Greening the Construction Industry

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Abstract

Many organization have begun to practice Green Supply Chain Management (GSCM) which is about using environmentally friendly products which bring about sustainability. The broad view of sustainability incorporates the concepts of economic, social, and environmental performance. The aim of this paper is to contribute significantly to the first wave of empirical investigations related to the impact of green supply chain management in Nigerian construction using a detailed questionnaire. This paper aims at looking the level of Green Supply Chain Management practices in Nigerian construction industry using a questionnaire.

Keywords: Construction, Green, Greening, supply chain management, and Sustainability

1. Introduction

In the light of construction, construction industry plays a vital role towards achieving national and international strategies for social and economic development. It contributes towards increasing the GDP, stimulating growth of other industries and creating job opportunities as well providing societies with facilities and infrastructure projects that meet their needs and fulfill their requirements but having a major impact on the environment because about 50% of the material resources for construction are taken from nature, 40% of energy consumption and 50% of total waste generated (Othman, 2010). The huge consumption of the resources by construction industry has called for sustainable construction in order to meet the present and future needs.

This study is thus aimed at providing insight into the extent to which Nigeria construction has fared in green supply chain management as means to ensuring sustainable construction to meet both the immediate and future construction needs (Wu et al., 2012)

2. Sustainable Construction

Sustainability is sometimes used interchangeably with green. Green or sustainable supply chain management is defined as the strategic, transparent, integration and achievement of an organization's social, environmental, and economic objectives in the systemic coordination of key inter-organizational business processes for improving the long-term performance of the firm and its supply chain partners(Wu et al., 2012). Sustainable construction is the one in which the construction companies in today's competitive environment understand the needs of current generations and offer them efficient and effective solutions that achieve their objectives without compromising new generations from achieving their own needs (Othman, 2010). Bob Hansen in Dow Corning magazine stated that sustainable constructions also aims at ensuring that buildings have long-term purpose even those that are built for one time events.Basically, the concerns of sustainable construction goes beyond the serviceability of a building during its lifetime, but also the recycling of resources to reduce waste streams associated with demolition is also given an important consideration. Increasing energy efficiency for the life of the structure is also a key, as is minimizing waste in the construction of a building through recycling and design. The four principal attributes which construction sustainability depends on are social, economic, biophysical and technical (Xiao, 2005) . In the light of achieving sustainable construction, green supply chain management (GSCM) has been adopted as an antidote(Ojo et al., 2012), Green supply chain management aims to maximize overall environmental profit by adopting a life cycle approach through product design, material selection, manufacturing, and sales and recovery, and therefore helps the firm to realize its sustainable development and improvement(Shi et al., 2012). GSCM has become popular and notable concept in sustainable construction because it largely takes environmental elements into consideration.

The term 'sustainable construction' is generally used to describe a process which starts well before construction (in the planning and design stages) and continues after the construction team have left the site (Hill & Bowen, 1997). According to the World Commission on the Environment and Development (WCED), sustainability is a form of development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainability design goes far beyond simply creating products that benefits consumer in terms of better air environment, cost savings and durability, rather effective sustainable design must illustrate a thorough understanding of a full systems approach of products in their environment and interaction , with other products, as well as the effect on many other factors.

Sustainability should be viewed as a process and not just a goal that allow a broader evaluation over time of the environmental, economic and societal impacts of buildings products (Ojo et al., 2013). Viewing sustainability as a process is essential for green designs as specifiers are challenged to evaluate the full life cycle of products (Ojo et al., 2013). This is becoming feasible with the introduction of programs such as bees and a building, rating system such as leed.

A systems approach should be used to determine a product's energy requirements- energy consumption at each state of a product's life cycle, beginning at the point of raw materials extraction from the earth and proceeding through processing, manufacturing and fabrication, end use and disposal. In some instances, end user can account for as much as 90 % of a product's impact on the environment.

According to the Oak Ridge National Laboratory, the following questions should be asked to determine if a product is sustainable:

i. Does it have a long life
ii. Does it save energy
iii. Does it add durability
iv. Does it contribute to the waste stream
v. It is renewable and recyclable

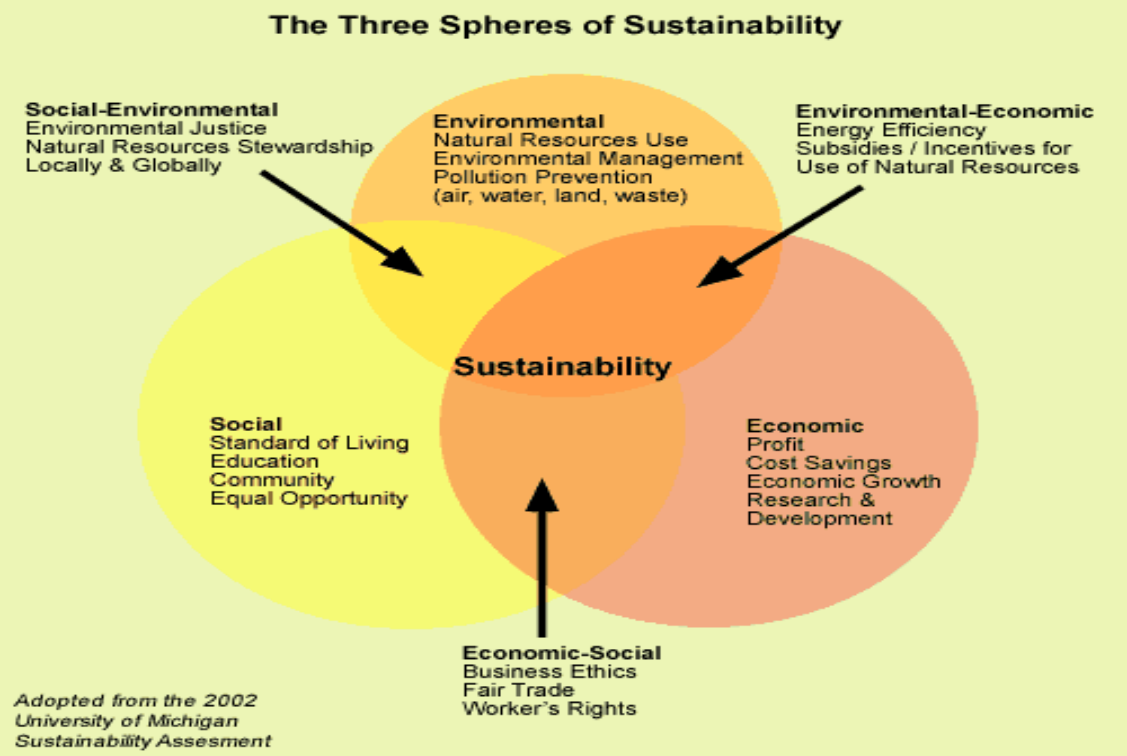

Figure 1: Spheres of Sustainability (Adapted: 2002 University of Michigan Sustainability Assessment)

2.1 Green supply chain management

Green supply chain management (GSCM) has a key role in ensuring that the factors driving the competitive advantage through environmental performance as market expectations, risk management, regulatory compliance and business efficiency are addressed (Zhu et al., 2012). Responsively, manufacturing organizations have begun to implement green supply chain management (GSCM) practices in response to customers' demands for products and services that are environmentally sustainable and that are created through environmentally sustainable practices and in response to governmental environmental regulations(Green et al., 2012).

Management scholars researched organizational environmental practices in 1990s and advocated more holistic and responsible practices in the supply chain (Shi et al., 2012). Responsively, the GSCM literature has grown considerably over the last decade. Theory and empirical research to date has explored the implementation and effects of such practices as eco-design, cleaner production, environmental purchasing, and green/reverse logistics, on selected performance outcomes, using financial, operational and environmental measures (Wu et al., 2012). Studies on green supply chain management have been carried out at different (Zhu et al., 2012). Simplified process of construction supply chain consist of five stages (UNEP, 2014) as illustrated in the figure below and explained:

Figure 2: Construction Supply Chain Process (Adapted: UNEP, 2014)

Concept definition: This is where the initial idea, scope and brief for a building is established and agreed.
Design: Translation of an initial idea for a building into a detailed design
Construction: Covering all on-site operations including a building is handed over to client. The procurement of materials and products is for reasons of simplicity, characterised as occurring in the construction stage. In practice, it can occur throughout the delivery and management process.
In – use: Covering the operation and maintenance of a building for the duration of its useful life. Divestment and leasing is for reasons of simplicity, characterised as occurring during in use stage. In practice it can occur throughout the delivery and management process
End of life- Signifies the point at which either a building is demolished or at which significant renovation occurs, but which is either case represent the end of the buildings useful life and prompts the building delivery and management process to restart.

2.2 Why construction firms needs to green the supply chain
Greening the supply chain can deliver important social and economic benefits that extend far beyond building and can contributes wider development goals (UNEP, 2014). UNEP –SBCI has previously reported that the construction sector typically provides 5-10% of employment at national level & typically accounts for employment at national level & typically accounts for 5-15% of the GDP (UNEP-SBCI, 2009). The construction, use and regeneration of buildings generate many social and economic benefits. By 2025, the volume of construction output is expected to reach an annual $15 trillion worldwide (Global Construction, 2013).

There are different reasons for firm to go ‘’green’’ in their supply chain. Some researches suggestes that some firms are simply going green because they feel it is the right thing to do for the environment(Wu et al, 2012). Proftability and cost reduction are some of the motivating factors for going green (Srivastava, 2007). Argues that reverse logistics were motivated primarily by economic factors and not concerns about protecting the eco-system. Zhu & Sarkis took this idea further and ergued that most of the 186 participants in their study all agreed rthat GSCM practices are only about win-win relating to environmental and economic performance (Zhu & Sarkis, 2004).

Thipparat stated that due to stricter regulations and increased community and consumer pressures, manufacturers need to effectively integrate environmental concerns into their regular practices and into their strategic planning agenda(Thiparrat, 2011). As a result, integrating environmental concerns into supply chain management has become increasingly important for contractors to gain and maintain competitive advantage. Construction company should be able to answer how green is supply chain is (Thiparrat, 2011) . This evaluation is essential for construction managers as it assists in achieving GSCM effectively.

Greening the building supply chain is seen as a necessary precondition for up-scaling delivery of green buildings and realising these opportunities on a commercially- viable and widespread basis. In its wider socio-economic context, greening the building supply chain has the potential to realise multiple environmental, social and economic opportunities, extending far beyond the walls of a green building itself. The transition to more resource efficient methods, materials and technologies can bring with it competitive advantage and permit new economies of scale for those businesses and territories that adapt fastest and most fully (Europe Commission). The new skills and organisational changes that will be required (UNEP, 2008), can create new jobs, stimulate economic growth and contribute to the emerging green and low-carbon economy.

There is a growing interest in going green or buying products and construction that are environmentally friendly meaning natural, sustainable, recyclable and more energy and water efficient (www.sbdcnet.org). Reasons for going green are:

- Increase in green construction is rating systems that give builders clear-cut methods to obtaim certification through the National Association of Home Builders (NAHB), Energy star and leadership in energy and environmental design.
- Growing concern about climate change as well as an interest in lowering monthly bills due to increased energy cost.
- Green is good, it is profitable, good for the environment, good for health and good for business.
- Takes an intelligent approach to energy
- Safeguards water resources
- Minimizes waste and maximizes re-use
- Promotes Health and well being
- Keeps lanscape green
- Creates resilent and flexible structures
- Considers all stages of a building's life cycle

3. The emperical research

In this sections the author presents the detailed greening construction and the driving forces or the benefits of green supply chain management in construction firms. To identify these driving force, a well structured questionnaire was administered to both public and private firms in Lagos. The questionnaires was mailed and also went in person to each of the companies selected in the sample. The questionnaire was divided into sections containing basic company information about the company and the focus of the research.

4. Findings and Discussions

The findings from the survey is presented below. The demographic information of the respondents are presented in Table 1 to Table 6.

Table 1: Type of Project

Variable Name	Variable Value		Frequency	Percent	Valid Percent	Cumulative Percent
Type of Project	Valid	Civil Engineering	21	60.0	67.7	67.7
		Building Construction	10	28.6	32.3	100.0
		Total	31	88.6	100.0	
	Missing	System	4	11.4		
	Total		35	100.0		

Table 1 illustrates the demographic information about the respondents of this study. From the Table, it could be seen that there are valid 35 respondents, though in some variables, there are some missing which means some of the respondents did not answer some of the questions. The results shows that the respondent are more into civil engineering compared to building construction.

Table 2: Years of Experience

Variable Name		Variable Value	Frequency	Percent	Valid Percent	Cumulative Percent
Years of Experience	Valid	2-4	6	17.1	19.4	19.4
		5-8	13	37.2	41.9	61.3
		9-11	6	17.1	19.4	80.7
		12-15	4	11.4	12.9	93.6
		16-18	1	2.9	3.2	96.8
		19-21	0	0		96.8
		22-24	1	2.9	3.2	100.0
		Total	31	88.6	100.0	
	Missing	System	4	11.4		
	Total		35	100.0		

For their years of work experience, the mean was estimated at 8 years, which represents the working experience of about 41.95% of valid respondents. Hence, with this average working experience, respondents are deemed experienced enough to supply reliable data for this study.

Table 3: Gender

Variable Name		Variable Value	Frequency	Percent	Valid Percent	Cumulative Percent
Gender	Valid	Male	21	60.0	60.0	60.0
		Female	14	40.0	40.0	100.0
		Total	35			

Table 3 shows that there are more male respondents compared to the females, thereby depicts the societal norm of more male engineers than female engineers.

Table 4: Accademic Qualification

Variable Name		Variable Value	Frequency	Percent	Valid Percent	Cumulative Percent
Academic Qualification	Valid	HND/BSC	27	77.1	77.1	77.1
		MSc	8	22.9	100.0	100.0
		Total	35			

Table 4 shows that majority of the respondents possess HND/BSc (77.1%) which revealed that the practicing Enginners in Lagos State posess basic knowldege and training on the field.

Table 5: Status in the Organization

Variable Name		Variable Value	Frequency	Percent	Valid Percent	Cumulative Percent
Status in the Organization	Valid	Managing Partner/Director	2	5.7	5.7	5.7
		Construction/ Project Manager	23	65.7	82.1	87.3
		Environmental/ Supply Manager	3	8.6	10.7	100.0
		Total	28	80.0	100.0	
		Missing	7	20.0		
Total			35	100.0		

Table 5 revealed that the majority of the respondents are consrtuction/project managers,while there are few environmental/supply manager which explained and butress that Supply chain management is new in Lagos state construction firms. Therefore H1 was accepted that Green Supply Chain Management is new in Lagos State Construction firms.

Section B (Research focus) is presented in Table 6 and Figure 3

Table 6: Benefits of Geen supply chain management

		No effect	Minor effect	Neutral	Moderate effect	Major effect	Total
Positive impact on financial performance.	Count	1	6	2	11	8	28
	%	3.6%	21.4%	7.1%	39.3%	28.6%	100.0%
Improved sustainability of resources	Count	1	3	6	5	13	28
	%	3.6%	10.7%	21.4%	17.9%	46.4%	100.0%
Improved sustainability of resources	Count	1	4	3	7	12	27
	%	3.7%	14.8%	11.1%	25.9%	44.4%	100.0%
Increased efficiency.	Count	2	2	3	14	6	27
	%	7.4%	7.4%	11.1%	51.9%	22.2%	100.0%
Improved product differentiation.	Count	1	4	7	10	6	28
	%	3.6%	14.3%	25.0%	35.7%	21.4%	100.0%
Improved product competition.	Count	3	5	3	11	6	28
	%	10.7%	17.9%	10.7%	39.3%	21.4%	100.0%
Stronger adherence to regulations.	Count	1	7	6	7	7	28
	%	3.6%	25.0%	21.4%	25.0%	25.0%	100.0%
Reduction in risks.	Count	2	5	6	7	8	28
	%	7.1%	17.9%	21.4%	25.0%	28.6%	100.0%
Improved quality of products.	Count	1	4	6	5	11	27
	%	3.7%	14.8%	22.2%	18.5%	40.7%	100.0%

Out of 28 respondents, 13 being the 44.4% of the respondent agreed that improved sustainability of resources is a major benefit of green supply chain management in Nigeria, 11 respondents being 40.7% agreed is improved quality of products, 8 respondents (28.6%) indicated positive impact on financial performance and reduction in risks as a major benefit, 7 respondents (25.0%) indicated stronger adherence to regulations while 6 respondents (21.4%) indicated increase efficiency, improve product differentiation and improve product competition as a major benefit of green supply chain management in Nigeria.

Alvarez Gil et al. indicated that GSCM has a positive relationship with an organization's economic performance (Alverez, 2001). Aslinda et al. said in their research that there is a greater benefit of the green technology adoption in the business operations which also affected suppliers and customers (Aslinda, 2012). Kumar & Chanaraka also pointed out in their research that GSCM practices improve both economic and environmental performance (Kumar & Chandrakar, 2012).

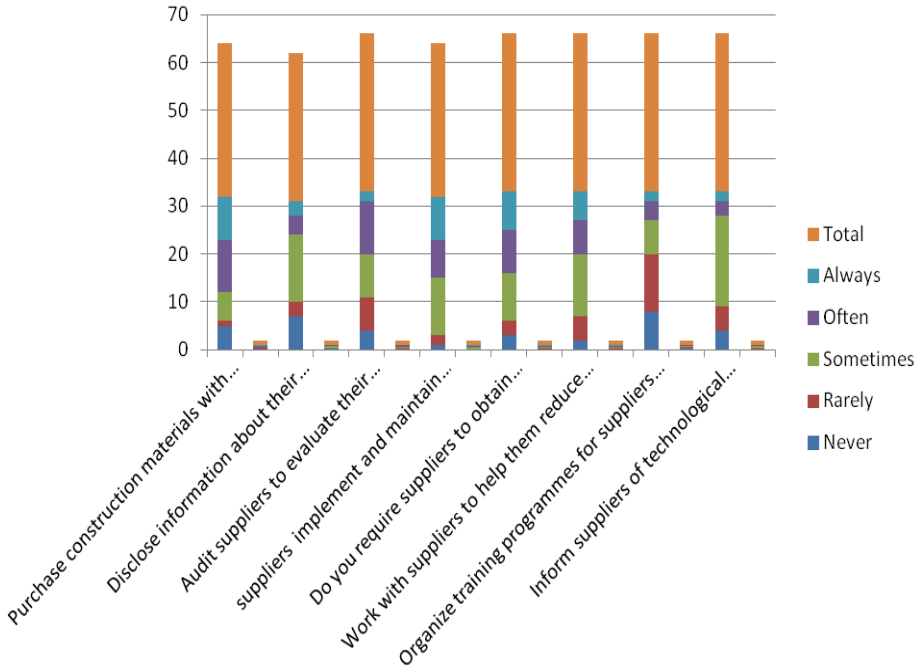

Figure 3: GSCM Practice

Out of the 35 respondents, 33 responded to this question and it was found that they sometimes engaged in the GSCM practice. The figure shows that construction firms in Lagos State expect the suppliers to be environmentally compliance and certified to a recognized body like ISO 141, but they are not investing in ensuring the compliance. The result answers the research question that environmental regulations have a significant impact on adopting Green Supply Chain management practices in Lagos Nigeria. Zelani et al, 2012 results proved that GSCM practices have a positive effect on sustainable supply chain performance particularly from the economic and social perspective. Zhu indicated that GSCM practices improve both their economic and environmental performance (Zhu & Sarkis, 2006).

5. Conclusion

The concept of Green Supply Chain Management is becoming popular, profitable and competitive day by day. The literatures present many findings regarding the need to green the construction; it improves the economic and environmental performance of an industry.

From the findings, construction firms in Nigeria are aware of the benefits of green supply chain management in construction. Also they are aware that suppliers need to be environmentally compliance and certified to a recognized body like ISO 141. It can be concluded that the problem, Nigerian construction firms are facing are not issue of making law, rather it is implementation problem. Proactive industries usually have greater implementation of environmental practices beyond requirements of laws and regulations, while reactive industries only seek compliance with regulatory requirements. Government, regulation bodies like professional body must rise up to their duties and ensure implementation of law. This study provided a valid reason to green the construction industry and ample reason for Nigerian construction industry to adopt GSCM.

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References

Alvarez Gil, M.J., Jimenez, J.B. and Lorente, J.C. ‘‘An analysis of environmental Management, organizational context and performance of Spanish hotels’’, Omega, Vol. 29 No. 6, pp. 457-71. 2001

Aslinda, A., Norhayati, Z., Ahmad, J., & Mohd, S. Green Supply Chain Management: A review and Research Direction. International Journal of Managing Value and Supply Chains (IJMVSC) Vol.3 No 1 March, 2012.

Eurpean Commission, Analysis associated with the roadmap to a resources efficient Europe part 1. Commission staff working paper to accompany the roadmap to a resource efficient europe brussels. Europe Commission.2011

Global Construction perspectives and Oxford Economics, 2013. Global Construction 2025.

Green Jr K.W., Zelbst P.J., Meacham J., and Bhadauria V.S.,"Green supply chain management practices: impact on performance", Supply Chain Management: An International Journal, Vol. 17 Iss: 3 pp. 290 – 305.2012

Hill, R.C and Bowen, P.A. (1997). Sustainable Construction, Principles and Framework for Attainment, *Construction Management and Economics*, 15, 223-239.

Kumar, R and Chandrakar R.: Overview of Green Supply Chain Management: Operation & Environmental Impact at Different stages of the supply chain, International Journal of Engineering AND Advanced Technology (IJEAT) ISSN: 2249-8958, Vol 1, Issue 3, February, 2012.

Monique De Vries, (Undated), Green Construction, Articles from SBDCNet-SBDC Clearing house, www.sbdcnet.org accessd Nov, 20, 2014.

Ojo, E., Mbohwa, C.and Akinlabi E.T, Benefits of green supply chain management in construction firms – a review, 2nd Nelson Mandela Metropolitan University, Construction management conference, 2012.

Ojo, E., Mbohwa, C. and Akinlabi E.T, Sustainable supply chain management in construction firms, *In:* Laryea, S. and Agyepong, S. (Eds) *Procs 5th West Africa Built Environment Research (WABER) Conference*, 12-14 August 2013, Accra, Ghana, 1077-1086.

Othman Ayman Ahmed Ezzat, Wallis Ian et al Industrialised, Integrated, Intelligent sustainable construction. UK: I3CON & BSRIA. 2010

Shi V.G. and Lenny Koh S.C., Baldwin J. and Cucchiella F. (2012) Natural Resource Based Green Supply Chain Management. Supply Chain Management: An International Journal Volume 17 No 1 pp 54-67, 2012.

Strivastava, S. (2007). Green Supply state of the art literature review. International Journal of management review 9 (1), 53-80.

Thipparat T. (2011) Evaluation of Construction Green Supply Chain Management. International Conference on Innovation, Management and Service IPEDR vol 14(2011).

UNEP, 2014. Greening the Building Supply chain.

UNEP, 2008. Green jobs: Towards decent work in sustainable; low carbon world.

UNEP-SBCI, 2009. Buildings & Climate Change.

Wu, G.C., Cheng, Y.H &Huang, S.Y. ''The study of knowledge transfer and green management'', African journal of business management vol.4 (1), pp. 044-048, 2010

Wu J. Dunn S. and Forman H.: A Study on Green Supply Chain Management Practices among Large Global Corporations. Journal of Supply Chain and Operations Management, Volume 10, Number 1, February 2012.

Xiao, T.G. Yu.Xiao, Supply disruption chain management and evolutionarily stable strategies of retailer in the quantity-setting duoploy situation with homogeneous goods. European journal oof operational Research, 173(2), 648-668.2005

Xiao X. Green Supply Chain Management in the UK and China Construction Industry. A master's degree thesis submitted at School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ. 2006

Zailani, S., Jeyaraman, K., Vengadasan, G. and Premkumar, R. (2012) Sustainable supply chain Management (SSCM) in Malaysia: A survey. *International Journal of ProductionEconomics*, Vol. 140, 330-340.

Zhu, Q. H., Sarkis, J. and Lai, K. H. Environmental management innovation diffusion and its relationships to organizational improvement: an ecological modernization perspective, Journal of Engineering and Technology Management, 29 (1), pp. 168-185. 2012

Zhu, Q & Sarkis, J. Relationship between operational practices and performance among early adopters of Green Supply chain Management practices in Chinese manufacturing enterprises, operational management, 22, 265-289.2004

Zhu Q, Sarkis J. An inter-sectoral comparison of green supply chain management in China: Drivers and practices. J. Clean. Prod., 14: 472–486. 2006

Biogrpahy

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