to newly imported CBUs: BMW 1 Series, 6 Series, X_5), and various MINI models, Brilliance (e.g., Galena 2.0L), Mahindra (e.g., Scoprio).			
8	Peugeot Egypt Cairo for Development and Cars Manufacturing S.A.E [Joint Venture	11 Salah Salem St., Cairo	Distributor (Agent, i.e., 3S: Sales, After Sales and Spare Parts) (Main Activities: Importing CBUs	Peugeot Vehicles (e.g., Peugeot 206, Peugeot 207, Peugeot 308, Peugeot 407, Peugeot 607, Pars, Partner,	- Hussein Hadeeb Hussein (Head of Importing Sector) - Tarek Essmat (Logistics Manager)		

	(Egyptian/ Foreign)]		and Spare Parts –Distributing)	and Boxer)			
9	Ghabbour Auto (GB Auto) [Egyptian Company]	Cairo-Alex Road Km. 28 Mohawelat Road, 2nd Industrial Zone, Abo Rawash	Manufacturer/ Assembler (Main Activities: Importing CBUs and Spare Parts – Manufacturing/ Assembling from Local Components and CKDs – Distributing) The sole representative of Hyundai and Mazda PCs and owning the biggest nationwide distribution and	Hyundai and Geely Vehicles Across five primary lines of business, Ghabbour Auto offers Passenger Cars, Motorcycles, Three-wheelers (Tuk-tuks), Buses, Trucks, Trailers, Superstructures, Construction Equipment and Tires, as well as after-sales service and spare parts for all of these vehicles	- Eng. Ashraf Mourice Youssef Eskander (Engineering Department Manager) - Eng. Sherif Mikhail Naguib Fawzy (Quality Department Manager) - Emil Amin Guerguis Ibrahim (Manufacturing Operation Planning Director)		

			after-sales service networks of any brand				
10	Egyptian German Automotive Co. S.A.E (EGA) [Mercedes-Benz Industrial Joint Venture in Egypt]	4^{th} Industrial Zone, 6^{th} of October City	Manufacturer/ Assembler (Main Activities: Importing CBUs – Manufacturing/ Assembling from Local Components and CKDs – Distributing)	Mercedes-Benz Passenger Cars: assembled from Local Components and CKDs (e.g., C200 C350, E-Class)	- Dr. Eng. Ahmed Fekry A. Wahab (General Manager and CEO) - Eng. Mohamed Salem (Business Development Senior Manager)		
11	Abouel Yazeed (AY) Group Engineering Co. for Exhaust Systems	2^{nd} Industrial Zone, Area 117/118, 6^{th} of October City	1^{st} Tier Supplier (Feeding Industry to Automotive Manufacturers operating in Egypt, e.g., GM, GB Auto, AAV)	Mufflers and Exhaust Systems	- Eng. Gasser Said Abdel-moneim (Projects Manager) - Eng. Hany Abou Zeid (Supply Chain Specialist)		

			(Main Activities: Importing – Manufacturing/ Assembling)				
12	Arab American Vehicles Co. (AAV) Arab Organization for Industrialization (AOI) [Joint Venture (Egyptian/ Foreign)]	Suez Road Km. 4.5	Manufacturer/ Assembler AAV is a joint venture between the AOI (51% ownership) and Chrysler Group LLC (49% ownership)	Sport Utility Vehicles (SUVs) (e.g., Toyota (Fortuner), Jeep Cherokee, and Jeep Wrangler)	- Eng. Mohamed Abd El-Hameed Mohamed Aly (Product Quality Manager)		
13	Industrial Development of Automotive Components S.A.E (IDACO)	3rd Industrial Zone, Area no. 243/17+250, 6th of October City	1st Tier Supplier (Feeding Industry to Automotive Manufacturers operating in Egypt, e.g., GM, Nissan, GB	Wiring Harnesses, Instrument Clusters, Sun Visors	- Eng. Mohamed Salah El Din (Supply Chain Manager)		

			Auto, AVM, AAV, Mitsubishi) (Main Activities: Importing – Manufacturing/ Assembling)				
14	LEONI Wiring Systems Egypt S.A.E	Public Free Zone, Cairo	1st Tier Supplier operating in Egypt -has about 36 other sites in different countries- but feeding Oversees Customers (i.e., Automotive Manufacturers worldwide, e.g., Land Rover, Aston Martin) (Main Activities:	Wiring Harnesses and Complete Wiring Systems for PCs & CVs, and Ready-to-fit Battery Cables	- Bassem El-Desouky (Planning Manager)		

			Importing – Manufacturing/ Assembling)				
15	Chrysler Group Egypt Limited (Owns 49% of AAV)	5th Settlement New Cairo, St. 90, PWC Building	Distribution, Marketing and After Sales support for Chrysler, Jeep, Dodge and Ram These Brands Retail Network in Egypt currently consists of 5 Authorized Sales and After Sales Dealers (e.g., Ezz Elarab Automotive Group is the Sole Agent to Chrysler, Abou Ghaly Motors is a Dealer to Jeep,	Chrysler, Jeep (i.e., locally assembled in Egypt by "AAV" factories), Dodge and Ram Passenger Cars and Trucks in Egypt	- Ayman Abu El Ela Radwan (Technical, Training and Warranty Manager)		

			and ElTarek) with 9 sales showrooms and 8 Authorized Service workshop				
16	El Zaharna Company (ELZ. CO.)	2nd Industrial Zone, Land no. D/1, 6th of October City	1st Tier Supplier (Feeding Industry to Automotive Manufacturers operating in Egypt, e.g., GM, GB Auto, AVM, MCV, Suzuki) (Main Activities: Importing – Manufacturing/ Assembling)	Sheet Metal Forming and Exhaust System	- Eng. Serag Eldin Gaber Serag (Factories Manager and Management Representative)		
17	ARTOC Auto (ARTOC Group Company)	Katameya – Ein Sokhna Road,	Exclusive Importer of Skoda Cars in Egypt, with a	CBUs of Skoda PCs (e.g., Superb, Octavia Fantasia, and	- Ahmed Khalil (Fleet Sales Manager)		

		Cairo	network of dealers and nationwide service centers, backed up by after-sales service (i.e., 3S: Sales, After Sales and Spare Parts) (Main Activities: Importing CBUs & Spare Parts – Distributing)	Fabia)			
18	Egyptian International for Trading and Agencies Co. (EIT) (Subsidiary of Egyptian International Motors (EIM)	3 Roxy Square, Heliopolis	The Sole Distributor of KIA Motors in Egypt Egypt Exclusive Importer of KIA PCs in Egypt (i.e., 3S: Sales, After Sales and	CBUs of KIA PCs (e.g., Cerato, Picanto, and Sportage) CBU Egyptian Market Leader 2012	- Sherif Fahim (Product Manager)		

	Group)		Spare Parts) (Main Activities: Importing CBUs & Spare Parts – Distributing)				
19	Ezz Elarab Automotive Group	Cairo-Alexandria Desert Road Km. 28, Abo Rawash	Distributor: Automotive Sales and Services Company. Ezz El Arab's automotive services, include Imports, Direct Sales operations, After-sales services and training facilities	CBUs of Volvo, Citroen, Chrysler, RAM, Dodge, Proton and Kawasaki, in addition to, Jeep (i.e., that was imported as CKDs and assembled in Egypt by "AAV" factories)	- Ahmed Mamdouh (Sales Consultant)		
20	Melco Metal Working Co.	Sadat City, 28 1^{st}	1^{st} Tier Supplier (Feeding	Manufacturer of Oil, Fuel and	- Eng. Mohamed Kamal (Chemical Engineer and Managing		

	(MELCO Filter) (Privately owned Egyptian Filter Manufacturing Company)	Industrial Zone	Industry to Automotive Manufacturers operating in Egypt (e.g., MCV), and other Oversees Customers (e.g., MANN) (Main Activities: Importing – Manufacturing/ Assembling)	Air Filters for Motor Vehicles and Equipment (Their Line of Products include: Liquid Filtration (e.g., Fuel, Oil, Hydraulic & Water Filters); Air Filters (e.g., Cartridges, Pocket, Roll); Bag Filters (e.g., for Jet Pulse, Reverse Air, Shaker); Cages for most bag houses; Dust Collectors (e.g., Jet Pulse Dust Collectors)	Partner)		
21	Al-Mansour Automotive	Gameat El-Dowal	Sole Distributor for GM	PCs and CVs: Chevrolet (e.g.,	- Mohamed El Zayat (Branch Sales Manager)		

		El-Arabia St., 54 Al-Zamalek Club, El-Mohandesin	automotive products in Egypt (Importer, Distributor and Retailer of Motor Vehicles)	Spark Lite, Spark, Aveo, Lanos, Sonic, Optra, Cruze, Captiva, Move, T-Series, N-Series); Opel (e.g., Astra, Corsa); Cadillac, and ISUZU			
22	Debes Company for Plastic Products + National Research Center (NRC)	National Research Center, Mechanical Engineering Department, Advanced Software Unit, Engineering Research Division Building,	2nd Tier Supplier to Automotive Manufacturers (i.e., Supplier of Supplier, which is 1st Tier Supplier (e.g., MOBICA), as it produces Semi-finished Plastic Products to MOBICA, which in turn	Plastic Products	- Dr. Eng. Mohamed Abdel Latif Ibrahim (Researcher in NRC and Managing Partner in Debes Co.)		

		Department of Solar Energy	provides it after being assembled as finished products to Automotive Manufacturers in Egypt)				
23	EL TERIAK Industrial Group	3rd Industrial Zone, Land no. 257, 6th of October City	1st Tier Supplier (Feeding Industry to Automotive Manufacturers operating in Egypt (e.g., AF, GM, AVM) (Main Activities: Importing – Manufacturing/ Assembling)	Al. Heat Exchangers, and Auto Air Conditioning (e.g., Cooling Modules, A/C Condensers and Radiators)	- Eng. Kirolos Teriak (Business Development Manager)		
24	ELTAREK Automotive	Mall of Arabia, Juhayna Square, 6th	Multi-brand Dealer (Both Fleet and Retail Sales)	Passenger Cars (e.g., Volkswagen, KIA, Hyundai,	- Mohamed El Zeiny (Branch Sales Manager)		

		of October City		Audi, Renault, Mitsubishi, Suzuki and Ford)			
25	Egyptian German Electric Systems S.A.E (EGES)	2nd Industrial Zone, Area 162, 6th of October City	1st Tier Supplier (Feeding Industry to Automotive Manufacturers operating in Egypt (e.g., EGA-Mercedes Benz, BAG-BMW) (Main Activities: Importing – Manufacturing/ Assembling)	Wiring Harnesses	- Eng. Samy Rahma (Operations Manager)		
26	FUTURE Industry & Trade (FIT) (MISRIAT)	2nd Industrial Zone, Area 113, 6th of	1st Tier Supplier (Feeding Industry to Automotive Manufacturers	Vehicle Audio Systems (e.g., Radio and CD Player)	- Eng. Amr Sakr (General Manager)		

		October City	operating in Egypt (e.g., GM, Nissan) (Main Activities: Importing – Manufacturing/ Assembling)				
27	ELSEWEDY CABLES Wires and Cables Sector United Industries Company (UIC)	5th Settlement, New Cairo, 1st District, Plot 27	2nd Tier Supplier to Automotive Manufacturers (i.e., Supplier of Supplier, which is 1st Tier Supplier (e.g., LEONI and IDACO), as it produces Wires and Cables Products to LEONI and IDACO, which in turn provide it after being	Wires and Cables Products (e.g., Power and Specialty Cables, Transformers, Accessories and other Electrical products) to both Local Egyptian Market and International Market (Top Exporter in Egypt and a	- Abdel Aziz El Gamal (Sales Accounts Manager)		

			assembled -as finished Wiring Harnesses and Complete Wiring Systems- to PCs and CVs Manufacturers in Egypt)	Prominent Player in the Turnkey project sector)			
28	Dr. Greiche (Leading Glass Processor in the Middle East and Africa)	3rd Industrial Zone A 1', 10th of Ramadan City	1st Tier Supplier (Feeding Industry to Automotive Manufacturers operating in Egypt (e.g., GB Auto, GM, Nissan, AF, MCV, AAV and Suzuki) Leading Glass Manufacturer in the region for Original Equipment	Glass (e.g., Glass for Vehicles, House Appliance Glass, Security Glass, Lighting Glass, Mirrors, and Architectural Glass) Glass for Vehicles (i.e., Complete Glass sets for vehicles are produced, and high quality	- Eng. Sayed Omara (Quality Assurance and Development Manager)		

			Manufacturers (OEM) and the Replacement Market.	vehicle Glass replacement is provided)			
29	Abou Ghaly Motors	Kilo 28, Ismailia Road	Authorized Dealer for several Passenger Car Brands (Subaru, Chrysler, Jeep, Dodge and Ram) (i.e., 3S: Sales, After Sales and Spare Parts)	CBUs of Chrysler, Dodge and Ram; in addition to Jeep (i.e., that was imported as CKDs and assembled in Egypt by "AAV" factories)	- Moataz Bellah Mohamed (Senior Service Advisor)		
30	Giza National Automotive (GNA)	1 El-Tahrir St., Dokki, Giza	Authorized Distributor (i.e., Authorized Mercedes-Benz Sales, Services and Parts) The National Automotive Company	Mercedes-Benz Passenger Cars: assembled from CKDs (e.g., C200 C350, E-Class), imported as CBUs (e.g., C180, B200)	- Hussein El Kholy (Authorized Sales Consultant)		

			(NATCO) is Mercedes Authorized Agent, which includes: Cairo National Automotive (CNA), Giza National Automotive (GNA), Alexandria National Automotive (ANA)				
31	Promise Insurance Brokerage (PIB) Egyptian Insurance Brokers Association (EIBA)	10 El-Gazaer St., Aswan Square, El-Mohandesin	One of the automotive supply chain stakeholders in Egypt	Auto insurance brokerage for automotive organizations in Egypt, as it is specialized in the insurance consulting, marketing and	- Ahmed Nagieb (Vice Chairman and Managing Director) Official Spokesman of the Egyptian Insurance Brokers Association (EIBA)		

				selling all types of insurance products, including automotive insurance packages			
32	Aboul Fotouh Service Center	Kilo 32, Cairo-Alexanderia Desert Road	Main Authorized Dealer (i.e., 3S: Sales, After Sales and Spare Parts) consists of 6 authorized sales and after sales service centers, with 5 service workshops and 1 retail shop (Main Activities: importing spare parts– distributing)	Speranza PCs (e.g., A113, A516, A620, Tiggo, M11, and M12)	- Eng. Ahmed Ghanem (Parts Manager)		

33	Modern Motors	26 El Messaha St., Dokki, Giza	Main Authorized Dealer (i.e., 3S: Sales, After Sales and Spare Parts)	Suzuki Vehicles (e.g., Alto, Celerio, and Swift)	- Hassan Selim (Sales Executive)		
34	Autocool- Auto A/Cs	Industrial Zone B2, 10th of Ramadan City, Sharkia	1st Tier Supplier (Feeding Industry to Automotive Manufacturers operating in Egypt) (Main Activities: Importing – Manufacturing/ Assembling)	Automotive air conditioning	- Eng. Hisham Mahmoud Sherif (OE Material Planning Manager)		
35	Egyptian International Motors (EIM)- Renault	19, 26 July St., Zamalek club trading center, Mohandesin	Sole agent of Renault, Importer and Distributor (Agent, i.e., 3S: Sales, After	Renault Cars	- Sherif El Alem (Deputy General Manager) - Mostafa El Kafif (Brand Manager)		

			Sales Service and Spare Parts) (Main Activities: Importing CBUs and Spare Parts –Distributing)				
36	Gorica Egypt Group (GEG) for Industry S.A.E	Heavy Industrial Zone A1, 10th of Ramadan City, Sharkia	Manufacturer/ Assembler and Exporter of Kastour buses and Gorica trailers and trucks	Commercial Vehicles (CV); namely buses, trucks and trailers	- Wahid Labib (Purchasing Manager)		
37	Almohandes Automotive	October house mall in front of MUST University, 6th of October City	Multi-brand Dealer	Passenger cars of different brands (e.g., Porsche, Volkswagen, BMW, Mercedes-Benz, Jaguar, Land Rover, and Audi)	- Eng. Khamis M. Khamis (Managing Director)		

38	Feeding Industries Manufacturing Company (FIMCO)	4th industrial zone, area 34, 6th of October City	1st Tier Supplier (Feeding Industry to Automotive Manufacturers operating in Egypt) (Main Activities: Importing – Manufacturing/ Assembling)	Automotive sheet metal forming and exterior plastic parts painting and assembling	- Eng. Khaled Khalil (C.E.O of FIMCO)		
39	Mitsubishi Motors (Diamond Motors Company)	Cairo-Alex Desert Road, Km 28	Sole agent of Mitsubishi, importer and distributor (Agent, i.e., 3S: Sales, After Sales Service and Spare Parts) (Main activities: importing CBUs and spare parts, and distributing)	Mitsubishi Vehicles	- Ahmed Aboustait (Marketing Supervisor)		

40	El Kady (Kady & Khalil)	Industrial Zone K18 Cairo-Ismailia Road	1st Tier Supplier (Feeding Industry to Automotive Manufacturers operating in Egypt) (Main Activities: Importing – Manufacturing/ Assembling)	Automotive hoses and pipes	- Eng. Mohamed A. El Kady (Quality Manager)		
41	Egyptian Axles Company	3 Babel Square, Dokki	1st Tier Supplier (Feeding Industry to Automotive Manufacturers operating in Egypt)	Automotive axles	- Eng. Raafat Elkhanagry (The General Manager)		
42	GB-Polo Bus Manufacturing Company S.A.E. (JV between	El Ain El Sukhna, 1st Industrial Zone, North West	Manufacturer/ Assembler of Buses	Microbus, Mini/Midi Bus, City Bus, School Bus, Intercity Bus	- Eng. Wafa Tawfillis (C.E.O of GB-Polo)		

	GB-Auto Egypt and Marcopolo Brazil)	Suez Gulf Attaka District, Suez		and Coach/Tourism Bus			
43	Chloride-Batteries	Abu Rawash Industrial Zone, Engineering Square, 6th of October City	1st Tier Supplier (Feeding Industry to Automotive Manufacturers operating in Egypt)	Automotive batteries	- Maher Mahmoud (Export and OE Sales Manager)		
44	Al-Masoud Automotive	26 July St., no. 209, Sphinx Square, El Mohandesin	Multi-brand Dealer	Passenger cars of different brands (e.g., Hyundai, Toyota, Chevrolet, Brilliance, Speranza, and Geely)	- Hussein Nour (Commercial Manager)		
45	General Techniques International (GTI) Group	10th of Ramadan City, District A6,	1st Tier Supplier (Feeding Industry to Automotive	Automotive interiors	- Basem A. Wahab (System Coordinator)		

		Land 87	Manufacturers operating in Egypt)				
46	Stop Automotive	Ali Amin St., Nasr City	Main dealer of Lada and BYD in addition to being a multi-brand dealer	Lada and Build Your Dreams (BYD) Vehicles	- Tarek M. Abdel Azeem (Sales Manager)		
47	AKL Factories for Auto Feeding Industries	22 Taksim Ibn Battouta, El-Mansoura	1st Tier Supplier (Feeding industry to automotive manufacturers operating in Egypt)	Lamps, mirrors, wheel covers and cooling fans	- Eng. Lamiaa Fathy Daw (Research and Development Manager)		
48	Egypt for Engineering Industries (EEI)- Auto parts	4th Industrial Zone, Piece no. 5, 6th of October City	1st Tier Supplier (Feeding industry to automotive manufacturers)	Auto parts (e.g., Tanks)	- Eng. Ihab Ibrahim (The General Manager)		
49	EEI- Chevrolet Express Bus	4th Industrial Zone, Piece no. 5, 6th of October City	Assembler of Commercial Vehicles	Chevrolet Express Bus			

50	International Supplementary Industries (ISI)	10th of Ramadan City	1st Tier Supplier (Feeding industry to automotive manufacturers operating in Egypt)	Wheel covers, rear and front combination lamps, and license lamps	- Eng. Ali Tawfik (The Owner)		
51	Nile Trading and Engineering (NTE)- Honda (Al-Futtaim Group Company)	Cairo Festival City, Ring Road, beside Police Academy, Fifth Settlement	Sole agent of Honda, importer and distributor (Agent, i.e., 3S: Sales, After Sales Service and Spare Parts) (Main activities: importing CBUs and spare parts, and distributing)	CBUs of Honda vehicles	- Hassan El-Eskandrany (Advertising Manager)		
52	Toyota Misr for Trading S.A.E	10 Greek Hospital St., Industrial Zone, Abbassia	Importer and distributor of Toyota (Agent, i.e., 3S: Sales, After Sales Service and Spare Parts)	CBUs of Toyota vehicles	- Mohamed Ehab Zaghloul (Assistant Marketing Manager)		

			(Main activities: importing CBUs and spare parts, and distributing)				
53	Aman and Safety Group (ASG)	3rd Industrial Zone, Plot no. 42, 6th of October City	1st Tier Supplier (Feeding industry to automotive manufacturers operating in Egypt, e.g., GB-Auto, GB-Polo, GM, Suzuki, MCV, Lada and BYD)	Automotive glass for PC and CV	- Mohamed Abdel Salam (Marketing Manager)		
54	Egyptian Automotive and Trading Company (EATC)-VolksWagen	Abo Rawash, Industrial Zone	Sole agent of VolksWagen, importer and distributor (Agent, i.e., 3S: Sales, After Sales Service and Spare Parts) (Main activities: importing CBUs	CBUs of VolksWagen	- Mariam Al Kady (Deputy Marketing Manager)		

			and spare parts, and distributing)				
55	GEG- MAN	Heavy Industrial Zone A1, 10th of Ramadan City, Sharkia	Sole agent and importer of MAN trucks (commercial vehicles-Germany), and agent of Carrier (A/C for buses-Germany)	MAN Commercial Vehicles	- Wahid Labib (Purchasing Manager)		
56	Bahgat Group-Audio speakers and cassettes	1st Industrial Zone, Plot 64, 6th of October City	1st Tier Supplier (Feeding industry to automotive manufacturers operating in Egypt)	Vehicle speakers and cassettes	- Alaa Mohammed El Fateh (Sales Manager)		
57	Manufacturing Commercial Vehicles (MCV)-Mercedes Benz	Km 24, Cairo-Ismailia Desert Rd, El-Obbour	Manufacturer/ Assembler (An agent for Daimler AG in Egypt; Mercedes-Benz	Minibuses, microbuses trucks, tankers, bulk carrier, fire fighting and rescue vehicles	- Eng. Ehab Farag Habib (Supervisor Local Manufacturing)		

			Commercial Vehicles)				
58	Tredco Engineering Industries	Industrial Zone 6A, Block 63, 10th of Ramadan City	1st Tier Supplier (Feeding industry to automotive manufacturers operating in Egypt) + Bus Assembler	Polyurethane in all forms: soft, rigid and semi-rigid; automotive carpets and seats; and dash boards + Assembled mini-bus and luxury bus	- Ranya El Sayed (Development Manager)		
59	Taki Vita Company S.A.E	Al-Fardous st., extension of Ahmed said st., Abbasia	1st Tier Supplier (Feeding industry to automotive manufacturers operating in Egypt)	Car seats and door panels	- Dr. Osama Sobhy (Marketing Manager)		
60	El-Wahab Group-Chevrolet	3rd Industrial Zone, Area 244/15, 6th of October	Manufacturer/ Assembler of Buses and other CVs (3 Factories)	Minibus, armored car, mini armored, microbus, and galaxy bus	- Eng. Maged Fathy Ghourieb (The General Manager)		

		City	using Chevrolet and Isuzu chassis produced by General Motors				
61	Al-Shehab Auto-Chevrolet	3rd Industrial Zone, Area 136, 6th of October City	Manufacturer/ Assembler of Buses	Midi-buses and minibuses	- A. Ayman (Accounting Manager)		
62	Trust for Engineering Industries	Industrial Zone Amal 1, El-khanka, Kaliobia	1st Tier Supplier (Feeding industry to automotive manufacturers operating in Egypt)	Automotive seats	- Eng. Doaa Abdel Hady (The Vice Chairman)		
63	Egyptian Aluminum Products Company (ALUMISR)	24 Lebanon Square, El Mohandiseen	1st Tier Supplier (Feeding industry to automotive manufacturers operating in Egypt)	Aluminum parts for Vehicles, especially CVs	- Eng. Tarek Mosad Madkour (General Manager of the Commercial Department)		
64	Ghabbour Egypt (GB)-	4th Industrial	Manufacturer/ Assembler	Trucks, buses, superstructures	- Eng. Adel Michael (Purchasing Manager)		

	Commercial Vehicles	Zone, Sadat City	(Assembly and distribution of trucks and buses; bus-body MFG; manufacturing and distribution of superstructures and trailers; distribution of construction equipment; and after-sales service and distribution of spare parts)	and trailers (Exclusive agent for Mitsubishi and Volvo trucks)			
65	El-Gammal Company for	1st Industrial Zone, no. 220, 6th of October City	1st Tier Supplier (Feeding industry to automotive manufacturers operating in Egypt)	Paints, chemical industries and spray products	- Eng. Mohamed Kassem (Business Development Manager)		
66	ALIAA Corporation	20 Abd El-Hameed, from Abd El-Wahab St., Makram Abid, 8th Zone, Naser City	1st Tier Supplier (Feeding industry to automotive manufacturers operating in Egypt)	Floor mats, seat covers and other interior automotive accessories	- Eng. Sherif Rayan (Supply Chain Manager)		
67	Automotive Filters Industrial	Al-Khartoom St., Industrial Zone B2, 10th	1st Tier Supplier (Feeding industry to automotive	Automotive filters (oil, fuel, and air filters)	- Joseph Yacob (Assistant Export Manager)		

	Company (AFICO)	of Ramadan City	manufacturers operating in Egypt)				
68	Spring and Transport Needs Manufacturing Company	8 El-Massaneh St., El-Ammeria	1st Tier Supplier (Feeding industry to automotive manufacturers)	Leaf spring, brake lining and clutch facing for busses, lorries, trailers, vans, and passenger cars	- Dr. Eng. Mostafa El-Kady (Chairman and Executive Director)		
69	El Magmoua Company For Design and Printing	1st Industrial Zone, Plot 9, Block 20024, Rd. 900, Western Extension, Obour City, Kaliobeya	1st Tier Supplier (Feeding industry to automotive manufacturers operating in Egypt)	Vehicles stickers	- Eng. Ahmed Omar Hassan El Fandry (The Owner)		
70	Engineering for Industries Company (ENGIN)	5th Industrial Zone, Plot 52, 6th of October City	1st Tier Supplier	Sheet metal			
71	Industrial Engineering Group (INDE)	1st Industrial Zone, Plot 45, Sadat City	1st Tier Supplier	Auto components	- Eng. Mohamed Abou Galalah (The General Manager)		
72	INDE Plast-Plastic injection factory	5th Industrial Zone, Plot 52, 6th of October City	1st Tier Supplier	Plastic injection			

73	INDE Moulds	5th Industrial Zone, Plot 52, 6th of October City	1st Tier Supplier	Tools and dies making	- Eng. Mohamed Abou Galalah (The General Manager)		
74	INDE Motorcycle-Egyptian Motorbikes and Bicycles Company (EMB)	Plot 16-17, 1st Industrial Zone, Sadat City	Manufacturer/ Assembler	Motorbikes, bicycles and tricycles (e.g., MZ)			
75	INDE Fire Industrial Company	5th Industrial Zone, Plot 52, 6th of October City	Manufacturer/ Assembler	Special purpose vehicles (SPV) Fire trucks (e.g., MAN, Mercedes)			
76	Star for Auto Feeding Industries	3rd Industrial Zone, St. 16, No. 36, 6th of October City	2nd and 1st Tier Supplier (Feeding industry to automotive manufacturers operating in Egypt)	1st Tier Supplier of rubber parts for cars except tires + 2nd Tier Supplier of cables and wiring harnesses to other 1st Tier automotive suppliers (e.g., IDACO) + produce various rubber components that are used in	- Eng. El Said Kamal El Said (The Chairman) - Eng. Ahmed Said Kamal		

				different other industrial fields such as petroleum			
77	FAC Filter S.A.E (The Arab Company Manufacturing of Filters) (Afify Group)	12 Zaki St., El-Tawfikya	1st Tier Supplier (Feeding industry to automotive manufacturers operating in Egypt)	All types of filters that are used in passenger cars and trucks	- Nagy Aly Zidan (Head Sector of Sales)		
78	Tawplast (The Plastic Company)	Industrial zone C1, 10th of Ramadan City	1st Tier Supplier to automotive manufacturers operating in Egypt in addition to being a manufacturer of plastic products (e.g., kitchenware and garden-ware)	Wheel covers for automobiles	- Eng. Ali Tawfik (The Chairman)		
79	Auto Plast-Lamps	Industrial zone 15 C1, 10th of Ramadan City	1st Tier Supplier	Automotive plastic parts (e.g., lamps)			
80	El Sobky Industrial	El Hikestep Zone, Sindbad Rd, Industrial	1st Tier Supplier (Feeding industry to automotive manufacturers	Automotive metal parts	- Hussin Abd El Hamed El Sobky (The Owner)		

		Zone, El-Nozha El-Gedida	operating in Egypt)				
81	El Dahshan for Auto Spare-parts (Ibrahim Dahshan Factory)	Facous, Abo Dahshan St., El-Sharqia	1st Tier Supplier (Feeding industry to automotive manufacturers operating in Egypt) and exporter to other countries (e.g., China, Jordon, Libya, Sudan, Tunis and Algeria)	Auto Spare-parts (e.g., head lamp, rear and front lamps and bulbs, rubber, filters, and mirrors)	- Ahmed Ibrahim Dahshan (The General Manager)		
82	FAIK Manufacturing Company	6 Helmi Hassan Ali St., 8th District, Nasr City	1st Tier Supplier (Feeding industry to automotive manufacturers operating in Egypt)	Suspension, disc wheels, brake drums, water pumps, wheel bolts and rubber products	- Eng. Mariam M. Faik (Foreign Trade Manager)		
83	AOI (Arab Organization for Industrialization) Aircraft Factory	Omr Ibn Abd-Elaziz St., Helwan	1st Tier Supplier	Sheet metal works, front chairs, rear seat axes, tank guard, balance parts, and gear stick	- Eng. Mohamed El Desouky (Marketing Manager)		

84	International Trade Agency and Marketing Company (ITAMCO)- Ghabbour Group	Alexandria Desert Road Km 28, 2nd Industrial Zone, Abu Rawash	Subsidiary of GB-Auto, Importer, and Distributor of PCs, three-wheelers and motorcycles	Passenger cars, three-wheelers and motorcycles	- Eng. Ahmed El Kazzaz (Luxury Department Manager)		
85	Industrial Control Group- Industrial Control for Engineering Industries (ICEI)	4th Industrial Zone, plot 31, St. 55, 6th of October City	1st Tier Supplier (Feeding industry to automotive manufacturers operating in Egypt, e.g., GM, GB-auto, and Nissan)	Chassis	- Saied Abd Rab El Rasol (IT Specialist and Document Control)		
86	Egyptian Auto-feeders Association (EAFA)	11 Mostafa El Baradi St., Nozha Gadida, Heliopolis	One of the automotive supply chain stakeholders in Egypt	An Egyptian not-for-profit association that provides its members with technical, financial, legal and marketing services	- Eng. Ali Tawfik (The Chairman) - Ehab Abu El Eneen Mohamed (Executive Secretary)		

Appendix (C/2): Research data collection/fieldwork tables

Table AIII.2. The research data collection/fieldwork table (Higher education sector/HESC)

<table>
<tr><th>Serial No.</th><th>Organization</th><th>Location</th><th>Position in ESC</th><th>Primary Product</th><th>Respondent/ Interviewee</th><th>Research Approach</th><th>Data Collection Method</th></tr>
<tr><td>1</td><td>Cairo University (CU)</td><td>Cairo University Rd, Oula, Giza (Dome Building and Faculty of Commerce)</td><td>Higher education service provider (Undergraduate and postgraduate studies, and research services)</td><td>Graduates and research outcomes (Intellectual)</td><td>- Professor Gamal Abd El-Nasser (Vice President for Society and Environmental Affair; Professor at Faculty of Science; Former Head of Physics Department and Dean of Faculty of Science)
- Professor Wael Kortam (Head of Business Administration Department at Faculty of Commerce; Former Vice Dean for Post Graduate Studies and Research; Professor of Marketing)</td><td rowspan="2">Mixed methods approach

- Qualitative approach</td><td rowspan="2">- Direct/face-to-face in-depth semi-structured interview

- Attended a meeting for signing a Collaboration Protocol Agreement between Helwan University and the Ministry of Trade, Industry and Investment-Industrial Development</td></tr>
<tr><td>2</td><td>Ain Shams University (ASU)</td><td>Khalifa El-Maamon st, Abbasiya sq., Cairo (Al-Zafaran</td><td>Higher education service provider (Undergraduate and</td><td>Graduates and research outcomes (Intellectual)</td><td>- Professor Ali Abdelaziz Ali (Vice President for Post Graduate Studies and Research; Professor of Food Science at Faculty of Agriculture)</td></tr>
</table>

		Palace)	postgraduate studies, and research services)		- Dr. Assem Abolmaaty Sayed Ahmed (Director of international collaboration, technology transfer and innovation [Technology Innovation and Commercialization Office (TICO)]; Vice Director of Microbial Resource Center; Assistant Professor of Food Microbiology and Safety at Faculty of Agriculture) - Dr. Neveen Asem (Coordinator of Technology Transfer and Commercialization at ASU TICO; Assistant Professor of Human Genetics at Faculty of Science (Girls)) - Dr. Rasha Hussein Abd ElAziz (Assistant Professor at Faculty of Commerce)	- Quantitative approach	Authority (IDA) - Attended/ participated in Collaborative Semi-structured Forums in The American University in Cairo (AUC) about strengthening Universities-Industries Relationships - Personal survey method
3	Suez Canal	The New	Higher	Graduates and	- Dr. Khaled Elsayed		

	University (SCU)- Ismailia branch	University, 4.5 km, Ring Road, Ismailia Governorate	education service provider (Undergraduate and postgraduate studies, and research services)	research outcomes (Intellectual)	(University's Public and External –Local and International–Relations Manager) - Dr. Mohamed Osman Ahmed Arnous (Director of the Center of Society/Industry Service and Scientific Consulting; Associate Professor at Faculty of Science, Geology Department)		
4	Benha University (BU)	Fareed Nada St., Benha, Qalubiya Governorate	Higher education service provider (Undergraduate and postgraduate studies, and research services)	Graduates and research outcomes (Intellectual)	- Professor Gamal Ismail Khaleel (Vice President for Community Service and Environmental Development; Professor of Civil Engineering at Faculty of Engineering) - Rania Zenhom (Accountant at at Faculty of Engineering; Graduate of Faculty of Commerce English Section BU)		

5	Kafrelsheikh University	El-Geish Street, Kafr El-Sheikh Governorate	Higher education service provider (Undergraduate and postgraduate studies, and research services)	Graduates and research outcomes (Intellectual)	- Professor El Sayed Mohamed Hegazy (Vice President of Postgraduate Studies and Researches; Professor at Faculty of Veterinary Medicine) - Professor Ali Ahmed Mohamed Abu Shushaa (Vice Dean for Community Service and Environmental Development; Professor of Genetics at Faculty of Agriculture) - Mostafa El Sayed Rezk (Public Relations Manager)		
6	Beni-Suef University (BSU)	Salah Salem St., Beni-Suef Governorate	Higher education service provider (Undergraduate and postgraduate studies, and research services)	Graduates and research outcomes (Intellectual)	- Professor Rabeh Rateeb Basta (The Vice President for Community Service and Environmental Development Affairs; Professor and Head of Public Finance and Tax Legislation Department at Faculty of Law; Former Vice Dean for Post Graduate Studies and Research at Faculty of Law)		

					- Professor Sayed AbdelKader Ahmed (Head of linking Research with Industry and Innovation Support Unit at the Faculty of Postgraduate Studies for Advanced Sciences; Professor of Organic Chemistry and Natural Products at Faculty of Science)		
7	Fayoum University	Tawfik ElHakeem, El-Fayoum Governorate	Higher education service provider (Undergraduate and postgraduate studies, and research services)	Graduates and research outcomes (Intellectual)	- Professor Mohammed Mohammed Rabeey (Vice Dean for Society Service and Environment Development at Faculty of Computers and Information; Assistant Professor at Faculty of Science, Chemistry Department; University's Representative at the Arab Council for Training Students of Arab Universities (ACTSAU); University's Coordinator for Students Exchange)		

					- Mohmaed AbdElFatah Hasan (General Manager of the Faculty of Computers and Information)		
8	Helwan University	Ain Helwan, Administrative Building and Faculty of Computers and Information + Industrial Development Authority (IDA) at 42 Al-Salam Axis, 5th Settlement, 90th street, New Cairo	Higher education service provider (Undergraduate and postgraduate studies, and research services)	Graduates and research outcomes (Intellectual)	- Professor Khaled El Kady (University President's Advisor for Community Communication; Vice Dean for Community Service and Environmental Development at Faculty of Home Economics) - Dr. Ayman M. Mahrous (Director of Technology Transfer Office (TTO); Associate Professor of Physics at Faculty of Science) - Sherif Hassan Hegazy (Manager at Technology Transfer Office (TTO); Teaching Assistant at Faculty of Science) - Dr. Hala Abdel Geleel (Assistant Professor at Faculty of Computers and Information, Computer Science Department) - Eng. El Saeed Ibrahim Ghozal (Head of Central Department for		

					Investment Policies and International Agreements at the Ministry of Trade, Industry and Investment, Industrial Development Authority (IDA)) - Shadya Qadry (General Manager of International Agreements at the Ministry of Trade, Industry and Investment, Industrial Development Authority (IDA))		
9	Zagazig University (ZU)	Zagazig, Sharqia Governorate	Higher education service provider (Undergraduate and postgraduate studies, and research services)	Graduates and research outcomes (Intellectual)	- Professor Zeinab Mohamed Elbashir Aly Saied (Head of Zoology Department, Faculty of Science)		
10	Tanta University	Tanta City, Al-Gharbiyah Governorate	Higher education service provider (Undergraduate	Graduates and research outcomes (Intellectual)	- Dr. Eng. Mohamed Kamal Metwally Ahmed Elnemr (Lecturer at Power and Electrical Machines Department, Faculty of		

			and postgraduate studies, and research services)		Engineering; Lecturer at Egyptian e-Learning University (EELU)- Tanta Branch at Tanta University; Tanta Engineering Quality Assurance Unit (TEQAU) Assistant Director)		
11	Suez University	Cairo-Suez Road, Suez Governorate	Higher education service provider (Undergraduate and postgraduate studies, and research services)	Graduates and research outcomes (Intellectual)	- Dr. Eng. Sabbah Ataya (Associate Professor at Faculty of Petroleum and Mining Engineering; Manager of Technology Innovation and Commercialization Office (TICO); Manager of Grants and International Collaboration Office (GICO))		
12	Alexandria University	Alexandria Governorate, Shatby, in front of Bibliotheca Alexandria, Faculty of Commerce	Higher education service provider (Undergraduate and postgraduate studies, and research services)	Graduates and research outcomes (Intellectual)	- Dr. Alaa Gharbawy (Associate Professor of Marketing at Computers and Information Systems Department, Faculty of Commerce) - Samar Mostafa (Teaching Assistant at Economics Department, Faculty of		

					Commerce) - Aya Abdel Salam (Teaching Assistant at The Arab Academy for Science, Technology and Maritime Transport; Master's Student at Accounting Department, Faculty of Commerce, Alexandria University)		
13	Damietta University (DU)	New Damietta, Damietta Governorate	Higher education service provider (Undergraduate and postgraduate studies, and research services)	Graduates and research outcomes (Intellectual)	Subject Matter Expert (SME) working at this organization		
14	Mansoura University	Elgomhouria St., Mansoura City, Dakahlia Governorate	Higher education service provider (Undergraduate and postgraduate studies, and	Graduates and research outcomes (Intellectual)	Subject Matter Expert (SME) working at this organization		

			research services)				
15	Al-Azhar University	Meet Ghamr, Dakahlia Governorate	Higher education service provider (Undergraduate and postgraduate studies, and research services)	Graduates and research outcomes (Intellectual)	Subject Matter Expert (SME) working at this organization		
16	The American University in Cairo (AUC)	AUC New Cairo campus + Tahrir Square campus + Zamalek campus	Higher education service provider (Undergraduate and postgraduate studies, and research services)	Graduates and research outcomes (Intellectual)	- Professor Tarek Wahdan (Director of Operations at the AUC Executive Education; Former Institute of Quality Management Director, AUC Management Center, School of Business; Former Vice Dean of Educational and Students Affairs at Faculty of Education Suez Canal University; and Associate Professor of Analytical Chemistry at Suez Canal University)		

					- Eng. Sameh Nagy (Supply Chain Management Program Leader at AUC Management Center, School of Business; Supply Chain Operations Manager at Electrolux Egypt; and Educational Leader of Supply Chain Council for MENA region) - Dr. Ali H. Awni (Lecturer of Operations Management AUC School of Business, Department of Management; Former Head of Qualifying Industrial Zones Unit at Egypt's Ministry of Trade and Industry; and Former Supply Chain Consultant at Industrial Modernization Center) - Mahmoud Ahmed Mohamed (Purchasing Manager)		
17	The British University in	El Sherouk City, Misr-	Higher education	Graduates (Intellectual)	- Dr. Samaa Taher Attia (Associate Professor of Marketing		

	Egypt (BUE)	Ismailia Road	service provider (Undergraduate studies)		at Faculty of Business Administration, Economics and Political Science)		
18	Pharos University in Alexandria (PUA)	Canal El Mahmoudia St., Smouha, Alexandria Governorate	Higher education service provider (Undergraduate studies)	Graduates (Intellectual)	- Dr. Lamiaa Moustafa Mohamed (Lecturer at Hotel Management Department, Faculty of Tourism and Hotel Management; Working at the Quality Assurance Unit of the Faculty) - Dr. Maher Fouad (Lecturer at Hotel Management Department, Faculty of Tourism and Hotel Management)		
19	October University for Modern Sciences and Arts (MSA)	26 July Mehwar Road intersection with Wahat Road, 6 October City	Higher education service provider (Undergraduate studies and post-graduate professional training programs)	Graduates and research outcomes (Intellectual)	- Dr. Nawal El Degwi (Head of Board of Trustees of MSA; Entrepreneur in the field of Private Education; namely general and higher education; Owner of Dar El Tarbiah Educational Institutions: Schools, University, Career Gates Center for Professional Training)		

					- Dr. Ghada Ali (Program Leader at Management and Information Systems Department, Faculty of Management Sciences; Lecturer of Production and Operations Management; Worked at Quality Assurance Unit of Faculty of Management Sciences) - Hala El Marsafy (Director of Students Affairs and Academic Advisor at Faculty of Management Sciences; Instructor of Management; Worked at Quality Assurance Unit of Faculty of Management Sciences) - Samia Elsheikh (Director of Students Affairs and Academic Advisor at Faculty of Management Sciences; Instructor of Business and Society; Worked at Quality Assurance Unit of Faculty of Management Sciences)		

					- Marwa Emam (Public Relations Specialist at MSA Marketing Department) - Eman Othman (Marketer at MSA Marketing Department; Graduate of MSA Faculty of Management Sciences)		
20	Ahram Canadian University (ACU)	4^{th} Industrial Zone, 6^{th} of October City	Higher education service provider (Undergraduate studies)	Graduates and research outcomes (Intellectual)	- Professor Galal Harby (Dean of School of Business; Counselor for the Egyptian Financial Supervisory Authority (EFSA); Professor and Former Vice Dean at Faculty of Commerce Cairo University; Member of the National Authority for Quality Assurance and Accreditation of Education (NAQAAE)) - Dr. Shahira El Alfy (Lecturer of Marketing at School of Business)		
21	Misr University	Al-	Higher	Graduates and	- Dr. Mustafa Mohammed		

	for Science and Technology (MUST)	Motamayez District, 6^{th} of October City	education service provider (Undergraduate and postgraduate studies in cooperation with other universities))	research outcomes (Intellectual)	Alnasharty (Vice Dean of Faculty of Business and Economics; Head of Finance and Investment Department) - Reem Abu Tabl (Assistant Lecturer at Faculty of Business and Economics)		
22	Future University (FU)	5^{th} Settlement, end of 90^{th} street, New Cairo	Higher education service provider (Undergraduate and postgraduate studies)	Graduates and research outcomes (Intellectual)	- Dr. Ghadeer Badr (Lecturer of Human Resources Management at Faculty of Commerce and Business Administration; Former Lecturer of Management at The American University in Cairo (AUC) and Ahram Canadian University (ACU))		
23	Nahda University (NUB)	Kornish Al Nile, Mror Road, Beni-Suef Governorate	Higher education service provider (Undergraduate studies)	Graduates (Intellectual)	- Professor Abdelhamid Mohamed Nigm (Dean of Faculty of Marketing and Business Administration; Professor and Former Head of Statistics Department, Faculty of Economics and Political Science, Cairo		

					University; Former Head of Performance Evaluation and Quality Assurance Unit, Cairo University)		
24	Heliopolis University (HU) for Sustainable Development	Cairo-Ismailia Desert Road, km 20	Higher education service provider (Undergraduate studies and research services)	Graduates and research outcomes (Intellectual)	- Professor Wael Kortam (Former Dean of Faculty of Business and Economics for Sustainable Development; Former Marketing Director for Heliopolis University; Professor of Marketing)		
25	Egyptian E-Learning University (EELU)	33 Elmesaha St., Dokki, Giza	Higher education service provider (Undergraduate and postgraduate studies)	Graduates and research outcomes (Intellectual)	- Dr. Mohamed Elmasry (Dean of Faculty of Business Administration) - Eng. Esmat El Wasley (Manager of IT Department and e-learning Support) - Eng. Medhat Rabie (IT Specialist at the Information Systems Department)		

					- Eng. Eman Samir (IT Trainer)		
26	The Arab Open University (AOU)	El-Shorouk City, Cairo	Higher education service provider (Undergraduate studies)	Graduates (Intellectual)	- Dr. Bassam El-Ahmady (Dean of Faculty of Business Studies at Egypt Branch) - Sahar Ahmed (Program Coordinator) - Marwa Sharawi (ICT Specialist) - Naser Ghazy (Head of Students Affairs and PR) - Hanady Al-naimi (Admission and Registration Officer)		
27	Nile University (NU)	Smart Village, B2, Km 28, Cairo-Alex Desert Rd,	Higher education service provider (Undergraduate and	Graduates and research outcomes (Intellectual)	- Dr. Khaled AbdelAziz Hegazy (Assistant Professor of Accounting and Program Director for the Bachelor of Business Administration		

		Giza + 26 July Mehwar Road, El Shaikh Zaied	postgraduate studies, and research services)		Program (BBA) at the School of Business; Financial Advisor to the University; Assistant Professor of Accounting at Cairo University; Visiting Professor at Kellogg Graduate School of Management at Northwestern University (Evanston, Illinois USA); Founding Member of Hegazy Management Consult LLC; Partner at Crowe Hegazy a member firm of Crowe Horwath International, and Public Company Accounting Oversight Board-PCAOB-USA) - Professor Eng. Tyseer AboulNasr (Director of the Technology Innovation and Commercialization Office (TICO) at NU; Participated in different projects related to Industry-Academia Collaboration; Visiting Professor of Engineering at NU; Former Dean of the Faculty of Applied Sciences at the			

					University of British Columbia; Former Professor of Electrical Engineering at School of Information Technology and Engineering, University of Ottawa) - Nezar Nabil Sami (Director of Information Systems Department (IT Manager); Professional Development Program Lead) - Aleya Serageldin (Grants and Development Manager; Engaged in many projects conducted between NU, European Union and other different international/national universities)		
28	Zewail City of Science and Technology	26 July Mehwar Road, El Shaikh Zaied; (Center for	Higher education service provider (Undergraduate studies and research	Graduates and research outcomes (Intellectual)	- Dr. Ahmed Ali Abdel-Alim (Assistant Professor, Researcher and Particle Physicist at the Center for Fundamental Physics (CFP))		

		Fundam-ental Physics)	services)				
29	French University in Egypt (Université Français d'egypte)	El Sherouk City, Misr-Ismailia Road	Higher education service provider (Undergraduate and postgraduate studies, and research services)	Graduates and research outcomes (Intellectual)	- Dr. Eng. Rania Elanwar (Head of Mechanical/Industrial Engineering Department at the Faculty of Engineering) - Eng. Mohamed Hegazy (Assistant Lecturer at Faculty of Engineering and Graduate of French University in Egypt)		
30	Sinai University (SU)	North Sinai, ElArish, ElMasaid	Higher education service provider (Undergraduate studies)	Graduates and research outcomes (Intellectual)	- Professor Abdelhamid Mohamed Nigm (Former Dean of Faculty of Business Administration and International Marketing SU; Professor and Former Head of Statistics Department, Faculty of Economics, Cairo University; Former Head of Evaluation and Quality Assurance Unit, Cairo University)		
31	October 6	6^{th} of	Higher	Graduates and	- Dr. Fatma Eldally		

	University (O6U)	October City on Elmehawar Almarkazy	education service provider (Undergraduate studies and postgraduate studies in cooperation with different governmental universities)	research outcomes (Intellectual)	(Microbiology and Immunology Instructor; Graduate of Faculty of Medicine O6U)		
32	Delta University for Science and Technology	International Coastal Rd in front of Industrial Area, Mansoura City, Dakahlia Governorate	Higher education service provider (Undergraduate studies)	Graduates (Intellectual)	Subject Matter Expert (SME) working at this organization		
33	Sadat Academy for Management Sciences (SAMS)	Nile Corniche, Al Maadi, Cairo	Higher education service provider (Undergraduate and	Graduates and research outcomes (Intellectual)	- Professor Noha Mohamed El Khateeb (Dean of Faculty of Management Sciences; Head of Local and Public Administration Department)		

			postgraduate studies, and research services)		- Ramez Mohamed (Assistant Lecturer at Faculty of Management Sciences)		
34	The Arab Academy for Science, Technology and Maritime Transport (AASTMT)	Cairo Branch at Smart Village	Higher education service provider (Undergraduate and postgraduate studies, and research services)	Graduates and research outcomes (Intellectual)	- Dr. Ahmed El-Rawas (Head of Scientific Departments at the College of Management and Technology (CMT); Assistant Professor of Quality Management) - Dr. Amr Hamed (Professor of Economics and Business at the AASTMT; Senior Consultant and Professional Trainer at the AASTMT Center that links the academy with the industry) - Eng. Mohammed Haytham (Business Analyst for Educational Systems and Management Information Systems Technical support at the academy)		

35	International Academy For Engineering and Media Science (IAEMS)	Egyptian Media Production City (EMPC), Giza-Wahat Road, 6th of October City	Higher education service provider (Undergraduate studies)	Graduates (Intellectual)	- Nehal Mohamed Elfayoumy (Director of Marketing and Training Department) - Menna Gamal (Teaching Assistant of Accounting at Faculty of Business Administration Department)		
36	Akhbar El-Yom Academy	4th Industrial Zone, 6th of October City	Higher education service provider (Undergraduate studies)	Graduates (Intellectual)	- Professor Adel Mabrouk (Vice President of the Academy; Head of Business Administration Department; Professor of Finance at the Academy and Cairo University)		
37	Arab Academy for Banking and Financial Sciences (AABFS)	11 Dr. Abdel Rahman Elsawy St., Elmohand-seen	Higher education service provider (Postgraduate studies and research services)	Graduates and research outcomes (Intellectual)	- Professor Abdel Aziz Elsayed Mostafa (Head of Accounting Department and Students Academic Advisor; Professor of Accounting and Accounting Information Systems at AABFS and Cairo University)		

38	Canadian International College (CIC)	District 12, ElOffoq Compound, Behind ElYasmeen Resort, ElSheikh Zayed City, 6th Of October	Higher education service provider (Undergraduate studies)	Graduates (Intellectual)	- Dr. Emaad Muhanna (Head of Business Department at the School of Business Administration; Worked at the Quality Assurance Unit of the School of Business)		
39	ESLSCA Business School	17 El-Sad El-Aaly St., Finney Sq., Dokki, Giza	Higher education service provider (Postgraduate studies)	Graduates and research outcomes (Intellectual)	- Dr. Gaziaa Zaatar (Assistant Professor of Business Administration at Faculty of Commerce Ain Shams University, Ain Shams Academy and ESLSCA)		
40	Thebes Academy	Corniche El-Maadi, Cairo Governorate	Higher education service provider (Undergraduate studies)	Graduates (Intellectual)	Subject Matter Expert (SME) working at this organization		
41	Ain Shams Academy (ASA)	New Cairo, 1st Settlement, 7th	Higher education service provider (Undergraduate	Graduates (Intellectual)	- Dr. Reda Youssef Asaad (Lecturer of Statistics at the Academy for Management		

		Neighbor-hood	studies)		Sciences and Computers)		
42	National Research Center (NRC)	National Research Center, Mechanical Engineering Department, Advanced Software Unit, Engineering Research Division Building, Department of Solar Energy	Research service provider	Research outcomes (Intellectual)	- Dr. Eng. Mohamed Abdel Latif Ibrahim (Researcher at NRC and Managing Partner at Debes Co.)		
43	Mubarak Cool (Al-Amal technical school)	Kilo 58, 10th of Ramadan City, 3rd Industrial Zone	Education service provider/supplier	Graduates (Intellectual)	- Eng. Sayed Kamel (Instructor and Administrator) - Mohamed Hassan Nofal (Administrator)		