MAGA Engineering (Pvt) Ltd., Sri Lanka

Country : Sri Lanka

ISO member body : Sri Lanka Standards Institution (SLSI)

Project team :

Project leader : Dr. Mrs. Priyadarshani Talgaswatta (Deputy Director General, SLSI)

Co-leader : Mr. Sunanda Fernando (Acting Director, Engineering Standards Division, SLSI)

Member : Mr. Kapila Abeygunawardana (Senior Deputy Director, Civil Engineering, SLSI)

Member : Ms. Thilakshi Yasaratne (Assistant Director, Engineering Standards Division, SLSI)

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Member : Ms. Gayani Manchanayake, (Assistant Director, Scientific Standardization Division, SLSI)

ISO Central Secretariat advisor : Reinhard Weissinger, Manager, Research, Education & Strategy

Duration of the study : October 2011 – March 2012

6.1 Background, objectives, and organization of the pilot project

6.1.1 Background

The pilot project was led by the Sri Lanka Standards Institution (SLSI) — the National Standards Body of Sri Lanka. SLSI was established in 1964 under the Bureau of Ceylon Standards Act and now functions under the Ministry of Technology and Research. As a member of ISO, SLSI exchanges copies of its national standards on a reciprocal basis with other national standards bodies, and is responsible for disseminating information on standards, technical regulations and standards-related activities to the community at national level. There are several ways in which ISO and SLSI promote the development of standardization. One is to assess the most important benefits of standards by prioritizing standardization activities, raising awareness, promoting such benefits, and encouraging stakeholder participation.

6.1.2 Objectives

Even though standardization activities in Sri Lanka have contributed to trade, industry and socio-economic development over several decades, there has been no systematic study of the impacts and benefits of standards in quantitative and monetary terms. It was recognized that participation in this pilot project would help SLSI address the issue to enable private and public sector stakeholders to appreciate the economic and social impacts of voluntary consensus standards better, and raise the awareness of policy makers and business leaders of the importance of standardization. Applying the ISO methodology was an excellent means of describing and quantifying the benefits.

SLSI was selected by ISO to participate in the project, and has chosen Maga Engineering (Pvt) Ltd., one of the leading construction companies in Sri Lanka, for this study.

6.1.3 Organization of the pilot project

The ISO pilot project in Sri Lanka was conducted by SLSI under the guidance by the ISO Central Secretariat.

We would like to thank the Chairman and Managing Director of Maga, Capt. M.G. Kularatne and his team, especially Mr. Asoka de Silva, Director (Engineering), Major Derrick de Silva, Director (Administration) and Mr. Raj Wettasinghe, Manager Quality Assurance, for their enormous support and contributions enabling the project to be completed successfully.

6.2 Introduction to Maga Engineering (Pvt) Ltd.

6.2.1 Background on the selected company

The project team chose Maga because it is recognized in Sri Lanka as a model construction company due to its commitment to implementing, developing and applying national and international standards successfully. It uses a variety of product standards and test methods in its business operations, in addition to holding ISO 9001:2008, ISO 14001:2004 and OHSAS 18001:2007 certifications. **Annex 1** lists the building construction materials standards used by the company.

Maga is the first Sri Lankan construction company to be recognized as a Business Superbrand [1)], and has won the most quality awards issued by the Institute for Construction Training and Development (ICTAD). In 2003, the company won the prestigious International Federation of Asian and Western Pacific Contractors' Association's (IFAWPCA) Gold Medal for the construction of the Colombo Apollo Hospital.

1) A Business Superbrand is one that has established the finest reputation in its field, and offers customers significant emotional and/or tangible advantages over its competitors which customers want and recognize. Business Superbrands must represent quality, reliability and distinction.

Maga started business as a construction company in 1984, when it became involved with several international contractors executing projects in Sri Lanka. A dedicated group under the leadership of the present Chairman and Managing Director, Capt. M. G. Kularatne, resolved to build a model construction company by harnessing the knowledge and experience of the members of the group, gained from working with these international construction companies.

In little over 25 years Maga has made significant inroads into the local construction industry by developing strong human resources, a dedicated professional team and an extensive plant and machinery base to meet industry demands. The professional team comprises over 180 graduate engineers, including senior chartered engineers, with wide experience in the technical and managerial aspects of the construction industry, both locally and overseas.

These resources have helped Maga to reach ICTAD " M 1 "[2] status in the categories of Buildings in 1990, Highways and Bridges in 1996, Water Supply and Drainage in 1999 and " C 1 " status in all of the above in 2009. Maga has not only established itself as the most experienced contractor in Sri Lanka, but is also the market leader in volume and quality of work.

In addition to its status within Sri Lanka, Maga has been engaged in construction activities outside the country since 1987, and has successfully completed over a dozen building, civil and marine engineering projects overseas. To date it has also completed over 200 multidisciplinary projects at home and abroad. The company is the

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2) ICTAD "M 1" status: In 1989 INCTAD established a national registration and grading scheme for construction contractors — a screening process to determine the capabilities of prospective contractors to undertake different types and sizes of projects. Registration and grading is determined by evaluating a contractor mainly on financial capability, the technical ability of staff, plant and machinery, and experience gained in relevant fields. Initially under this scheme contractors were classified on financial ability under 10 grades (M1 to M10).

main contractor for the 32 000m^2 Sethsiripaya Stage II Administrative Complex for Urban Investment and Development Co (Pvt) Ltd (UNIDEP), valued at LKR 1.89 billion, and the 42 000m^2 headquarters building for Sri Lanka Customs, valued at LKR 2 589 billion.

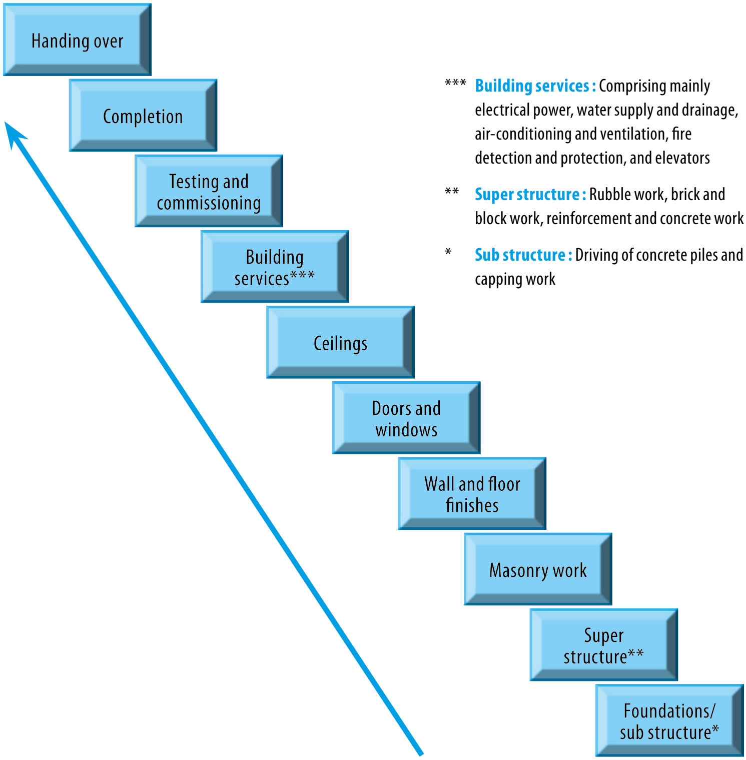
The ahead-of-schedule completion of the longest highway rehabilitation project in the country, the 158 km long Matara Wellawaya road, has won praise from its funding agent, the European Union. The company's foray into Design and Build has been exemplified by the 32-storey Fairmount Residencies building at Rajagiriya, recently completed on a structural design and build basis at a value of LKR 1.46 billion.

6.2.2 Construction management

A construction project embraces many participants and stakeholders from inception to completion. To progress a project to a successful conclusion, a contractor holds a key responsibility in facilitating and coordinating the interactions between different parties, requiring highly developed skills in project management. All construction projects demand close cooperation of the parties and processes involved, from the design and planning stages to the mobilization, material supply, construction and commissioning phases. By successfully managing their engineers, foremen, workmen, subcontractors and suppliers they strive to give their clients the desired result as the product of one entity, adhering to the project-specific conditions and quality objectives.

Overview of the building construction process

The following major steps constitute a typical building construction process:



*** **Building services:** Comprising mainly electrical power, water supply and drainage, air-conditioning and ventilation, fire detection and protection, and elevators

** **Super structure:** Rubble work, brick and block work, reinforcement and concrete work

* **Sub structure:** Driving of concrete piles and capping work

Figure 1 – Major steps in the building construction process

6.3 Company attitude towards standardization

Since its inception Maga has ensured that its operations comply with relevant standards. The main reason for selecting this company for the pilot project was its attitude in implementing standards, as demonstrated by its track record in winning numerous quality and business excellence awards.

6.4 Analysis of the value chain

A value chain describes the full range of activities required to bring a product (or service) from conception, through the different phases of production, to delivery to final consumers, and ultimate disposal after use. The simple value chain diagram in **Figure 2** shows a number of value added links and ranges of activities within each link.

6.4.1 Construction industry value chain

As the construction industry is very complex and versatile, it tends to have many links and inputs in the value chain, which are mainly two-fold:

- Material inputs
- Intellectual inputs (for example, design, specifications, consultancy, etc.)

Construction companies			
Inputs	**Company process**	**Output**	**Customers/clients**
Material inputs • Cement • Plastics • Steel • Plumbing		Building	• Government agencies • Real estate companies • Private clients
Project planning and design inputs • Design • Specifications • Consultants • Analytical design • Project design			

Figure 2 – Construction industry inputs and outputs

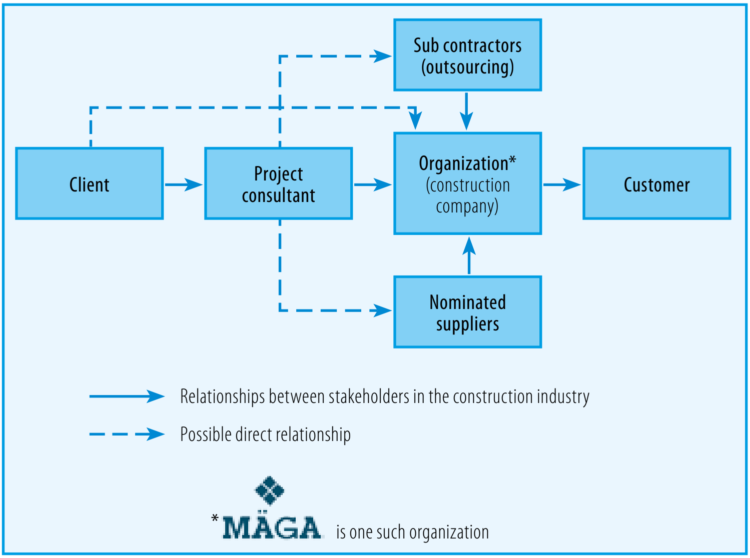


Figure 3 – Governance, organization and core process of the construction industry

As shown in **Figure 3,** a client charges a project consultant with the overall planning of a project. The project consultant, and suppliers selected by the project consultant, plan and design a construction project for delivery to the customer.

6.4.2 Company value chain

A simple value chain diagram, originally developed by Michael Porter of Harvard Business School, is shown below. The model provides an overview of a number of value added activities that are linked together. Each block in the value chain may contain a large number of activities. The model distinguishes between a certain number of primary activities, which represent the core activities of a company, and other activities that support the core activities.

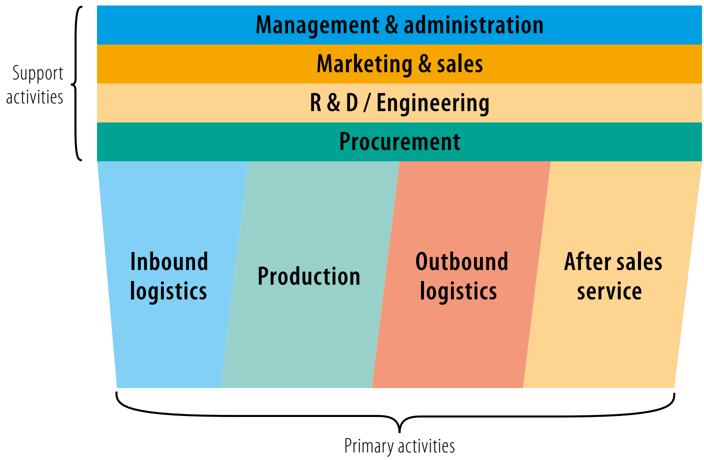


Figure 4 – Value chain model (Source : Michael Porter, Economic Benefits of Standards, ISO Methodology Guide, Version1, 2010.)

After some modifications, the model can be made to fit the building construction sector and Maga's operations. The company value chain can be described as follows, with the scope of the pilot study encompassing the activities highlighted in the model below :

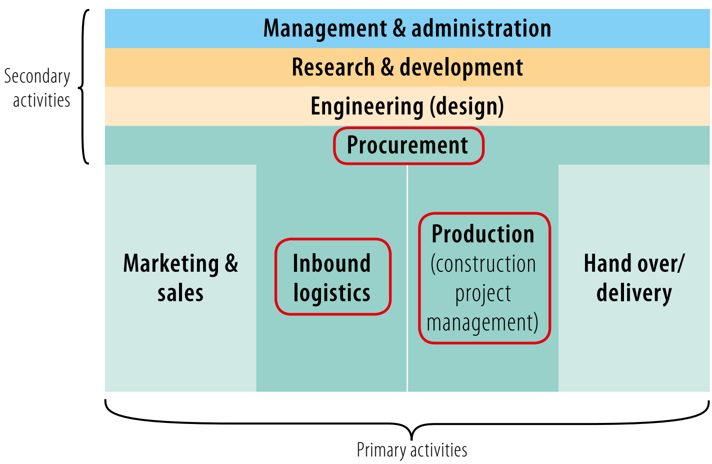


Figure 5 – Value chain model modified to reflect Maga activities (Source : Michael Porter, Competitive Advantage, 1985)

6.4.3 Key value drivers

Maga's competitive advantage lies mainly in its professional expertise and construction quality, coupled with flexibility, mutual cooperation and dedicated teamwork. As its reputation has grown, so too have the financial rewards reflected in a substantial increase in turnover, particularly over the last five years. This has enabled Maga to stay ahead of competitors and maintain its market leader status in the Sri Lankan construction industry.

Maga's extensive resource base has helped provide cost-effective design and construction management solutions as well as allowing country-wide supply of ready-mixed, asphalt and pre-cast concrete products. The company has established ten ready-mixed and asphalt concrete batching plants in different locations, and has pioneered the production of high-strength triple-blend temperature controlled concrete.

6.5 Scope of the pilot project assessment

In agreement with Maga, it was decided to limit the scope of the case study to the following key business functions:

- Procurement
- Inbound logistics
- Production (construction project management)

A further limitation was to focus the assessment only on the **building construction sector**. This means that other Maga operations, such as bridge and road construction, are not included in the scope of this study.

6.6 Use of standards in the company value chain

External standards used by the company can be divided into two main application areas:

1. Standards for raw materials (see **Annex 1)**
2. Management system standards:
   - ISO 9001:2008, *Quality management systems – Requirements*
   - ISO 14001:2004, *Environmental management systems – Requirements with guidance for use*
   - OHSAS 18001:2007, *Occupational health and safety management systems – Requirements*

Standards identified for the selected business functions and how they support the company's value drivers are described in more detail below.

6.7 Operational indicators to calculate the impact of standards

The objective of the study is to quantify the economic impact of the standards implemented by Maga and the resulting economic benefits. To measure the impacts before and after implementation of standards, we have chosen a set of operational indicators on the basis of a series of interviews with Maga. We started initially with a set of 14 indicators, but decided then to reduce this set to a more limited one of six operational indicators (see **Table 1)**. This decision was taken jointly with Maga experts in view of the limited time available to complete the project, the lack of past data and in order to allow the project team to undertake the study in a more reliable and productive manner.

<table>
<tr><th>No.</th><th>Operational indicators</th><th>Business function</th><th>Relevant standards</th></tr>
<tr><td>1</td><td>Reduction in cost of raw materials testing</td><td rowspan="2">Procurement</td><td rowspan="2">SLS 26:1993
SLS 107:2008
SLS 139:2003
SLS 375:2009
SLS 1181:2005</td></tr>
<tr><td>2</td><td>Reduction in raw material rejection</td></tr>
<tr><td>3</td><td>Preservation of raw material due to proper storage.
Note : with the implementation of a First-In-First-Out (FIFO) system</td><td rowspan="2">Inbound logistics</td><td rowspan="2">ISO 9001:2008</td></tr>
<tr><td>4</td><td>Space savings due to lean construction (on time delivery to the site)</td></tr>
<tr><td>5</td><td>Reduction in cost of rework and repairing defects</td><td rowspan="2">Production (construction project management)</td><td rowspan="2">ISO 9001:2008</td></tr>
<tr><td>6</td><td>Minimizing defective work at hand over (snag list)</td></tr>
</table>

Table 1 – Final list of operational indicators selected to measure the impacts of standards

The next step was to select suitable parameters for gathering information, in order to measure the economical impact of standards associated with each operational indicator.

For the purpose of our evaluation and in deciding on suitable parameters for our study, we focused on widely used cement, steel and tiling materials. For example, consider the first operational indicator – reduction in cost of raw materials testing :

To ensure good quality output (that is, a high quality building), all inputs and processes need to be controlled from beginning to end. Therefore, before using raw materials (in this case, cement, steel and tiles), the company must ensure that the inputs for the building construction process are of high quality. A sample from each consignment of raw material is tested, and this is an extra cost to the company. However, in Sri Lanka, these products come under SLS compulsory items. Hence no manufacturer can market these products (cement, steel, etc.) without obtaining SLS certification. For example, cement carrying an SLS 107 mark implies that it conforms to the Sri Lanka Specification for Ordinary Portland Cement. Hence there is no need to test samples from each consignment, and companies can decide themselves on the frequency of testing — for example, Maga undertakes a sample test from every tenth consignment.

After further discussions with Maga experts, we identified several parameters and measures for each operational indicator as shown in **Table 2**:

No	Operational indicator	Parameter	Measures	
1	Reduction in cost of raw materials testing	Testing fees	Cement	• Number of consignments of cement • Total quantity of cement • Total number of bags • Testing fees for cement
			Steel	• Number of consignments of steel reinforcement material • Tonnage of steel • Testing fees for steel
			Tiles	• Total number of square feet tiled • Testing fees for tiles
2	Reduction in raw material rejection	Loss and delay due to raw material rejection	Cement	• Number of rejected lots
			Steel	• Number of rejected lots
3	Preservation of raw material due to proper storage. Note : with the implementation of a FIFO system	Reduction in cost of rejected cement, after the implementation of the FIFO system	Cement	• Number of rejected cement bags (after storage) • Previous project rejection (before storage) • Cost of cement
			Tiles	• Number of tile breakages (after storage) • Previous project rejection (before storage) • Average cost of a 400 mm × 400 mm tile

4	Space savings due to lean construction	Space saving	Cement	• Storage space (after lean construction) • Storage space (before lean construction) • Outside rental rate (current average)
			Steel	• Storage space (after lean construction) • Storage space (before lean construction) • Outside rental rate (current average)
5	Reduction in cost of rework and repairing defects	Cost due to rework of defects such as honeycomb, levelling and wall cracks		• Cost due to honeycomb • Cost of levelling rework • Cost of reworking wall cracks
6	Minimizing defective work at hand over (snag list)	Reduction in cost of snag list repairs		• Number of days to complete snag list repairs • Cost of snag list repairs per day

Table 2 – Operational indicators, parameters and measures used

6.8 Calculation of the economic benefits of standards

In order to calculate the economic benefits of standards, and in consideration of the specifics of the building construction industry, we had to make a number of further decisions.

6.8.1 Characteristics of building construction projects

Activities in building construction projects are different from those of mass produced products, such as foodstuffs, cars, pre-cast items, furniture and textiles. Typically, building construction projects can take over a year to complete, and some run for several years.

Building designs vary considerably depending on the type of use. For example, hospitals, office buildings, factories, schools, houses and hotels are all used for different purposes. Even buildings designed for the same purpose differ, for example, some residential houses have three storeys, whereas others have only a single storey. Other differentiating factors are climate conditions and geographical location.

6.8.2 Selection of a sample construction project

Building projects undertaken by large companies like Maga are very complex and cannot be evaluated using a simple annual framework. Because of this construction industry characteristic, it was decided to determine the impact of standards on a **single sample project**. This decision was based on the following assumptions:

- It would be possible to identify the type and range of the impacts of standards from the sample project
- Having understood the type and range of the impacts, we could arrive at generalizations from the sample project that would also apply to other projects of the same type

The **Sambuddha Jayanthi building project** was selected as our sample project for the ISO pilot study, for the following reasons:

- This project was completed recently, enabling us to obtain more reliable data and information than for some other projects
- The project duration could be considered as average compared to some other projects undertaken by Maga

It was therefore assumed that this case study project could — at least to a certain degree —represent other similar projects within the chosen scope of the building construction industry.

6.8.3 Additional assumptions

Additionally, we chose a ten-year time period from 2001 to 2011 for the purposes of the study. Based on the information obtained from Maga's management, and during our visits to the company, we were able to make the calculations of the impact of standards as shown in **Table 3.**

To do so, we assumed that no standards had been implemented by Maga for the selected business functions in 2001, but that by 2011, all standards listed in **Table 3** had been successfully implemented.

The total financial impact of implementing standards on each of the three business functions over the past ten years (based on information from Maga's Sambuddha Jayanthi building project) is given in **Table 3** [3)]:

Business functions	Standards						Financial impact
	SLS 26:1993	SLS 107:2008	SLS 139:2003	SLS 375:2009	SLS 1181:2005	ISO 9001:2008	(in LKR)
Procurement	×	×	×	×	×	-	1 054 048 00
Inbound logistics	-	-	-	-	-	×	63 600 00
Production (construction)	-	-	-	-	-	×	1 739 972 08
Total savings derived from use of standards (in LKR)							**2 857 620 08**

× = relevant for the business function
- = not relevant for the business function

Table 3 – Impact of standards across selected business functions at Maga (based on the sample case study project)

6.8.4 Generalization of the findings from the sample project

After having identified and quantified the impacts of standards as shown in **Table 3** on the basis of the Sambuddha Jayanthi building

3) 1 LKR – 0.00778 USD.

project, we can apply the findings to similar projects by making the following assumptions:

- Maga uses more or less the same standards in construction projects similar to the Sambuddha Jayanthi building
- The standards used in other Maga projects make the same percentage contributions as in the sample project. This means that if the impact of standards in the procurement process was x % in the sample project, then we assume that it is also x % in other similar projects

On the basis of these assumptions, we can calculate the annual contribution of standards for Maga's operations as follows:

There are on average eleven concurrent building construction projects at any time, each of which has an average duration of 22 months. Thus, we can calculate the **total average contribution of standards for all eleven projects over the period of twelve months (one year)** as:

(Savings/benefits for one project) × (number of projects) / (average duration of a project) × 12, that is:

(LKR 2 857 620.08 × 11) / 22) × 12 = LKR 17 145 720.48.

The **annual percentage contribution to total annual revenue**, amounting to LKR 3 174 419 723 from the use of standards for Maga's building construction projects, can then be calculated as:

(LKR 17 145 720.48 / LKR 3 174 419 723) × 100 = **0.54 %**

In **Annex 2,** more details on these calculations ca be found.

6.9 Qualitative and semi-quantitative considerations

Some of the impacts of existing standards cannot be quantified since the Sri Lankan industry, including Maga, have been using standards from the very early stages of construction. As a result, it is difficult to obtain comparative data for most of the construction processes.

However, some of the most important contributions of standards were identified during the project study, although direct quantification was not possible.

For example, most of the purchasing processes such as selection and evaluation of suppliers, and stores management processes such as sorting, stock verification and preparation of monthly bills have become more efficient following ISO 9001:2008 implementation. However, the impact of the standard cannot be quantified since a time monitoring system has not been established.

Maga has switched to alternative energy sources as a result of ISO 14001 implementation, but its impact cannot be quantified since the company does not keep comprehensive energy savings records.

The reduction in the costs of testing and rejecting raw materials and in rework and repairing defects were identified as operational indicators, and the impacts were quantified for three major raw materials only since the data required for other raw materials such as roofing sheets and pipes were not available in detail from the company. Therefore, some of those impacts were not totally quantified.

It was observed that Maga gained a significant marketing advantage in winning contracts as a result of ISO 9001 certification, but this impact was not measurable and could therefore not be quantified.

6.10 Evaluation of results

Building construction projects are different from most other manufacturing processes. They also vary greatly due to factors such as the total design (including structural and finishing work), the type of building, and the climatic and geographical influences.

Many building projects undertaken by construction companies like Maga are very complex and cannot be evaluated on an annual basis. Because of these characteristics, the single Sambuddha Jayanthi Mandiraya building project was chosen as the case study to calculate the impact of standards, for the following reasons:

- The project is typical of many, with average design, costs and project duration, and the calculation of the impact of standards can be applied in general to other construction projects. More complex projects use more structural work, concrete and finishing work. Depending on complexity, projects can vary in costs from LKR 100 million to 5 billion and in duration from one month to several years
- We were able to obtain more data on the impact of standards on the three selected business functions, since it is a more recently completed project compared to others
- There is little possibility of utilizing the same group of skilled personnel in construction projects due to heavy labour turnover. Hence, it is very difficult to find realistic data covering the operations and activities of past projects

Even with the recent Sambuddha Jayanthi Mandiraya project, data was not available for some aspects of the construction. Consequently, and after discussions with Maga management, estimated values in the sample project have been used as substitutes, as identified with an asterisk '*' in **Annex 2.**

The findings from this study cannot be applied to other types of Maga operations such as road construction, bridges and water projects. However, they can be applied to other companies engaged in building construction. Most of Maga's construction projects are located in Colombo and its suburbs. If the calculations derived from the sample project are applied to construction projects in remote areas, there may be additional costs of transport and importing skilled workers, for example, which should be considered.

6.11 Conclusions and recommendations

6.11.1 Conclusions

In Sri Lanka, large construction companies like Maga have been using standards for a long time. The key to Maga's success as a model construction company is its commitment to implementing, developing and applying both national and international standards successfully. Even though it is very difficult to quantify the impact of using standards in financial terms, after the study, we could find that there is a significant impact of standards in the building construction industry.

6.11.2 Recommendations

- Due to time constraints, we selected only three business functions for this study. However, the approach could be applied to other business functions as well
- More information could be obtained by changing or broadening the scope of such studies to include more areas or functions where the company would typically use standards, thus identifying a greater range of impacts resulting from their use
- Instead of only one company, several construction companies could be studied
- To enable this method to be more representative of the Sri Lankan construction industry as a whole, projects from different areas of the country could be selected to increase the sample size
- Previously, there was no systematic way of conducting a study to quantify the benefits of standards. In future, Maga and other

construction companies could apply this approach so that necessary data can be easily obtained. For example, many enterprises could link this methodology with their enterprise resource planning or other data management systems and relevant software.

Annex 1 : Standards for building construction materials used by Maga

Subject fields	Standards	Revision
Cement	SLS 107-1:2008, *Ordinary Portland cement – Requirements*	4^{th}
	SLS 107-2:2008, *Ordinary Portland cement – Test methods*	4^{th}
	SLS 1247:2008, *Blended hydraulic cements*	1^{st}
	SLS 1253:2008, *Portland limestone cement*	1^{st}
	SLS 515:2003, *Masonry cement*	1^{st}
Bricks	SLS 39:2008, *Common burnt clay building bricks*	1^{st}
Asbestos	SLS 9-1:2001, *Asbestos cement products – Flat sheets*	2^{nd}
	SLS 9-2:2001, *Asbestos cement products – Corrugated sheets*	2^{nd}
Pre-cast concrete products	SLS 1425-1:2011, *Paving blocks – Requirements*	
	SLS 1425-2:2011, *Paving blocks – Test methods*	
	SLS 855-1:1989, *Cement blocks – Requirements*	
	SLS 855-2:1989, *Cement blocks – Test methods*	
	SLS 452:1979, *Concrete non-pressure pipes*	
Steel (reinforced)	SLS 26:1993, *Plain steel bars for the reinforcement of concrete*	1^{st}
	SLS 375:2009, *Ribbed steel bars for the reinforcement of concrete*	4^{th}
	SLS 139:2003, *Mild steel wire for general engineering purposes*	1^{st}
PVC pipes and fittings	SLS 147:1993, *Rigid unplasticized polyvinyl chloride pipes for potable cold water supplies*	2^{nd}
	SLS 659:1993, *Unplasticized polyvinyl chloride pipe joints and fittings for potable cold water supplies*	
	SLS 1202 : 2000, *Unplasticized polyvinyl chloride pipes for soil and waste discharge systems inside buildings*	
GI pipes	SLS 1285:2006, *Unplasticized polyvinyl chloride pipe fittings for non-pressure underground drainage and sewerage*	
Paints	SLS 533:2009, *Emulsion paints for interior use*	1^{st}
	SLS 557:2009, *Emulsion paints for exterior use*	1^{st}
	SLS 555:1982, *Varnish for interior use*	
	SLS 556:1982, *Varnish for exterior use*	

Structural steel	SLS 907-3:1990, *Dimensions and sectional properties of hot roll structural steel sections-U Sections*	
	SLS 907-4:1990, *Dimensions and sectional properties of hot roll structural steel sections-L Sections*	
	SLS 907-5:1990, *Dimensions and sectional properties of hot roll structural steel sections-T Sections*	
	SLS 949-1:1992, *Dimensions of hot roll steel bars for structural and general engineering purposes-round bars*	
	SLS 949-2:1992, *Dimensions of hot roll steel bars for structural and general engineering purposes-square bars*	
	SLS 949-3:1992, *Dimensions of hot roll steel bars for structural and general engineering purposes-hexagonal bars*	
	SLS 949-5:1992, *Dimensions of hot roll steel bars for structural and general engineering purposes-flat*	
Tiles	SLS 2:1975, *Corrugated sheets*	
	SLS 1181:2005, *Ceramic tiles*	1st
Plywood	SLS 261-1:1991, *Plywood for general purposes – Terminology*	1st
	SLS 261-2:1991, *Plywood for general purposes – Specification for manufacturer*	1st
	SLS 261-3:1991, *Plywood for general purposes – Methods of tests*	1st
Timber	SLS 1170-1:1998, *Code of practice on identification, grading and marking of imported construction timber – Grading, marking, and guidance on usage*	
	SLS 1170-2:1998, *Code of practice on identification, grading and marking of imported construction timber – Nomenclature, identification, and general information*	
	SLS 1170-3:1998, *Code of practice on identification, grading and marking of imported construction timber – Properties*	
Glass	SLS 718:1985, *Glass mirrors for general purposes*	
Sanitary ware	SLS 568:1982, *Ceramic squatting pans and traps*	
	SLS 878:1989, *Plastic flushing cistern*	
	SLS 449:1978, *Glazed earthenware pipes*	
	SLS 377:1976, *Wash basins*	
	SLS 921:1991, *Vitreous pedestal bidets*	
	SLS 864:1989, *Ceramic flushing cistern*	

Power cables	SLS 733:2005, *PVC insulated, non-armoured cables with copper conductors, for voltages up to and including 450/750 V, for electric power, lighting and internal wiring*	2nd
	SLS 1143:2008, *Electric flexible cords rated up to 300/500 V, for use appliances and equipment intended for domestic, office and similar environments*	1st
	SLS 987:1992, *PVC insulated electric cables 600/1000V*	
	SLS 1186:1999, *600/1000V armoured electric cables having thermosetting insulation*	
Switches and sockets	SLS 948-1:*1991, Three-pin plugs socket-outlets and socket-outlet adaptors – Covers plugs and socket-outlets and fused socket-outlet adaptors*	
	SLS 948 -2:1991, *Three-pin plugs socket-outlets and socket-outlet adaptors – Plugs made of resilient material*	
	SLS 948 -3:1991, *Three-pin plugs socket-outlets and socket-outlet adaptors – Switched socket-outlets*	
	SLS 734:1996, *13A fused plugs and switched and unswitched socket-outlets*	1st
Light fittings	SLS 138:2009, *Bayonet lamp holders*	2nd
Bus bar (bus ways)	SLS 1223-1:2001, *Low voltage switchgear and controlled gear assemblies – Type tested and partially type tested assemblies*	
	SLS 1223-2:2001, *Low voltage switchgear and controlled gear assemblies*	
	SLS 1223-3:2001, *Low voltage switchgear and controlled gear assemblies – Particular requirements for low voltage switchgear and controlled gear assemblies intended to be installed in places where unskilled persons have access for their use*	
Distribution boards	IEC 60439-3:1999, *Low-voltage switchgear and controlgear assemblies –* Part 3 : *Particular requirements for low-voltage switchgear and controlgear assemblies intended to be installed in places where unskilled persons have access for their use – Distribution boards*	
Cable trucking	SLS 1206:2000, *Cable Trucking made of insulating material*	
Ceiling/wall fans	SLS 814-1:1988, *Electric fans and regulators – Performance*	
	SLS 814-2:1988, *Electric fans and regulators – Safety requirements*	

Annex 2 : Calculation of the impacts of standards on the basis of a sample project (details)

Business function	Operational indicator	Measures			Comparison		Saving LKR
					2001	2011	
1. Procurement	Reduction in cost of raw materials testing	Cement	• No. of cement consignments • Total quantity of cement • Total number of bags • Testing fees for cement	50 246 600 kg 4932 LKR 15 680	Testing fees = 50 × LKR 15 680 = LKR 784 000 **Note :** Testing was carried out on one sample from each consignment	Testing fees = 5 × LKR 15 680 = LKR 78 400 **Note :** Frequency of testing is one sample for every 10 consignments *	**705 600.00**
		Steel	• No. of consignments of steel reinforcement material • Tonnage • Testing fees for steel	06 317.8 LKR 13 216	Testing fees = 6 × LKR13216 = LKR 79 296 **Note :** Testing was carried out on one sample from each consignment	Testing fees = 1 × LKR 13216 = LKR 13 216 **Note :** Frequency of testing is one sample for every 5 consignments *	**66 080.00**
		Tiles	• Total number of square feet tiled • Testing fees for tiles	1200 400mm×400mm tiles LKR 32 368	Testing fees = 1 × LKR 32368 = LKR 32 368 **Note :** Testing was carried out on one sample from each consignment	Nil (No testing)	**32 368.00**
	Reduction in raw material rejection	Cement	• Number of reject lots (2011) • Number of reject lots (2001)	- 4*	Loss per one day delay = LKR 50 000* Loss per 4 day delay due to rejection of cement = LKR 50 000 × 4 = LKR 200 000	No rejection	**200 000.00**

Business function	Operational indicator	Measures			Comparison		Saving LKR
					2001	2011	
		Steel	• Number of reject lots (2011) • Number of reject lots (2001)	- 1*	Loss per 1 day delay due to rejection of steel = LKR 50 000 × 1 = LKR 50 000	No rejection	**50 000.00**
		Tiles	• Number of reject lots (2011) • Number of reject lots (2001)	- -	No rejection	No rejection	**-**
		Tiles	• Number of tile breakages (after storage) • Previous project rejection (2001) • Average cost of a 400mm × 400mm tile	- 1 %* LKR 300	Rejection = 1 % Number of tile breakages = (1200 × 0.01) = 12 Cost due to rejection of tiles = LKR 300 × 12 = LKR 3 600	No rejection	**3 600.00**
2. In-bound logistics	Space savings due to lean construction	Cement	• Storage space (2011) • Storage space (2001) • Outside rental rate (current average)	200 ft^2 500 ft^2* LKR 50 000* (per 1000 ft$^{2)}$	LKR 50 000 × 500 ft^2 1000 ft^2 = LKR 25 000	LKR 50 000* 200 ft^2 1000 ft^2 = LKR 10 000	**15 000.00**
		Steel	• Storage space (2011) • Storage space (2001) • Outside rental rate (current average)	150 ft^2 300 ft^2* LKR 50 000 (per 1000 ft$^{2)}$	LKR 50 000 × 300 ft^2 1000 ft^2 = LKR15 000	LKR 50 000 × 150 ft^2 1000 ft^2 = LKR 7 500	**7 500.00**

Business function	Operational indicator	Measures			Comparison		Saving LKR
					2001	2011	
3. Production (construction)	Reduction in cost of rework and repairing defects	Rework %	**a. Honeycomb** • Honeycomb (2011) • Honeycomb (2001) • Concrete cost per mt^3 • Total area concreted in mt^3	 0.004 0.008* LKR 11 669.42 2 074.43	Cost due to honeycomb = LKR 11 669.42 × 2 074.43 × 0.008 = LKR 93 35536 × 2 074.43 = LKR 193 659.16	Cost due to honeycomb = LKR 11 669.42 × 2 074.43 × 0.004 = LKR 46 677.68 × 2 074.43 = LKR 96 829.58	**96 829.58**
			b. Levelling • Levelling (2011) • Levelling (2001) - Internal area - External area • Plastering cost per m^2 - Internal area - External area	 No rework 75 m^2 25 m^2* LKR 494.61 LKR 619.63	Cost for rework LKR 494.61 × 75 + LKR 619.63 × 25 = LKR 52 586.5	-	**52 586.50**
			c. Wall cracks • Wall cracks (2011) • Wall cracks (2001) • Total wall area	 0.007 0.5* 6000 m^2	Cost for rework 0.5 × LKR 494.61 × 6 000 = LKR 1 483 830	Cost for rework 0.007 × LKR 494.61 × 6 000 = LKR 20 773.62	**1 463 056.00**

Business function	Operational indicator	Measures			Comparison		Saving LKR
					2001	2011	
	Minimizing defective work at hand over (Snag list)		• No. of days to complete snag list repair (2011) • No. of days to complete snag list repair (2001) • Cost of repair snag list per day	5 20* LKR 8 500	20 × LKR 8500 = LKR 170 000	5 × LKR 8500 = LKR 42 500	**127 500.00**
Total savings from the use of standards							**2 857 620.08**

Total savings from the use of standards, as a percentage of the total cost of the pilot project (Sambuddha Jayanthi Mandiraya building construction) :

= LKR 2 857 620.08 × 100

= LKR 285 000 000.00

= 1.00 %

Note :

(1) In the absence of factual data, some information has been assumed based on experience and observations

(2) * = estimated values